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REAL EFFECTIVE EXCHANGE RATE OF INDIA: PATTERNS AND DETERMINANTS

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ABSTRACT

In this paper, author endeavors to establish the patterns and trends of Real Effective Exchange Rate of India during 1970-2015 and tries to show the determinants of REER e.g., growth rate, current account deficit as percent of GDP, percent of openness, foreign direct investment inflows, and foreign exchange reserves excluding gold. The author used semi-log, double log linear and exponential model, autoregression, ARIMA, GARCH models for trends and volatility. Bai and Perron (2003) model was applied to show structural breaks and Hodrick and Prescott (1997) model was applied for smoothness of cyclical trend. Johansen (1988, 1991, 1996) models were used to fit co-integration test and vector error corrections. Residual tests were done to verify autocorrelations, normality and impulse response functions were found to show stability and convergence.

The paper concludes that REER has been declining at the rate of 0.4085 percent per year which is insignificant at 5% level during 1970-2015 but it is exponentially declining at the rate of 0.2028 percent which is significant. AR (1) of REER is convergent, stationary and significant but AR (2) is convergent, non-stationary and insignificant. Even ARIMA (1,1,1) is non-stationary because AR (1) is stationary but MA (1) is non-stationary. GARCH(1,1) showed insignificant. Thus the series REER is highly volatile. This series contains five significant structural breaks in 1976, 1986, 1992, (downward) 2004 and 2010 (upward). Its pattern is cyclical which was turned to smooth cycle. Trace statistic showed three cointegrating vectors and Max-Eigen Statistic showed two cointegrating vectors that verify cointegration in the order one. Vector Error Correction model is stable because all roots lie in the unit root circle but it is non-stationary because impulse response functions are diverging and error corrections are significant only in degree of openness and FDI inflows in relating REER during 1970-2015 with one period lag. Residuals test of VECM confirmed non normality and autocorrelations.

Only sound fiscal and monetary policy can control upward movement of REER so that significant relationships can be achieved with those selected determinants that would spur the growth of international trade.

Keywords: Real Effective Exchange Rate, Stationary, Structural Breaks, Causality, Co-integration, Vector Error Correction

INTRODUCTION

Real Effective Exchange Rate is an important tool in managing international trade and finance and macroeconomic stability in an open economy. It influenced export and import prices and trade volumes. Appreciation and depreciation of REER determined terms of trade, openness, foreign exchange reserves of an economy to a great extent. FDI inflows and current account balance are largely depend on the REER because in the liberalized and globalised world the adjustment in balance of payments is largely correlated with the movement of REER. The REER is closely related with the nominal and real rate by definition when it is trade weighted or export weighted with group of countries. Exchange rate policy whether it is nominal or real controls national inflation and influenced international inflation in which interest rate differential is the crucial and key variable. Today, under globalization REER is closely related with the growth rate also since volatility of REER is the barrier of high growth in which volume of trade matters. According to Balassa-Samuelson effect, volatility of REER influences export competitiveness and productivity. In calculating REER based with export or trade weighted 36 countries, RBI did not consider productivity. Even, India has not long run data on REER and NEER. However, India could not predict well the nature of capital account convertibility, the productivity changes and terms of trade changes in relation to REER. Therefore, the task before RBI is crucial because policy of exchange rate is also related with monetary and fiscal policies as well.

(A) Objective of the study

This paper endeavors to study the behavioral patterns of REER and its determinants in India during 1970-

2015 where the author assumed that the basic determinants of REER are growth rate, current account deficit as percent of GDP, openness of the economy, foreign direct investment inflows, foreign exchange reserves excluding gold and so on. The relations were calculated through cointegration and vector error correction models. The policies of REER and limitations of the paper are also the aims of this study.

(B) Methodology and Data

Semi-log and double-log regression models have been used for trends and relations and exponential model was used also for goodness of fit. AR(1), AR(2), ARIMA(1,1,1) and GARCH(1,1) models were applied to show autoregression, stationary and volatility analysis. Bai-Perron (2003) model was applied to find structural breaks. Granger model (1969) was used to get causality. Hodrick-Prescott Filter model (1997) was used to find smoothness of cycles which allows to manage the exchange rate volatility. Johansen models (1988, 1991, 1996) were applied for cointegration and vector error correction analysis. Moreover, residual tests of VECM were also done for autocorrelation and normality. The data of REER, growth rate, current account deficit, openness, FDI inflows, foreign exchange reserves during 1970-2015 have been collected from RBI, World Bank and International Financial Statistics (IMF).

LITERATURE REVIEW

Muhammad Tahir Khan (2013) found causality and cointegration between REER and foreign exchange reserves of Pakistan during 1983-2009. Davide Romethi, Cristina Terra and Enrico Vasconcelos (2014) verified the improvement in current account and trade balances which are accompanied by a smaller real exchange rate depreciation in more open economies during 1970-2011. Thomas Munthali, Kisusimwaka and MacDonald Murale (2010) showed that volatility of REER has adverse effect on growth in Malawi during 1970-2007 i.e., REER depreciation has insignificant effect on economic growth in the long run. Enisse Kharroubi (2011) verified that the changes in real exchange rate depreciation improved the US trade deficit than reducing Chinese trade surplus during 1985-2008. Giancarlo Gandolfo and Giulio Nicoletti (2002) showed by Geweke's measure that there is causality between REER volatility and openness in Finland, France and Japan and also in 10 OECD countries during 1975-1998. Harald Hau (2002) confirmed that more openness leads to less real exchange rate movements i.e. negative relationship between REER volatility and openness during 1980-1998 in cross section data of 48 countries including OECD countries. Mehmet E.Yaya and Xiaoxia Lu (2012) showed in China during 1994-2009 that there is unidirectional causality between REER and trade balance, i.e., trade balance causes a change in REER. Papaioannou and Portes (2008) found that volatility of REER is negatively related with growth in OECD countries during 1970-2009. Maurizio Michael Habib, Elitza Mileva and Livio Stracca (2016) found REER appreciation led to reduce real GDP growth rate significantly in 150 countries panel data in post Bretton Woods period 1970-2010. Mona Haddad, James Jerome Lim, Cosimo Pancaro and Christian Saborowski (2013) verified that trade openness reduces growth volatility during 1976-2005 in 77 developing and developed economies employing GMM regressions. Tran Phuc Nguyen and Duc-Tho Nguyen (2010) found that Vietnam adopted adjustable peg exchange rate regime which acted as a retardant to the development of the country's forex market during 1992-2008 where NEER and REER lost competitiveness. Mohammad Yusoff and Ilza Febrina(2012) showed that there is a long run relationship among growth, trade openness and REER in Indonesia using cointegration and Granger causality tests during 1967-1997.

(A) Econometric observations

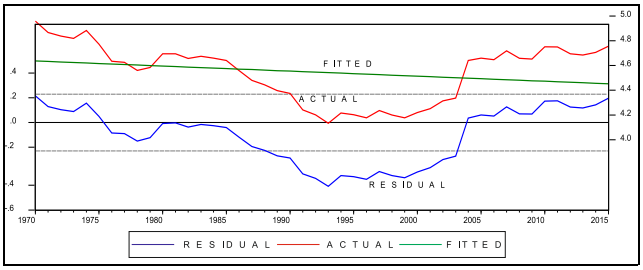
In India, REER has been declining at the rate of 0.4085 percent per year during 1970-2015 which is insignificant at 5% level.

$$\text{Log}(y) = 4.6050 - 0.004085t$$
$$(67.13)^{*}\ (-1.60)$$

R^2=0.055, F= 2.58, DW= 0.10, y= REER,*= significant at 5% level, t= year

In Figure 1,the fitted line is shown downward sloping from left to right.

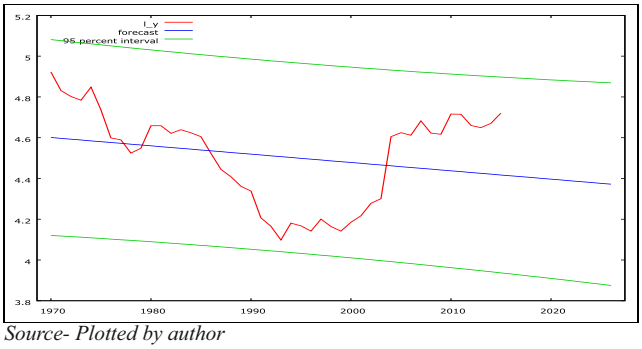
Figure 1: Linear fitted trendline



Source- Computed by author

The forecast for 2026 is plotted below where log(y) in 2026=4.372 and the forecast trend line is downward sloping.

Figure 2: Forecast linear model



Source- Plotted by author

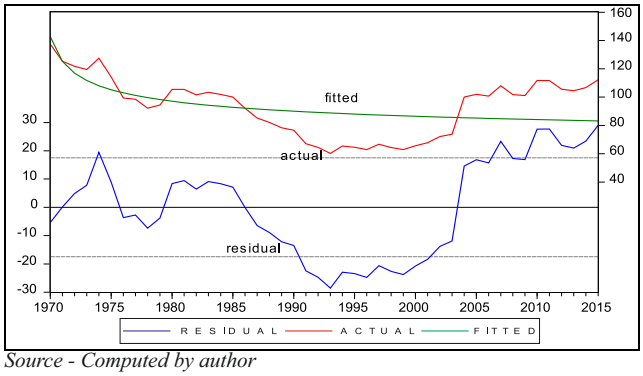
But, REER has been declining exponentially at the rate of 0.2028 percent per year which is significant at 5% level.

$$y = e^{3.961+t^{-0.2028}}$$

R^2= 0.3026, DW= 0.1461, *t* values of 3.961 and -0.2028 are 41.82 and -3.22 which are significant at 5% level.

In Figure-3 the fitted exponential curve which is downward is shown below:

Figure 3: Fitted Exponential REER



Source - Computed by author

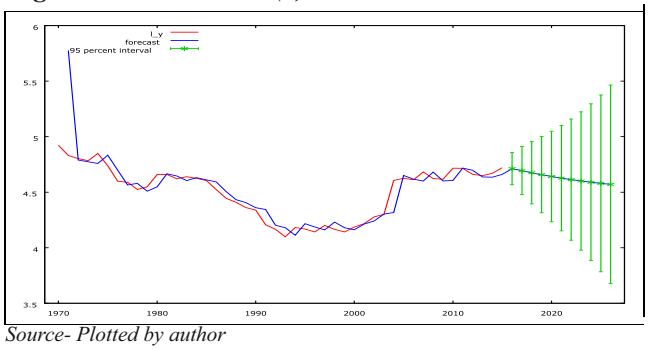
AR(1) process of REER is stationary and significant but AR(2) process is insignificant, therefore the whole process is non-stationary. The estimated equation is shown below:

$\log Y_t$= 4.642832+1.136434$\log Y_{t-1}$-0.185203$\log Y_{t-2}$+0.005071σ_t^2
(25.92)* (5.14)* (-0.82) (5.71)*

R^2= 0.904, F= 132.41*, DW= 2.03, AR roots= 0.94 and 0.20 ,*= significant at 5% level.

AR (1) forecast model for 2026 is significant, stationary and stable which is plotted below:

Figure 4: Forecast AR(1)



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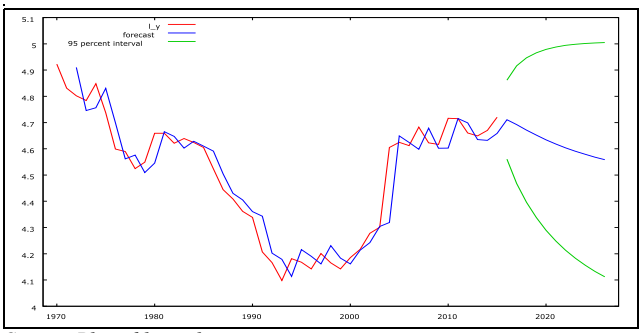
AR (2) forecast model for 2026 is predicted declining trend but it is non-stationary which is shown in Fig 5.

Figure 5: AR(2) forecast model



Source- Plotted by author

ARIMA (1,1,1) model showed non-stationary because AR (1) is significant, stationary and convergent but MA(1) is insignificant, convergent and non-stationary. It is also a stable model.

logYt= 4.64746+0.944167logYt-1+εt+0.185613εt-1+0.005086σt2
(25.229)* (15.88)* (0.86) (6.28)*

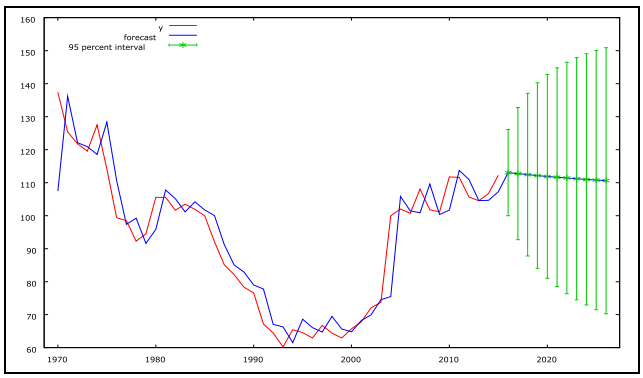
R2= 0.904, F= 131.99*, DW= 2.0, AR root= 0.94, MA root= -0.19

This non-stationary REER is fitted in the forecast ARIMA (1,1,1) model for 2026 which is tending towards stationary where coefficient of AR (1) is significant and stationary but MA (1) is not significant at 5% level showing declining REER to 110.60 in 2026 which is plotted in Figure 6 below.

Yt= 107.445+0.9442Yt-1+εt+0.2199εt-1
(6.05)* (19.85)* (0.216)

AIC= 315.61, SC= 322.93, *= significant z statistic at 5% level, AR root= 1.05, MA root= 4.54. It is unstable.

Figure 6: ARIMA forecast model



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GARCH (1,1) model is insignificant since the z statistic for all coefficients are insignificant which showed that REER is highly volatile in nature.

h_t= 1.38469+1.073161ε_{t-1}^2-0.141678h_{t-1}

(0.00063) (0.0023) (-0.00029)

R^2= -383.36, AIC= 5.97, SC= 6.09, DW= 0.00025

India's REER during 1970-2015 showed five structural breaks in 1976, 1986, 1992, 2004 and 2010 which are computed by Bai-Perron (2003) test which was found significant at 5% level and sequential F statistic of break test are significant for those five breaks. HAC standard errors and covariance (Bartlett Kernel, Newey-West fixed bandwidth = 3.0, Trimming 0.15) technique was applied. The estimated values are arranged in Table 1.

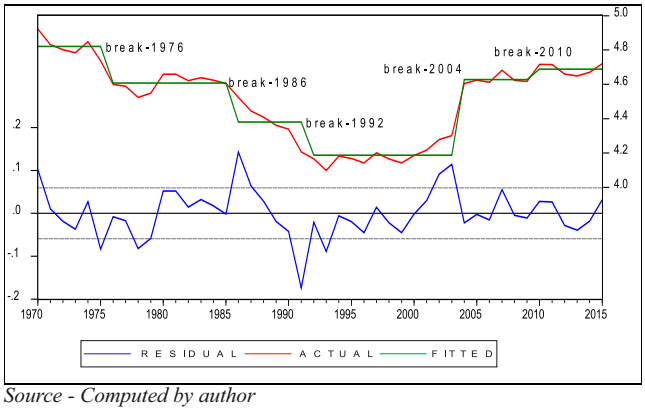
Table 1: Structural breaks

Variable	Coefficient	Std. Error	t-Statistic**	Prob.
		1970 - 1975 -- 6 obs		
C	4.820906	0.023066	209.0075	0.0000
		1976 - 1985 -- 10 obs		
C	4.6069	0.01682	273.859	0.0000
		1986 - 1991 -- 6 obs		
C	4.38048	0.05216	83.969	0.0000
		1992 - 2003 -- 12 obs		
C	4.18706	0.02285	183.1996	0.0000
		2004-2009,6 obs		
C	4.627285	0.007236	639.4919	0.000
		2010-2015,..6obs		
C	4.688499	0.010132	462.7528	0.000
		R^2=0.94,F=131.60*,	DW=1.30	

** Significant at the 0.05 level, ** Bai-Perron (Econometric Journal, 2003) critical values.*

In Figure 7, the structural breaks of REER of India during 1970-2015 are clearly shown year wise both downwards and upwards.

Figure 7: Structural breaks of REER



Source - Computed by author

The variance ratio test of REER showed that z statistic values of each variance ratio are significant when REER is a martingale and even maximum z values of joint test is significant, thus REER follows random walk hypothesis since martingale of null hypothesis is significant. In Table 2, the values of variance ratios are given.

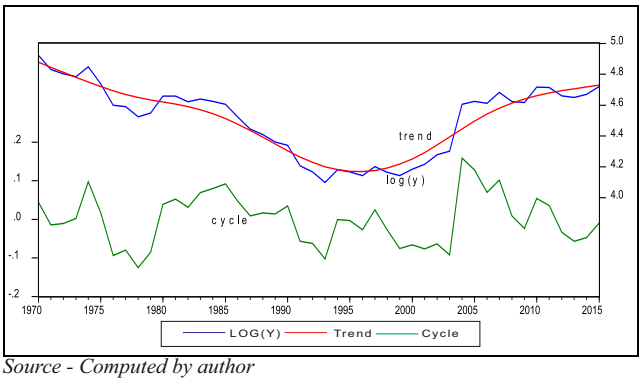
Table 2: Variance ratio test (Lag specified as grid; min=2, max=16, step-1), Null Hypothesis, Log(y) is a martingale

Joint test	Value	df	prob	
Max|z| (at period 12)	4.6222	45	0.0001	
Individual test				
period	Var ratio	Standard error	Z statistic	Prob
2	1.195	0.096	2.0203	0.04
3	1.341	0.151	2.246	0.02
4	1.569	0.200	2.847	0.00
5	1.779	0.243	3.202	0.00
6	1.972	0.28	3.463	0.00
7	2.137	0.314	3.616	0.00
8	2.329	0.345	3.845	0.00
9	2.464	0.399	3.913	0.00
10	2.092	0.422	3.984	0.00
11	2.827	0.444	4.323	0.00
12	3.054	0.465	4.622	0.00
13	3.139	0.485	4.599	0.00
14	3.210	0.504	4.556	0.00
15	3.255	0.522	4.422	0.00
16	3.299		4.397	0.00

Source - Computed by author

The Hodrick-Prescott Filter model turned the cyclical fitted path of REER of India from 1970 to 2015 into the smooth non-linear curve in which the adjustment of the sensibility of the trend to short term fluctuations is achieved by modifying a multiplier λ=100 where Baxter-King fixed length symmetric filter was operated. It is seen in Figure 8 below:

Figure 8: Smooth REER curve



Source - Computed by author

The Granger's causality test (1969) confirmed that REER has bidirectional causality with growth rate, current account balance, FDI inflows but it has unidirectional causality with openness and foreign exchange reserves. In Table 3, the values are given.

Table 3: Granger's Causality Test

Null Hypothesis	0bs	F statistic	Prob
Y does not Granger cause x_1	45	10.1515	00.28
X_1 does not Granger cause y		00.09126	00.76
Y does not Granger cause x_2	45	10.2715	00.26
X_2 does not Granger cause y		10.2510	00.26
Y does not Granger cause x_3	45	00.4982	00.48
X_3 does not Granger cause y		40.6070	00.03
Y does not Granger cause x_4	42	00.8208	00.37
X_4 does not Granger cause y		20.6492	00.11
Y does not Granger cause x_5	45	10.0870	00.30
X_5does not Granger cause y		70.5366	00.0089

Source - Computed by author

The depreciation of REER leads to increase in growth rate, FDI inflows and foreign exchange reserves where FDI inflows is significant, others are insignificant during the study period 1970-2015 in India. On the other hand, the more the appreciation of REER the more is the current account deficit and the more is the openness of the economy which are insignificant.

The above results are estimated in the following equations:

$$\text{Log(y)=Log(y)=3.9627860.01559log(x1)+0.014002log(x2)}$$
$$\text{(13.7)* (-0.46) (1.049)}$$
$$\text{+0.387001log(x3)-0.057512log(x4)- 0.0257log(x5)}$$
$$\text{(1.49) (-2.147)* (0.73)}$$

R^2= 0.13, DW= 0.28, F= 1.20 ,*= significant at 5% level,x_1= growth rate of GDP percent per year, x_2= current account deficit per cent of GDP, x_3= degree of openness per cent, x_4= FDI inflows million dollars, x_5= foreign exchange reserves million dollars excluding gold.

Johansen unrestricted cointegration rank test among REER, growth rate, current account deficit, trade openness, FDI inflows and foreign exchange reserves assured that Trace Statistic contains three cointegrating equations and Max Eigen Statistic contains two cointegrating equations which determined that they are cointegrated in the order one. In Table 4, it is shown.

Table 4: Cointegration

Hypothesized no. of CEs	Eigen value	Trace Statistic	0.05 critical value	Prob**
None*	0.83126	157.294	95.7536	0.00
At most 1*	0.5721	84.3368	69.8188	0.0023
At most2*	0.41276	48.8458	47.856	0.040
At most3	0.34528	27.0205	29.797	0.10
At most4	0.18656	9.65505	15.4947	0.30
At most5	0.02858	1.18898	3.8414	0.23
		Max Eigen Statistic		
None*	0.83126	72.9575	40.0775	0.00
At most 1*	0.5721	35.49099	33.8768	0.03
At most2	0.41276	21.8253	27.5843	0.22
At most3	0.34528	17.36547	21.1316	0.15
At most4	0.18656	8.46606	14.2646	0.33
At most5	0.02858	1.188989	3.841427	0.27

= rejection of the hypothesis at 0.05% level,= Mackinnon-Haug-Michelis (1999) p value*
Source- Computed by author

Since there is cointegration among the variables, therefore, we have to find out the process of vector error correction which is estimated below:

$$\Delta y_t = -0.22801 - 0.00177\Delta y_{t-1} - 0.283\Delta X_{1t-1}$$
$$\text{(-0.142) (-0.009) (-0.87)}$$
$$+0.0373\Delta x_{2t-1} - 0.0869\Delta x_{3t-1} - 9.92E\text{-}05x_{4t-1}$$
$$\text{(-0.024) (-0.15) (-0.418)}$$
$$+7.43E\text{-}06\Delta x_{5t-1} - 0.0608EC$$
$$\text{(0.045) (-1.15)}$$

Δx_{1t}=-0.6060-0.05825Δy_{t-1}-0.576ΔX_{1t-1}+

(-0.81) (-0.70) (-3.88)*

0.438Δx_{2t-1}-0.0244Δx_{3t-1}-0.000109x_{4t-1}

(0.612) (-0.091) (-0.99)

+0.00014Δx_{5t-1}+0.0402EC

(1.87) (1.65)

Δx_{2t}=0.248+0.0424Δy_{t-1}-0.0178ΔX_{1t-1}

(1.32) (2.01)* (-0.47)

-0.174Δx_{2t-1}-0.0623Δx_{3t-1}+4.65E-05x_{4t-1}

(-0.96) (-0.92) (1.67)

-2.83E-05Δx_{5t-1}-0.0098EC

(-1.48) (-1.60)

Δx_{3t}=2.038+0.0514Δy_{t-1}+0.097ΔX_{1t-1}

(4.74)* (1.06) (1.125)

-0.199Δx_{2t-1}+0.2105Δx_{3t-1}-0.00011x_{4t-1}

(-0.47) (1.35) (-1.88)

-0.00018Δx_{5t-1}-0.069EC

(-4.26)* (-4.88)*

Δx_{4t}=3996.08-11.782Δy_{t-1}-45.507ΔX_{1t-1}

(3.62)* (-0.095) (-0.205)

+498.757Δx_{2t-1}-6.132Δx_{3t-1}+0.0366x_{4t-1}

(0.46) (-0.015) (0.22)

-0.44Δx_{5t-1}-188.813EC

(-3.93)* (-5.2)*

Δx_{5t}=8201.79-95.188Δy_{t-1}+90.72ΔX_{1t-1}

(1.97) (-0.20) (0.109)

-6377.93Δx_{2t-1}-705.56Δx_{3t-1}+0.522x_{4t-1}

(-1.58) (-0.47) (0.83)

+0.0524Δx_{5t-1}-128.159EC

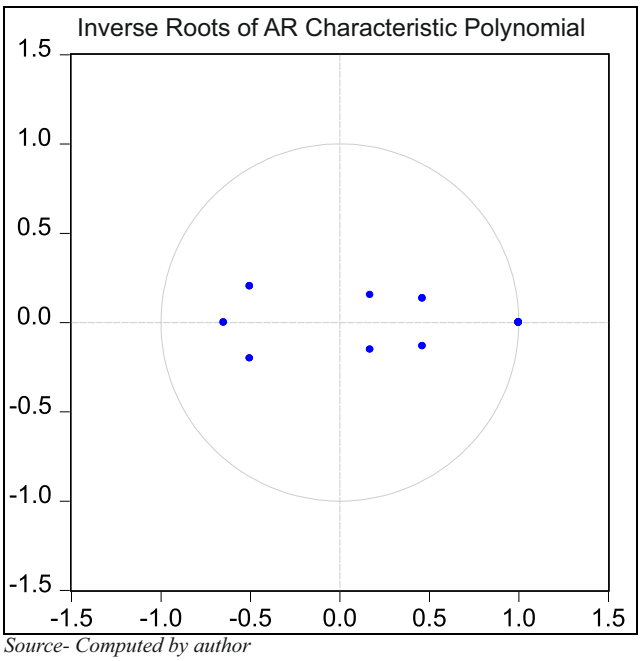
(0.12) (-0.93)

R^2= 0.35, F= 2.63, AIC= 22.48, SC= 22.82,

All the estimated equations of VECM are not good fit except Δx3t and Δx4t where error correction processes are significant and even the changes of variables are not related with previous period significantly.

But, this VECM is stable because all the roots lie in the unit circle where five roots are unity and others are less than one and imaginary.(1,1,1,1,1,-0.648,-0.5027±0.203178i,0.4625±0.134242i, 0.170106±0.152601i)

Figure 9: Unit circle



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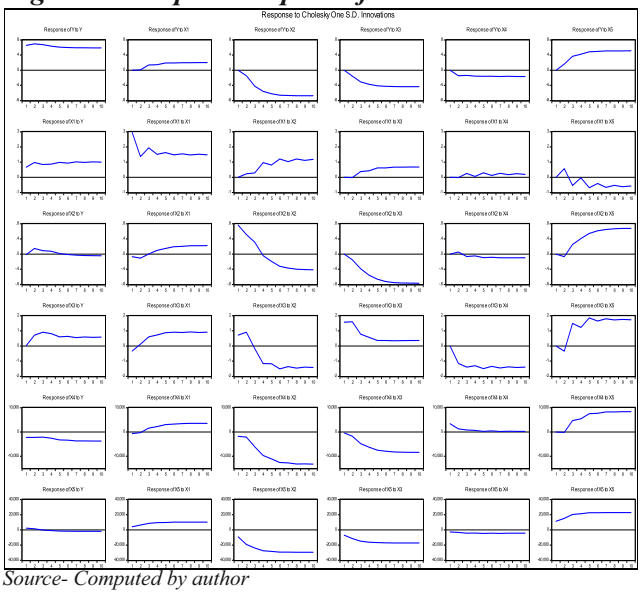
But, any external shock in the vector error correction process turns the system into non-stationary and divergent which are clearly visible in the impulse response functions.

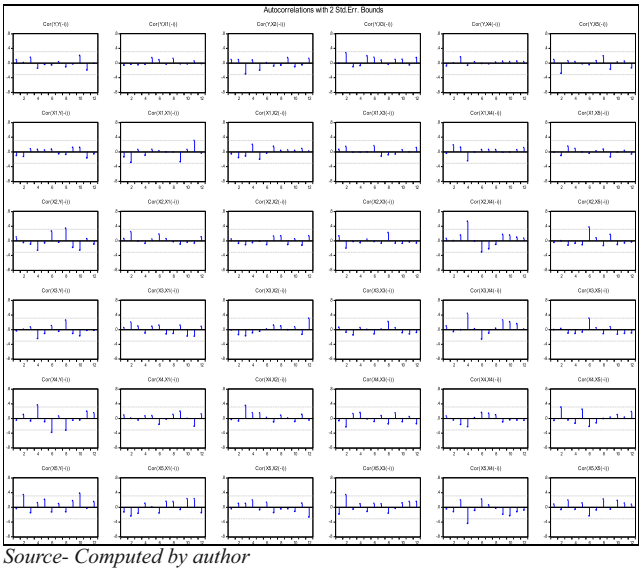
Figure 10: Impulse response functions



Source- Computed by author

The residual test of the VECM states that there are problems of autocorrelations which are seen in the Fig 11.

Figure 11: Residual test for autocorrelations



Source- Computed by author

VEC residual normality test of the Doornik-Hansen method showed that most of the components of the skewness, Kurtosis and Jarque Bera are insignificant although their joint components are significant, however the test is rejected for normality. The values are given in the Table 5.

Table 5: Normality test

Component	Skewness	Chi-square	df	prob
1	0.7618	4.383	1	0.036
2	-0.099	0.087	1	0.767
3	-0.1977	0.34	1	0.559
4	0.052	0.0239	1	0.877
5	-1.1467	8.610	1	0.00
6	0.91191	5.953	1	0.014
joint		13.399	6	0.0035
Component	Kurtosis	Chi-square	df	prob
1	4.504	1.738	1	0.18
2	2.874	0.318	1	0.57
3	2.342	0.420	1	0.51
4	3.296	1.723	1	0.18
5	5.993	1.654	1	0.19
6	6.404	8.925	1	0.00
joint		14.779	6	0.02
Component	Jarque-Bera		df	prob
1	6.121		2	0.04
2	0.406		2	0.81
3	0.760		2	0.68
4	1.746		2	0.41
5	10.264		2	0.00
6	14.878		2	0.00
joint	34.178		12	0.00

Source- Computed by author

(B) Limitations and future scope

Comparative study can be done between pre-reform and post-reform periods. The study would be explained in different exchange rate regimes in India. Even, NEER can be included in this analysis for further studies. Growth and volatility of NEER and REER in India are to be compared with Euro Area and other developed countries.

Terms of trade is excluded in this study because India's TOT is extremely volatile consisting of both positive and negative frequently. Even, the productivity is excluded since RBI has not taken into account productivity measures in REER and NEER. Moreover, fiscal deficit and interest rate differentials are also excluded in this model.

(C) Consideration of some policies

Appreciation of REER is a loss of export, therefore, it is necessary to reduce inflation, to rise foreign exchange reserves, to increase trade surplus and to rise productivity which will lower cost that may decrease price level and REER. According to Balassa-Samuelson effect, if a county's price index rise relative to international price level then REER will rise. Then, adopt policy of TOT in favour, lower fiscal deficit and allow low tariff. More the protection the less is the REER volatility, so avoid capital account liberalization. Again, the higher the foreign exchange reserves the lower is the commodity TOT shock to REER which tends to lower volatility of REER. In case of high debt, it is difficult to apply fiscal policy to affect commodity TOT shock into the economy. So, financial integration economies will face less volatility of REER. RBI is trying to resist volatility of REER and formulates (i) to develop skill in dealing with spot and forward market, (ii) to compete with FED rate by reducing interest rate, (iii) to increase in outflow of portfolio which will call for new exchange rate and monetary policy, (iv) to

allow alternative exchange rate policy to check appreciation of REER which enhance capital inflows, (v) to monitor excessive exchange rate depreciation which follows loss of foreign exchange reserves during macro economic shocks, (vi) thus former RBI governor Dr. R.Rajan said that India needs macroeconomic stability.

CONCLUSION

The paper concludes that REER of India during 1970-2015 is significantly decreasing exponentially at the rate of 0.2028% per year. AR (1) is stationary but AR (2), ARIMA (1,1,1) are non stationary, GARCH (1,1) is extremely volatile. REER has five structural breaks in 1976, 1986, 1992, 2004 and 2010, it follows random walk, REER has bidirectional causality with growth rate, current account balance, FDI inflows but unidirectional causality with openness and foreign exchange reserves.

The paper also concludes that Johansen unrestricted cointegration rank test among REER, growth rate, current account deficit, trade openness, FDI inflows and foreign exchange reserves assured that Trace Statistic contains three cointegrating equations and Max Eigen Statistic contains two cointegrating equations which determined that they are cointegrated in the order one. All the estimated equations of VECM are not good fit except Δx_{3t} and Δx_{4t} where error correction processes are significant and even the changes of variables are not related with previous period significantly.

The paper also stated that RBI is trying to resist volatility of REER and formulates (i) to develop skill in dealing spot and forward market, (ii) to compete with FED rate by reducing interest rate, (iii) to increase in outflow of portfolio, (iv) to allow alternative exchange rate policy to check appreciation of REER which enhance capital inflows, (v) to monitor excessive exchange rate depreciation respectively.

REFERENCE

Gandolfo, G. & Nicoletti, G. (2002). Exchange rate volatility and economic openness: A causal relation? *Working Papers 68, Sapienza University of Rome, CIDEI.*

Granger, C.W.J. (1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods, *Econometrica*, 37(3), pp 424 - 438.

Habib, M.M., Elitza, M. & Stracca, L. (2016). The Real Exchange Rate and Economic Growth: Revisiting the case using external instruments, ECB Working Paper Series 1921.

Haddad, M.E., Lim, J.J. & Christian, S. (2013). Trade openness reduces growth volatility when countries are well diversified. *Canadian Journal of Economics, Canadian Economics Association*, 46(2), pp 765-790.

Hau, H. (2002). Real Exchange Rate Volatility and Economic Openness: Theory and Evidence, *Journal of Money*, Credit, and Banking, 34(3), pp 1-22.

Hodrick, R.J. & Prescott, E.C. (1997). Post War US Business Cycles: An Empirical Investigation, *Journal of Money, Credit and Banking*, 29(1), pp 1-16

Johansen, S. (1988). Statistical Analysis of Co-integrating Vectors. *Journal of Economic Dynamics and Control*, 12(2-3), pp 231-254.

Johansen, S. (1991). Estimation of Hypothesis Testing of Co-integration Vectors in Gaussian Vector Autoregressive Models, *Econometrica*, 59(6), pp 1551-80.

Johansen, S. (1996). Likelihood-Based Inference in Co-integrated Vector Autoregressive Models, 2nd Edition, Oxford University Press, UK.

Jushan, B. & Perron, P. (2003). Critical values for multiple structural change tests. *Econometrics Journal*, 6, pp 72-78.

Khan, M.T. (2013). Exchange rate as a determinant of fluctuation in foreign exchange reserves: *Evidence from economy of Pakistan, Social Sciences and Humanities*, 4(2). pp 459-471.

Kharroubi, E. (2011). The Trade Balance and the Real Exchange Rate, *BIS Quarterly Review*, September 2011, pages 10.

Munthali, T., Simwaka, K. & Mwale, M. (2010). The real exchange rate and growth in Malawi: Exploring the transmission route. *Journal of Development and Agricultural Economics*, 2(9), pp 303-315.

Nguyen, T.P. & Nguyen, D.T. (2010). Vietnam's

Exchange Rate Policy and Implications for its Foreign Exchange Market, 1986-2009. Griffith University, Australia. pp1-31.

Papaioannou, E. & Portes, R. (2008). Costs and Benefits of Running an International Currency, European Commission. DG-EC/FIN, Special Report on the European Economy, European Economy Economic Papers No. 348.

Romelli, D., Terra,C. & Vasconcelos, E. (2014). Current Account and Real Exchange Rate Changes: The Impact of Trade Openness. ESSEC Working Paper 1520. Available at: https://ssrn.com/abstract=2439832

Yaya,M.E. & Xiaoxia, L. (2012). The Short-Run Relationship between Real Effective Exchange Rate and Balance of Trade in China, *International Journal of Applied Economics*, 9(1), pp 15-27.

Yusoff, M.B. & Febrina, Y.I. (2014). Trade Openness, Real Exchange Rate, Gross Domestic Investment, and Growth in Indonesia, *The Journal of Applied Economic Research*, 8(1), pp 1-13.