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The Competitiveness of Indian Rupee in Long Run

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Abstract
This study investigates the determinants of competitiveness of Indian rupee in the long run. The consumer price index based index of real effective exchange rate is widely agreed and frequently used as representative of competitiveness across countries. ARDL bound test approach for co-integration has been applied to test the long-run relationship between the real effective exchange rate and the independent variables- real economic growth, broad money supply growth, terms of trade and external current account balance.This study uses yearly time series data on the concerned variables for Indian economy for the period, 1990 to 2019. The results of long-run ARDL bound testpoint out that real economic growth and terms of trade have a significant positive effect on real effective exchange rate. Current account balanceis also positively related with real effective exchange rate, albeitnot statistically significantly.While, money supply is found almost neutral in both long run and short run. The outcomes of the error correction model propose the significant positive relationship of real economic growth, the terms of trade and current account balance with real effective exchange rate in the short run as well. It is well known fact that technology is the driving force for real economic growth and terms of trade. Based on the results of this study, it is suggested that the policymakers should devisethe policies leading tothe technological advancement in the country, which in turn improves the competitiveness of currency of the country in the long run through its determinants.

Keywords*: Real effective exchange rate, time series, ARDL, Co-integration*
JEL classification: *F62, F31, C22*

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I. Introduction

The competitiveness of currency of a nation plays an important role in its economic prosperity and in properrecognition in the world economy. Exchange rate of a country indicates its competitiveness in international economy and supports the inward economic stability in the country (Gala & Lucinda, 2006). The indices of Nominal Effective Exchange Rate(NEER) and Real Effective Exchange Rate (REER) areused as indicators of external competitiveness. NEER isthe weighted average of bilateral nominal exchange ratesof the home currency in terms of foreign currencies.Theoretically, the REER, defined as a weighted averageof nominal exchange rates adjusted for relative pricedifferential between the domestic and foreign countries,is associated with the purchasing power parity (PPP) hypothesis.

Nominal effective exchange rate indicates a stable exchange rate and it is a better indicator than spot exchange rates. Nevertheless, it can be a misleading variable of competitiveness during times of high inflation.The Consumer Price Index based index of real effective exchange rate is widely recognised and frequently used to measurethe competitiveness across countries. For that reason, real effective exchange rate index constructed for both India and its trade partner countries using consumer price index would provide a higher degree of comparability of India's international competitiveness vis-à-visits trading partner countries. Hence, real effective exchange rate has been considered as a measure of competitiveness of Indian rupee in this study.Increase in real effective exchange rateindices indicates appreciation of rupee and vice versa.

According to Berka & Devereux(2010), exchange rates' stability results in stimulation of foreign investments, increase of exports and a positive change in balance of trade of the country. As such, the economic policy of a country should be devised in a way to achieve stability in exchange rate.

There has been debate in the literature on what factors determines the exchange rate.There is no unanimity on how exchange rates are determined and why exchange rates have demonstrated increased volatility in the past. The interpretations given by the various theories, including the flow- market approach and the modern asset- market approach depart significantly from each other.According to Balassa (1964),the appreciation of currency of a country improvesthe growth of its economy.Kumar (2010) argues that the appreciation and depreciation of the currency of a country are also influenced by terms of trade. Terms of trade also have an impact on the economic performance of a country. According to Smith (1999), the competitiveness of a country in international market is minimised by higher inflation rates. In attendant, it reduces a country's

exports and decreases the demand of concerned country's currency. Inflation rate in a country is dependent on its money supply policy.The excess supply of money leads to higher inflation rates. The resultant effect is the depreciation of domestic currency. Another factor affecting the exchange rate is external current balance of the country. Surplus in current account leads to appreciation of domestic currency or vice versa. According toDornbusch and Fischer (1980), it is the asset markets which determine exchange rates, but it is the current account, which influences the track of the foreign exchange ratethrough its effect on the net asset positions, and afterwards on the asset markets. Hogan et al (1991) find, in contrast to the previous studies thatthroughout the 1980s exchange rates have been significantly influenced by larger US trade balance deficits.

Thereis no unanimity in literature relating to the impact of real exchange rate on economic performance of an economy. Aguirre and Calderon (2005) find that the growth of an economy is hampered by large overvaluations and undervaluation in real exchange rate, while a small undervaluation can be helpful in boosting the growth.On other things remaining same, a rise in real exchange rateleadsto country's exports more expensive and imports relatively cheaper. Consequently, through effect on the prices of exports and imports, real exchange rate movements lead to variation in the allocation of internal production and consumption between traded and non-traded goods. However, whether devaluations in the real exchange rate havecontractionary or expansionary effect on an economy still remains a matter of controversy. According to the conventional textbook model, if the Marshall-Lerner condition holds, devaluations are supposed to increase competitiveness, production and exports of tradable goods, and to reduce imports, and resultantly improve trade balance, GDP and employment. On the other side, confirmation from many countries reveals that currency appreciation is result of accelerated economic development, while reverse is true in case of deceleration in economic development.

Known the fact that real exchange rate movements and economic growth have got some association, whether positive or negative, the determinants of real exchange rate become more relevant from policy perspective. The volatility and misalignment of real exchange rate from its equilibrium level adversely affects the competitiveness and economic growth of developing countries. It is also debatable whether appreciation of real effective exchange rate reduce the competitiveness or not. However, it is sure that stability of real exchange rate helps in maintaining the competiveness of the currency. Thus, investigation into the determinants of real exchange rate in the long term becomes so important. This is the basic objective of this study. Attendantly, the results of this study would be useful for economic policy makers in India. In this study, an attempt to find cointegration between real exchange rate and economic growth, money supply, terms of trade and current account balance has been made.

Objective of the Study

The basic objective of the study is to find the determinants of competitiveness of Indian rupee in the long run. To accomplish the objective, the study has

• To empirically examine the long run relationship ofreal effective exchange rate of Indian rupee with the real economic growth, the broad money growth, the terms of trade and the current account balance.

• To examine the short term causal relationship of real effective exchange rate of Indian rupee withthe real economic growth, the broad money growth, the terms of trade and the current account balance.

• To determine long run equilibrium correction factor among the real economic growth, the broad money growth, the terms of trade and the current account balance onreal effective exchange rate of Indian rupee.

This research article is arranged in eightsections. The second section provides insights into empirical literature relating to the exchange rate determination. The third section comprises of the determinants, data sources and empirical framework used in the study.The fourth section deals with estimation and the results. The fifth section signifies the post estimation diagnostic testing of the model, while sixth section evaluates the stability of coefficients using CUSUM and CUSUMSQ framework. The seventh section carries out the analysis of the results. Finally, the eighth section deliberateson conclusion and policy implication.

II. Literature Review

Volatility in the external value of the currency is immediately demonstrated by any disturbance in the smooth functioning of the economy. This volatility in the external value of currency has attendant effect on its competitiveness. Instability in the value of currency of a country affects the foreign investments and trade balance. Stability in the value of currency can be achieved by monitoring the factors that determine the exchange rate.

There is controversy on how exchange rates are determined and why exchange rates demonstrate volatility. Most of the studies have confirmed that productivity differentials, terms of trade, net foreign assets, foreign exchange reserves, government expenditure, inflation rate differentials, capital flows, interest rate differentials and degree of openness are some of the major determinants of the real exchange rate. The issue still remains unsettled.

Balassa-Samuelson (1964) developed one of the most important hypotheses with respect to the equilibrium real exchange rate level. This hypotheses proposes that because of differential productivity growth between tradable and non-tradable sectors the real exchange rate appreciation leads to the rapid economic growth in the economy.

There are fundamental as well as monetary determinants of the exchange rate as put forward by Edwards (1988). The model of real exchange rate determination developed by Edwards allows for both real and nominal factors to play a role in the short-run. However, according to his model, only real factors influence the equilibrium real exchange rate in the long run. Choudhury (2000) studies the real and nominal determinants of real exchange rate based on the Edward (1988) model. His study demonstrates that the terms of trade, capital flows, and government expenditure have a positive although openness has a negative effect on the real exchange rate in India.

Chaudhri and Khan (2004) findstrong verification of Balassa-Samuelson effects for developing countries. The paper provides that the traded-non-traded productivity differential is animportant determinant of the relative price of non-traded goods, and the relative price in turn exercises a significant effect on the real exchange rate. The terms of trade also influences the real exchange rate.

Integrating money, relative prices, and the current account balance as factors,Branson (1981) developed a model toexplain the movements in effective exchange rates. This model is applied to the quarterly data spanning from 1973 to 1980 for four countries namely, the U.S., the U.K., Germany and Japan.The money and the current account are the proximate determinants of changes in real (effective) rates. The basic model is first analysed under static expectations. When rational expectations are introduced in the model, it is shown that the nominal and realexchange rates are expected to jump promptly in response to new information or innovations in money, the current account, and relative prices.

To investigate determinants of the real exchange rate in India,Kumar (2010) applies an ARDL modeltaking into consideration the quarterly data on the real exchange rate of the rupee against the U.S. dollar from 1997 to 2009. He investigates the impact of productivity differentials, government consumption, terms of trade,foreign exchange assets and external openness on real exchange rate. He observes that there is a convergence to the long run equilibrium exchange rate. The long-run relationship shows that the coefficients of productivity differential, net foreign assets and terms of trade have negative signs. The results have been significant at 1% significance level, which indicates that increase in these variables leads to appreciation in real effective exchange. Enhanced external sector opennessresults in depreciation of the exchange rate. Although,increase in government consumptionleads to depreciate the exchange rate,albeit it is found to be insignificant.

Suthar (2008) investigatesthe impact of the supply of foreign exchange reserves, liquidity conditions in the economy as determined by money supply, central bank's policy intentions and differences in the interest yield on dated securities of the concerned economieson the appreciation or depreciation of the domestic currency. It is found that the monetary policy actions as depicted by the bank rate of the RBI, the short-term and long-term domestic interest differentials and interest yield differentials, and the rate of change of foreign exchange reserves have a significant impact on the monthly average of the exchange rate between Indian rupee and the US dollar. The results are in line as suggested by the economic theory.

The study by conducted by Elbadawi and Soto in 1997 finds that real exchange rates are mainly determined by the terms of trade, the openness degree of the economy, imports and capital flows. The study investigates the impact of macroeconomic determinants on real exchange rate in case of seven emerging economies.

Joyce and Kamas (2003)use cointegration analysisto investigate into the real and nominal factors that determine the real exchange rate in long run.The study comprises of Argentina, Colombia and Mexico. It is found that the real variables that determine the real exchange rate to a large extent included the terms of trade and productivityas suggested by variance decompositions. Nominal variables that accounts for most of the variation in the real exchange rates in case of all three economiesare nominal exchange rate and money.

Mallick (2010) examines the Indian rupee-US dollar exchange rate behaviour using monthly data for 1994-2007. This period is post reform era witnessing the increasing and ample capital inflows in India. The study estimates a basic exchange rate model in a time series framework in order to assess the relative significance of capital inflows in the presence of interest rate, inflation rate and growth rate differentials and other factors. It finds that the rupee-dollar exchange rateis predominantly affected by foreign institutional investments. Further, the study identifies that the growth rate differential affects the exchange rate behaviour in India.

In general, monetary policy has been used as an important tool to explain the behaviour ofexchange rates. Taking this into consideration,Wilson (2009) investigates the behaviour of the effective exchange rate of dollar with its trading partners by using quarterly data from 1973 to 2008.It is observed that monetary approach plays important role in explaining the behaviour of exchange rate in the long term. In addition, it has been found

that deficits and outstanding debt whether financed domestically or by foreign investors plays a role in explaining the effective exchange rate in the long run, but not in the short run.

Ahmed (2009) studies the behaviour of capital flows and real exchange rate in Pakistan using time-series data from 1973 to 2007. He also included the terms of trade and degree of trade openness in the model to explain the variation in the exchange rate. The terms of trade,degree of openness, government spending in the non-tradable sector, and capital flows are significant in determining the equilibrium exchange rate according to results of thestudy. These variables are also helpful in explaining the extent of deviation from equilibrium exchange rate.

Hau (2002) conducts a study on the exchange rate behaviour of a cross section of forty eight countries. The volatility of the trade-weighted effective real exchange rate is found associated to the degree of trade openness of an economy. Empirical resultsindorse that both monetary as well as aggregate supply shocks are shown to produce smaller real exchange rate movements provided the country is more open to foreign trade. The study suggests an inverse relationship between the trade openness and real exchange rate.

Khattak et al. (2012) investigate the behaviour of the nominal exchange rates in Pakistan. They use time-series data for the period of 1982 to 2008 and apply Ordinary Least Squares and Johansen's cointegration techniques. The results show that both monetary and real factors i.e. money supply, trade balance, foreign exchange reserves, inflation and interest rate have long run relationship with the exchange rate of Pakistanrupee. The study shows that money supply and inflation are positively significant, while real GDP and interest rates possess a negative significant relationship with exchange rates in Pakistan. The results from Granger causality also indicate a bidirectional association of real GDP and inflation with exchange rates. On the other side,a unidirectional relationship is evident between interest rates and money supply.

Mirchandani (2013) investigates the association between exchange rate of Indian rupee and the macroeconomic variables like inflation, interest Rate, foreign investment, GDP growth and current account balance. Results show mild direct correlation between exchange rate and GDP growth, while between current account balance and exchange rate there is very weak correlation.

Parveen, Khan and Ismail (2012) study the underlying forces of exchange rate in Pakistan from 1975 to 2010. The results based on regression technique find that inflation is the most important determinant for predicting exchange rate in Pakistan. The negative relationship inflation and rupee valuationis evident from the study.The results further show that second important variable which bring more variation in exchange rate is economic growth, while order of export and import in variation lies at third and fourth position.

The analysis of above mentioned studies undoubtedly reveals thatproductivity and terms of trade are the most important determinants of exchange rate. Next in line are money supply and current account balance.

Determinants, Data Sources and Empirical Framework

Economic literature suggests a number of economic variables affecting the exchange rates. There seems some overlapping in the selection of variables used in different studies. This study tries to use the basic variables to solve the problem of overlapping or duplication in finding the determinants of real exchange rate in the long run. Real economic growth, broad money supply growth, terms of trade and current account balance are employed as independent variables.

Economic growth

Effect of the productivity differential on the real exchange rate is known as the Balassa-Samuelson hypothesis. Balassa (1964) in his study regressed the real exchange rate on the GDP per capita and found that productivity differentials are positively correlated with the real exchange rate appreciation. The main and only factor responsible for productivity differential is technological advancement. In this paper, real GDP (natural logarithmic value)is used as a determinant of real exchange rate.

Broad money supply

The OECD Economic Outlook (1981) reports a theoretical view on determinants of currency exchange rate.According to the report, theexchange rates are generally believed to be explained by main economic variables such as monetary conditions (and especially interest rate differentials), current account developments, and relative price performance. Report further states that over recent months the influence of inflation differentials has been uncharacteristically small, or operated with considerable delay. Hence, the monetary conditions and current account developments play dominant role in explaining exchange rate.

Abundant money supply reflects the accessibility of funds in the market to purchase goods and services. In order to meet this excess demand, manufacturers will employ more workers. This will raise the cost of output and subsequently resulted in higher prices to meet the extra cost of manufacturing (Bleaney & Fielding, 2002).

More money supply leads to depreciation of the domestic currency. Money supply is also related to inflation in the country. A higher rate of inflation in the home country compared to foreign countries will as per economic theory lead to a depreciation of the domestic currency.

The study conducted by De Bruyn, Gupta and Stander in (2013) investigates the role of the monetary model in exchange rate determinationin South Africa. Using annual data from 1910 to 2010, the study tries to test the long-run monetary model of exchange rate determination in case of the South African Rand in relation to the US Dollar. The long-run co-integration is found between the nominal exchange rate and the output, and money supply deviations confirming thesupport for the monetary model. Superiority of the monetary model in forecasting is established by a subsequent comparison of nominal exchange rate forecasts based on the monetary model with those of the random walk model.

In 2012, Saeed et al. conduct a study to analyse determinants of exchange rate of Pakistani Rupee in relation toUS Dollar employing the monetary approach framework.The study uses monthly data spanning from 1982 to 2010. They use ARDL approach to co-integration and error correction model to analyse the determinants of the exchange rate. The empirical results shown by the study find stock of money, debt and foreign exchange reserve balance, all in relative terms, as significant determinants of exchange rate in case of Pakistan rupee and US Dollar.

The effect of money supply on nominal exchange rate is quite logical, but effectiveness of money supply on the real exchange rate is ambiguous. It can be inferred that the real disturbances to the economy dochange the equilibrium real exchange rate andmonetary disturbances generally do not change the equilibrium exchange rate.Inclusion of broad money supply in the model being used in this paper would give some insight into this aspect. Broad money supply growth is employed as the determinant of the real exchange rate in this study.

Terms of trade

The terms of trade are considered one of the most important causes of variations in the real exchange rate. There are two dominant effects of terms of trade, namely- income effect and substitution effect, which in turn decide the ultimate impact on the real exchange rate.

i. The deterioration in the terms of trade induces a negative effect on income through making imported goods costlier. A decline in domestic purchasing power reduces the private demand for non-traded goods leading to appreciation of the real exchange rate.

ii. The substitution effect makes imported goods more expensive. This would shifts demand in favour of non-traded goods. This would increase prices of non-traded goods leading to depreciation of the real exchange rate.

The final effect of the terms of trade on real exchange rate will depend upon the strength of the income and substitution effects. However, recent empirical studies have found that the income effect is predominant.Hence, terms of trade improvements are associated with real exchange rate appreciation in the long-run. The terms of trade is used asa determinant of the real exchange rate in the model used in the study.

Current account balance

If the current account shows a surplus, the capital account is in deficit and the private sector's accumulation of foreign assets is increasing. Monetary disturbances cause an initial jump in the nominal and real exchange rates, which is reversed as the accumulation dynamics take over. The long run effect of any single shock is a movement in the real exchange rate due to the change in the foreign asset position between equilibrium. If monetary shocks are repetitive and random, this will produce random movement in the real exchange rate, related to accumulation of foreign assets (Branson 1981). The current account balance is an important determinant of real exchange rate. Dornbusch and Fischer (1980) study finds thatit is the current account which influences the track of the foreign exchange rate.

This study uses current account balance- GDP ratio as determinant of real exchange rate.

The following model is used to analyse the determinants of the real exchange rate:

$$LREER_t = \beta_0 + \beta_1 LGDP_t + \beta_2 BMNG_t + \beta_3 LTOT_t + \beta_4 CAGDP_t + \varepsilon_t$$

In this model, ε_t is the error term, LREER is natural logarithmic value of real effective exchange rate index, LGDP is natural logarithmic value of real gross domestic product, BMNG is growth of broad money supply (%), LTOT is natural logarithmic value of terms of trade index and CAGDP is external current account balance as ratio to gross domestic product. Data on real effective exchange rate (REER) index, terms of trade (TOT) index, current account balance (CA) in U.S. dollars are gathered from Handbook of Statistics on Indian Economy, published by Reserve Bank of India. Data on gross domestic product (GDP) in current prices and constant prices in U.S. dollars, and broad money supply growth (BMNG) are collected from Data Bank of World Bank (IBRD). Annual time-series data spanning from 1990 to 2019 are used in the study.

To examine the stationary properties of the time series variables used in the model, the augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) unit root tests are employed. The following equation is used for augmented Dickey & Fuller (1979) unit root test:

$$DY_t = \propto_0 + \alpha_1 Y_{t-1} + \sum_{i=1}^{k} \lambda_i DY_{t-i} + \varepsilon_t$$

In this equation, ε_t is pure white noise error term, D is the first difference operator for the variable concerned, Y_t is a time series for the variable concerned, α_0 is a constant and k is the optimum number of lags of the variable concerned. The ADF test is used to know whether the estimates of coefficients are equal to zero. The ADF test generates cumulative distribution of ADF statistics. In case the value of ADF statistic is more than the critical value from Fuller table, the variable is said to be stationary.

The following equation is used to test the unit root in variable as per Phillips & Perron(PP) unit root test:

$$DY_t = \propto_0 + \rho^* Y_{t-1} + \varepsilon_t$$

The PP unit root test is used to know whether the estimated coefficient ofρ*is equal to zero.The PP test is based on t-statistics.

After unit root testing, ARDL bound test approach for co-integration is applied to test the long-run relationship between the real effective exchange rate and the independent variables- realeconomic growth, broad money supply, terms of trade and external current account balance.The ARDL approach has many advantages compared to the other measures of co-integration.

First, in case of small sample size, ARDL modelling approach provides reliable statistics to identifythe co-integration, while the technique of Johansen co-integration requires larger sample to achieve reliability.

Second, in contrast to the conventional method used to find long-term relationships, ARDL approach instead estimatesonly a single equation.

Third, in the ARDL approach, the regression variables can allow different optimal lags.

Last, in ARDL approach bound testing can be applied to any combination of I(1) or I(0) variables. (Pesaran et al., 2001).

The following model will be used to estimate the long-run coefficients:

$$LREER_t = \propto_0 + \sum_{i=1}^{p} \propto_{1i} LREER_{t-i} + \sum_{i=0}^{p} \propto_{2i} LGDP_{t-i} + \sum_{i=0}^{p} \propto_{3i} BMNG_{t-i} + \sum_{i=0}^{p} \propto_{4i} LTOT_{t-i} + \sum_{i=0}^{p} \propto_{5i} CAGDP_{t-i} + \varepsilon_t$$

Following is the bound test co-integration model:

$$DLREER_t = \beta_0 + \sum_{i=1}^{p-1} \beta_{1i} DLREER_{t-i} + \sum_{i=0}^{p-1} \beta_{2i} DLGDP_{t-i} + \sum_{i=0}^{p-1} \beta_{3i} DBMNG_{t-i} + \sum_{i=0}^{p-1} \beta_{4i} DLTOT_{t-i} + \sum_{i=0}^{p-1} \beta_{5i} DCAGDP_{t-i} + \lambda_1 LREER_{t-1} + \lambda_2 LGDP_{t-1} + \lambda_3 BMNG_{t-1} + \lambda_4 LTOT_{t-1} + \lambda_5 CADGDP_{t-1} + \varepsilon_t$$

D is the first difference operator for the variable concerned. The parameters β (1– 5) explain the short run dynamic coefficients, while the λ (1–5) explains the long run multipliers of the equation.

If the long-run relationship between the independent variables and the real effective exchange rate is established, then the following Error Correction model (ECM) can be employed to estimate the short-run coefficients:

$$DLREER_t = \theta_0 + \sum_{i=1}^{p-1} \theta_{1i} DLREER_{t-i} + \sum_{i=0}^{p-1} \theta_{2i} DLGDP_{t-i} + \sum_{i=0}^{p-1} \theta_{3i} DBMNG_{t-i} + \sum_{i=0}^{p-1} \theta_{4i} DLTOT_{t-i} + \sum_{i=0}^{p-1} \theta_{5i} DCAGDP_{t-i} + \eta ECT_{t-1} + \varepsilon_t$$

In the error correction model (ECM),the coefficient of term (ECT_{t-1}) shows the speed of adjustment needed to restore the long-run equilibrium after experiencing a short-run shock. ηis the coefficient of error correction term (ECT_{t-1}) in the model that indicates the speed of adjustment in short run.Once the error correction model has been estimated, it is suggestedto apply the cumulative sum of recursive residuals (CUSUM) and the CUSUM of square (CUSUMSQ) tests to assess the parameter constancy of the long run ARDL model.

III. Estimation and Results

To check the stationary properties, we use Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root tests. First, these tests are applied on level of variables, then on their first difference. The tests results as shown in Table 1confirm that all variables are stationary and integrated at first difference (I_1) of unit root at 1% level of significance. Thus, there is no issue of unit root or stationary. The time series of variables is eligible for further long-run estimations according to the model employed in this Paper.

Table 1
Unit Root Test

Variable	Augmented Dickey-Fuller Test		Phillips-Perron Test	
	I(0)	I(1)	I(0)	I(1)
LREER	0.739920	-5.268210*	-3.069455**	-8.679894*
LGDP	1.506744	-5.441132*	2.528646	-6.669271*
BMNG	-1.150143	-9.352787*	-2.481036	-9.401492*
LTOT	-2.697479	-5.138300*	-2.776305***	-5.137198*
CADGDP	-2.559235	-5.685882*	-2.578997	-5.711089*

Note: 1. Variable lags have been selected automatically according to Akaike Information Criteria (AIC).
2. * represents significance at 1% level, ** represents significance at 5% level and *** represents significance at 10% level.

After testing the unit roots, the ARDL method for co-integration is used to estimate the long-run relationship of considered independent variables with real effective exchange rate in India. Before applying the ARDL test,there is need to determine the optimal lag length of the variables. The order of optimal lag length is determined by using the AIC, SC, HQ and adjusted r- square criteria through automatic selection process inbuilt in E-Views software package. Fortunately, all criteria have suggested 4,3,3,2 and 3 lag lengths for LREER, LGDP, BMNG, LTOT and CADGDP respectively.

Table 2
Lag Selection-ARDL Model

Variable	Criteria			
	AIC	SC	HQ	Adjusted R^2
LREER	4	4	4	4
LGDP	3	3	3	3
BMNG	3	3	3	3
LTOT	2	2	2	2
CADGDP	3	3	3	3

Note: 1. AIC: Akaike information criterion, SC: Schwarz criteria, and HQ: Hannan Quinn criterion.
2. Lags have been selected automatically by E-Views software.

After lag length selection ARDL co-integration method is applied. The results of the ARDL model- F bound test are shown in Table 3. The ARDL model results suggest that the null hypothesis of no co-integration in the model should be rejected because the value of the F- statistic is greater than the upper bound critical value at 1 per cent level of significance. The alternative hypothesis that the valid long-run relationship exists among the considered variables is accepted.

Table 3. Significance of ARDL Model – F Bound Test

Equation	F-Stat	Critical Values (1% significance)	
		Lower bound	Upper bound
F_{REER}(LREER/LGDP,BMNG,LTOT,CADGDP)	13.96025*	4.77	6.67

Note: * represents significance at 1% level.

The ARDL method for co-integration is used to estimate the long-run relationship of considered independent variables with real effective exchange rate in India.Theresults of long-run estimations as per ARDL model are shown in Table 4. Results of Table 4 show almost no impact of broad money supply on the real effective exchange rate in long run. The results are as expected and logical since money supply is neutral on real variables as suggested by Edwards (1988), Hua (2002) and Wilson (2009). Current account balanceseems positively related with real effective exchange rate in the long run, though insignificantly. The results are consistent with Dornbusch and Fischer (1980),and Branson (1981) studies.

On the other hand, real GDP growth and terms of trade have significant positive relationship with real effective exchange rate in the long run in case of India.Coefficient of real gross domestic product indicates that 1% increase in real gross domestic product leads to the appreciation of real effective exchange rate by 0.13%. Similarly, 1% in increase in terms of trade index seems to appreciate the real effective exchange rate by 0.45%. These results are quite convincing. Results relating to gross domestic product growth are consistent with the results of established by Balassa (1964), Kumar (2010) and others. The results of terms of trade are in line with Elbadawi and Soto (1997), Kumar (2010), Joyce and Kamas (2003) and some others. Thus, real GDP growth and terms of trade are the main factors determining the competitiveness of Indian rupee in long run.
Results of descriptive statistic R-square indicate that 98.8% variation in the real effective exchange rate is explained by the independent variables employed in the study.

Table 4
ARDL Long Run Approach

Variable	Coefficient	Standard Error	t-Stat	Probability
LGDP	0.133063	0.041865	3.178419**	0.0191
BMNG	-0.002036	0.004172	-0.488081	0.6428
LTOT	0.513125	0.198666	2.582853**	0.0416
CADGDP	3.646325	2.282850	1.597268	0.1613
C	1.101166	1.344389	0.819083	0.4440
R^2	0.988036		A.I.C.	-5.504236
Adjusted R^2	0.950152		S.C.	-4.536470
F-Statistic	26.08001		D.W. stat	2.907909
Prob.	0.000303			

Note: * *represents significance at 5% level.
The co-integrating equation normalised on real effective exchange rate is given below:

$$LREER = 1.1012 + 0.1331LGDP - 0.0020BMNG + 0.5131LTOT + 3.6463CADGDP$$

The ARDL based error correction model (ECM) has been used to analyse the short-run relationship among the real effective exchange rate; and real GDP, broad money supply, terms of trade and current account balance. Table 5presents the results of the error correction model. Results indicate that the lagged error correction term for the estimated exchange rate equation is both negative and statistically significant. This confirms a valid short-run relationship between real effective exchange rate and the predictors of this study in India. The coefficient of the error correction term (ECT) showing the value of –0.62 suggests that about 62 per cent of disequilibrium in the real effective exchange rate is corrected in the current year itself.The positive and significant effect of real GDP growth, terms of trade and current account balance on real effective exchange rate is established in the short run as well.On the other hand,broad money supply growth is found insignificant in impacting the real effective exchange rate even in short run.Results of real economic growth indicate that 1% increase in real economic growth causes 0.56 percent appreciation in real effective exchange in short run. The Short run ARDL results of real gross domestic product, terms of trade and current account balanceare consistent with the long run results.

Table 5
ARDL Short Run Approach

Variable	Coefficient	Standard error	t-Statistics	Probability
C	0.684350	0.74932	9.132974	0.0001*
D(LREER(-1))	0.046581	0.096056	0.484931	0.6449
D(LGDP)	0.558990	0.170667	3.275318	0.0169*
D(BMNG)	0.000266	0.000972	0.273217	0.7938
D(LTOT)	0.272764	0.032260	8.455199	0.0001*
D(CADGDP)	1.505381	0.305523	4.927223	0.0026*
ECT(-1)	-0.621477	0.052048	-11.94040	0.0000*
R^2	0.974568		D-W stat	2.907909
Adjusted R^2	0.942201		F-Stat	25.54720
			Probability (F)	0.000006

Note: * represents significance at 1% level.

Diagnostic Testing of the Model

Results of Table 6 show some post estimation diagnostic tests, namely- serial correlation, functional form, normality and heteroscedasticity. There is no problem of serial correlation in the data according to the Breusch Godfrey test result since the p Value (0.1717) of F statistic is higher than 0.05. According to results of Breusch Pagan Godfrey testthere is no problem of Heteroscedasticity in the data asthe p value (0.6057)of F

statistic isgreater than 0.05.Ramsey's RESET test validates the functional form of model as p value (0.3912) of F- Statistic is higher than 0.05. The non-normality of the errors is also tested. The Jarqe-Bera statistic value is 0.7674. It can be said that results of research have economic significance and are reasonable.

Table 6
Diagnostic tests

Diagnostic test	Statistic	Value	Probability
Serial correlation	F-stat	2.826965	0.1717
Heteroscedasticity	F-stat	0.903042	0.6057
Functional form	F-stat	0.880237	0.3912
Normality	Jarque-Bera	0.529507	0.7674

Stability of the Long Run Model

CUSUM and CUSUM of square tests on recursive residuals are used to check the steadiness of the coefficient of the long-run model in the sample period. According to Brown, Durbin, & Ewans(1975), the systematic changes from the coefficient of regression are detected using the CUSUM test, whereas the sudden changes from constancy of regression coefficients are detected using the CUSUM of square test.
Figures 1 and 2 show the results of CUSUM and CUSUMSQ tests.

Figure 1. Cumulative sum (CUSUM) test

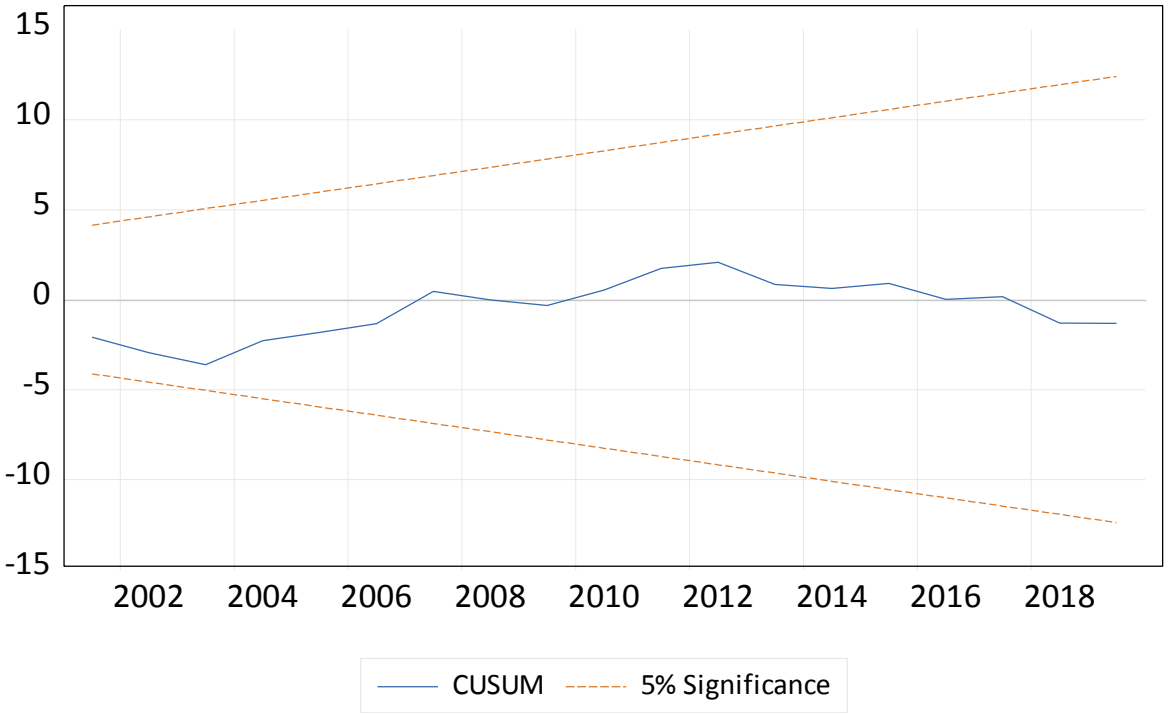
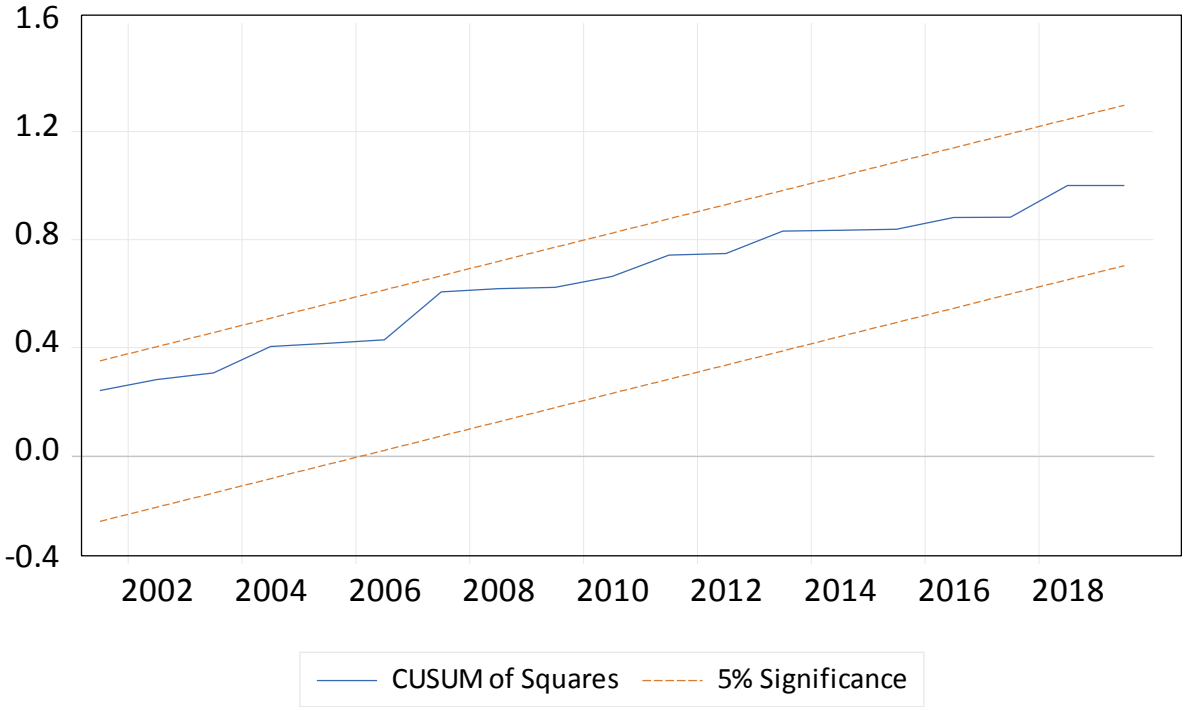


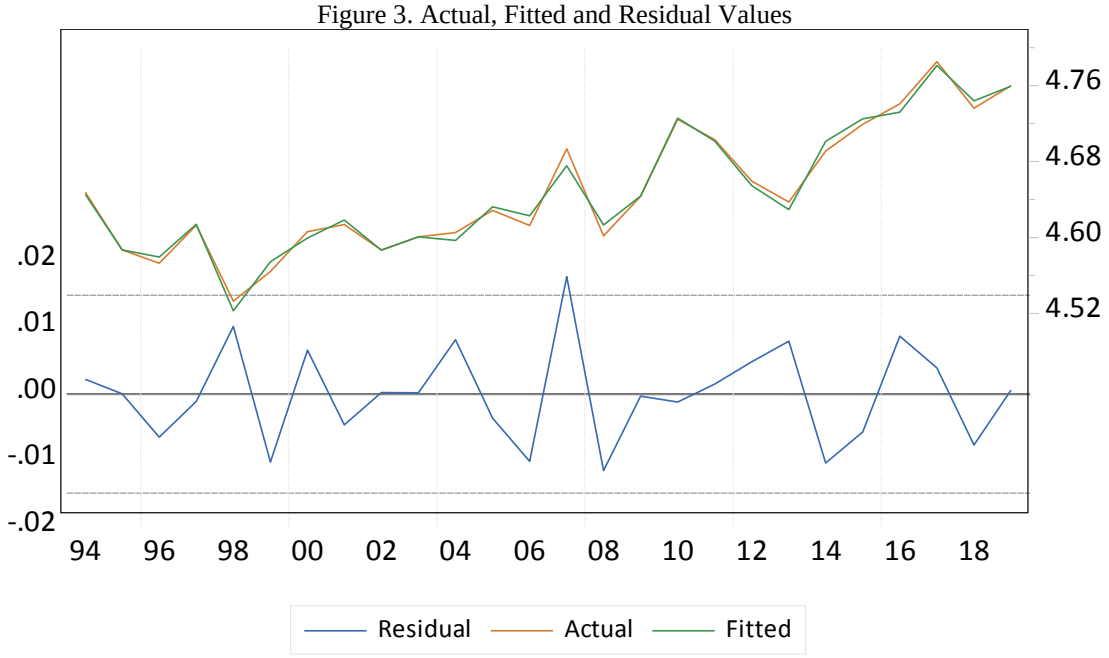
Figure 2. Cumulative sum squares (CUSUMSQ) test



The findings based on results from Figures 1 and 2 indicate that both CUSUM and CUSUM of square tests lie within the interval band at 5 percent level of significance. Consequently, the null hypothesis that there is the long-run relationships among variables is accepted. This implies stability of coefficients and finds the long-run relationship among variables. This also cofirms that the structural instability is absent in the residuals of the exchange rate model in the short run.

Figure 3 shows graph of the actual values, fitted values and residuals. A highly closed estimation of real effective exchange is evident from the graph.

Figure 3. Actual, Fitted and Residual Values



Analysis of the Results

The analysis of above mentioned results of this study indicates that real effective exchange of Indian rupee in the long run is determined by real GDP growth, terms of trade and current account balance. It seems that money supply plays no role in the determination of real effective exchange rate in both short and long runs.

Basically, technology advancement in the country is driving force behind these determinants of real effective exchange rate i.e. real GDP growth, terms of trade and current account balance. Hence, competitiveness of rupee in long run, as represented by real effective exchange rate, is determined by technological advancement/innovations in the country.

According to Solow, almost 90 percent of US output expectedly came due to technological change. Afterwards, more fine-tuned researches estimated thatbetween one to two-third of economic growth anywhere comes from innovation. Later on, the models of the endogenous growth such as Romer (1990); Aghion and Howitt (1992); and some others all supported the theory thatthe creation of new technologies through a continued increase in the level of resources spent on research leads to a continued increase in economic growth. Finally, there has emerged a consensual view today that innovation is a key driver of economic growth.

Debaere and Lee (2003) study confirm that increased world demand for a country's products leads to its terms of trade improvement. According to the study, there is a positive correlation between a country's terms of trade and its higher per capita GDP or its R&D induced higher productivity relative to the rest of the world. The study further suggests that fast expanding countries can avoid deteriorating terms of trade through quality and variety upgrading.Hence, it is innovation that plays role in improving the terms of trade of a country.

It is well known fact that innovations are the driving force for economic growth and terms of trade in a country, even for its current account balance. Economic growth and terms of trade determine the real effective exchange rate of Indian rupee in the long run. More specifically, we can say that competiveness of Indian rupee in long run would depend on innovations that take place in the country.

IV. Conclusion and Policy Implication

Since non-tradable goods constitute a large segment of the goods market in developing countries,aninstability and disorder of real effective exchange rate from its equilibrium level adversely affects their competitiveness and economic growth. Therefore, during recent years, real exchange rate stability and its alignment have become very important in policy formulations in developing countries to improve economic performance. This research paper examines the determinants of real effective exchange rate of Indian rupee in the long run.

Economic literature suggests a number of economic variables affecting the exchange rates. There seems some overlapping or duplication in the selection of variables. This study tries to use the basic variables to find the determinants of real exchange rate in the long run. There seems no logic to include the intermediate variables as these variables manifest the impact of underlying basic variables. Real economic growth, broad money supply, terms of trade and current account balance are included as independent variables in this study. The impact of aforementioned macroeconomic fundamentals on real effective exchange rate has been tested estimating ARDL co-integration model. The bound test of co-integration indicates that there exists a long-run relationship between real effective exchange rate and the independent variables viz., economic growth, broad money supply, terms of trade and current account balance, as the value of the F- statistic is greater than the upper bound critical value at 1 per cent level of significance. Post estimation diagnostic tests show that econometric model is stable. There is no problem of heteroscedasticity, functional form and serial correlation.

This study reveals that economic growth and terms of trade are significant determinants of real effective exchange rate of rupee in the long run. Both determinants are dependent on technological advancement in the country. Current account balance also seems to have positive impact on real effective exchange rate in the long run, albeit results are not statistically significant. Innovations in a country can increase the worldwide demand for its output, leading to current account surplus. The money supply growth seems neutralin the determination of real effective exchange rate in bothshort and long run.

The coefficient of the error correction term in ARDL short term model showing the value of –0.62 suggests that about 62 per cent of disequilibrium in real effective exchange rate is corrected in the current year itself. The outcomes of the ARDL error correction model suggest that there is significant relationship of real economic growth, the terms of trade and current account balance with the real effective exchange rate in the short run. This inferenceis consistent with the long term results of ARDL model employed in this study.

Generally, an appreciation in real exchange rate is seen as worsening in the competitiveness of the traded goods sector. But it cannot be true in the long run, if real exchange rate is improving owing to factors like increased productivity, terms of trade and net foreign assets (as result of current account surplus) as shown in this study, which attributes higher growth reflecting improvement in the traded goods sector's competitiveness. All this happens due to technological advancement, i.e. innovations. Considering the results of this study, it is recommended that the policymakers should devise the policies leading to the technological advancement in the country.

In nutshell, real effective exchange rate of Indian rupee in the long run is determined by economic growth (real GDP) and terms of trade, which are in turn determined by the innovations in the country. Thus, the empirical results of this Paper provide support for the economic theory of determination of effective exchange

rate. The improvement in real effective exchange rate led by technological innovations enhances the competitiveness of the currency.There is scope for further econometric research to be done on this subject.

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Appendix

Descriptive statistics

	LREER	LGDP	BMNG	LTOT	CADGDP
Mean	4.648575	7.068455	15.44667	4.929435	-0.013
Median	4.633019	7.046785	16.4	4.915161	-0.01191
Maximum	4.809824	7.994295	22.3	5.245971	0.023163
Minimum	4.529045	6.230482	6.8	4.694097	-0.04823
Std. Dev.	0.07272	0.553721	3.859939	0.140327	0.014274
Skewness	0.487826	0.084414	-0.30684	0.434537	-0.12142
Kurtosis	2.427771	1.777678	2.340417	2.792945	4.180332
Jarque-Bera	1.599179	1.903218	1.014579	0.997702	1.815197
Probability	0.449514	0.386119	0.602126	0.607228	0.403492
Observations	30	30	30	30	30

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