The Relationship Between Exchange Rate Depreciation And Inflation In India: A Bounds Cointegration Analysis

Nirmali Borkakoty

Abstract : This paper attempts to investigate the relationship between exchange rate depreciation and inflation in India utilising annual time series data for the period 1980-81 to 2018-19. For this purpose, the bounds cointegration approach is used by taking wholesale price index, a measure for inflation as the dependent variable and exchange rate, money supply, import price and gross domestic product as independent variables. The bounds cointegration test demonstrated the existence of cointegration between inflation and exchange rate along with other macroeconomic variables. In both long run and short run, exchange rate depreciation has a positive and significant impact on inflation in India. The study suggests that although exchange rate depreciation is encouraging for the export sector, it should be used as a complementary measure to a judicious mix of other macroeconomic policies such as restrictive monetary policy, import substitution measures and measures for output growth, especially in the export sector.

Keywords : Inflation, Exchange Rate Depreciation, Wholesale Price Index, Money Supply, Long Run Equilibrium, Unit Root, ARDL Model, Bounds Cointegration Test, CUSUM, CUSUMQ.

1. INTRODUCTION

Exchange rate fluctuations significantly affect the level of inflation in emerging economies (Dornbusch, 1976). In simple terms, the exchange rate of a national currency is defined as the value of the domestic currency in terms of foreign currency. When the value of the home currency in terms of foreign currency increases, it is called appreciation of domestic currency or fall in the exchange rate of the domestic currency. On the other hand, depreciation of the domestic currency is the situation where it's value in terms of foreign currency decreases or the exchange rate of domestic currency increases. Both situations affect the macroeconomic performance of the national economy. According to Agenor and Monteil (1996) exchange rate has both a direct and indirect impact on the level of inflation in the economy. They explained three situations: "firstly, the exchange rate directly affects inflation via the cost of imported goods. An appreciation of the real exchange rate lowers the domestic price of imports and has a direct downward effect on the price of import-competing goods. The effect of lower import prices would pass-through to consumer prices over time and lower consumer prices would tend to moderate wage demands thereby gradually bringing down the level of inflation. Secondly, the exchange rate indirectly affects inflation via aggregate demand and expenditure channel. For instance, a real appreciation of the exchange rate would tend to lower the demand for non-tradable goods and put downward pressure on inflation. Finally, fluctuation in the exchange rate has a supply-side impact on inflation via the cost of imported inputs. A depreciation of the nominal exchange rate raises the domestic-currency price of imported inputs which further raises the cost of production if perfect substitutes for these inputs do not exist in the domestic market. This ultimately raises the price of final goods" (Agenor and Monteil, 1996, p.180) Exchange rate depreciation, thus, has an inflationary effect on the economy. The transmission mechanism of the impact of a change in the exchange rate to domestic prices is called exchange rate pass-through (EPRT). It is defined as the percentage change in domestic prices, which includes consumer prices, producer prices and import prices, due to one per cent change in the exchange rate. ERPT is complete if there is a proportional change in prices on account of a unit change in the exchange rate and is incomplete if the change in price is less than proportional. The exchange rate of Indian Rupee (INR) has depreciated to a great extent in the post-independence period. The INR was devalued three times during this time frame. At the onset of the planning era, Indian government resorted to external debt to finance its developmental activities and consequently, the demand for U.S.Dollar (USD) went up causing an appreciation of USD in comparison to the INR. To cope with the financial need, the INR/USD exchange rate was changed to Rs. 4.76 per USD from earlier Rs.3.30 per USD through devaluation of the Rupee by 44 per cent in 1949. The second time devaluation of the INR was taken place when India faced the first-ever balance of payments crisis after independence in 1966. High trade deficit as well as heavy defence expenditure due to two consecutive wars, i.e. Indo-China war in 1962 and the Indo-Pak war in 1965, worsened the financial condition of the Indian government. This led the government to make steep devaluation of the rupee by 57 per cent and the par value of the INR went from Rs. 4.76 to Rs. 7.50 per USD. Again, India faced the second major balance of payments crisis after her independence in 1991. It was said that "the country was in the grip of high inflation, low growth and the foreign reserves were not even worth to meet three weeks of imports" (Saket, 2013, p.1). A two-step downwards exchange rate adjustment was done and the INR was devalued for the third time since independence. On March 1993, market-determined exchange rate regime was introduced and the INR was freed to float against the US dollar in the market with provisions of interventions by the Reserve Bank of India (RBI) under the situations of extreme volatility. Since 1993 the INR has largely depreciated against the USD even though there has been an improvement in India's balance of payments position and foreign exchange reserves. The INR/USD exchange rate, which was Rs. 31.37 per US Dollar in 1993-94, has increased to Rs. 69.17 at the end of the financial year 2018-19 representing a depreciation of the Indian Rupee by 120 per cent during this period. The global financial crisis of 2008 was another turning point in the history

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of exchange rate depreciation in India. Before the crisis, due to weakening of the Dollar and huge inflows of foreign capital the INR has appreciated during 2003-05 and in 2007-08. But from early 2008 the INR started depreciating again due to large scale outflow of foreign exchange as a result of the recession in the USA and European Union (Datt and Mahajan, 2013). Again, due to an upsurge in the inflow of foreign institutional investments in the last quarter of 2009, the INR started appreciating against the USD and the INR/USD exchange rate during 2010-11 stood at Rs. 44.6 per US Dollar. The present decade has witnessed continued depreciation of the INR against the US Dollar except for the financial year 2016-17. On October 2018, the exchange rate has hit its all-time low of Rs. 73.63 per US Dollar. Persistent depreciation of the exchange rate of INR has adversely affected the profitability of various industries, widened the current account deficit and has also fuelled inflation that has adversely affected the common man (Gupta et al., 2014). Strong inflationary pressure was always there in the Indian economy since the time of independence although the country has never had to experience the terror of hyperinflation (Rajadhyaksha, 2008). The ever-mounting demand due to the rapid increase of population, rising money incomes, expansion in money supply, liquidity in the country, the increasing volume of black money and continuous rise in demand for goods and services due to rapid economic development at one side and inadequate rise in supply due monsoon dependent agriculture, the use of backward technology, the transport and power issues and the lack of various inputs are the responsible for inflationary pressure in Indian economy for a long time (Arunachalam and Sankaranarayanan, 1998). The average annual inflation rate during the 1960s stood at 6.4 per cent which rose to 9.0 per cent during 1970s and in 1980s it had lowered marginally to 8.0 per cent (Alam and Alam, 2016). For the immediate period after economic liberalisation, the average annual rate of inflation was about 8.1 per cent and during 2000-10, it had fallen to 5.6 per cent which again rose marginally to around 6.8 per cent during 2011-18. It is against this background of the persistence depreciation of the exchange rate of INR and a stable yet strong inflationary pressure in the Indian economy, this paper attempts to empirically examine the relationship between these two macroeconomic variables in the Indian context. A growing body of economic literature has shown interest in examining the impact of changes in the exchange rate on the domestic price level in case of developing open economies in recent decades. The chief objective of this paper is to investigate the relationship between exchange rate depreciation and inflation in India. To fulfil this purpose the paper has been divided into five sections. The first section introduces the issue; in section 2 a brief review of related literature has been done; Section 3 summarises the methodology adopted in the study; Section 4 presents the empirical findings and in the last section conclusion about the problem is made.

2. LITERATURE REVIEW

In Zimbabwe, Chhibber et al. (1989), considering both monetary and structural factors, studied the causes of inflation and they found that the exchange rate was one amongst the numerous significant determinants of inflation in the country. Using the Vector Autoregression (VAR) analysis, Canetti and Greene (1991) studied the relative importance of monetary expansion and exchange rate depreciation on inflation in the case of 10 African countries covering the period 1978-89. The Granger Causality test results revealed that exchange rate had a significant impact on consumer price rise in Sierra Leone, Tanzania, Congo (then Zaire), Kenya and Gambia. Contrary to this, in the case of Nigeria and Zambia the causality test findings showed that neither monetary expansion nor exchange rate had a significant impact on the inflationary process at conventional level of significance. Using quarterly data Laryea and Sumaila (2001) studied the various determinants of inflation in Tanzania for the period 1992:Q1 to 1998:Q4. They used the Error Correction Model (ECM) to examine the relationship between inflation and the explanatory variables. The empirical results showed that Tanzania's inflation was driven more by the monetary factors and to a lesser extent by volatility in output or depreciation of exchange rate. Berument and Pasaogullari (2003) through their VAR-based analysis provided the evidence that real exchange rate depreciation was inflationary in the case of Turkey. Maswana (2005) tested the causal pattern among inflation, monetary growth and exchange rate using monthly Congolese data for the period 1990:1 to 1996:9 by applying Hsiao's version of Granger Causality test. The causality test results showed the existence of unidirectional causality from money growth to exchange rate and from the exchange rate to inflation in the country. Taking exchange rate regime into consideration, Vinh and Fujita (2007) studied the impact of real exchange rate depreciation on the economic performance of Vietnam using annual data from 1992 to 2005 and found that real exchange rate depreciation had a positive impact on inflation and output level. They observed from the Granger Causality test results that under multiple exchange rate policy, bi-directional causality exists between real exchange rate depreciation and inflation while under crawling peg regime exchange rate had no significant effect on inflation. Asad et al. (2012) found a strong positive correlation between real effective exchange rate and inflation in Pakistan. The OLS regression analysis, however, showed that impact of real effective exchange rate on inflation during 1973-2007 was insignificant. Mirchandani (2013), on the other hand, found a moderate, but significant negative correlation between exchange rate and inflation while studying the macroeconomic determinants of exchange rate volatility in India for the period 1991-2010. Similarly, Raju and Gokhale (2014) also examined the relationship between the exchange rate, inflation and interest rate in India for the period 1991- 2010 using a VAR model. The study found that the exchange rate, inflation and interest rate did not have long-run association among them. However, in the short-run, both the interest rates and inflation jointly influences the exchange rate. Saxena and Singh (2015) by utilizing quarterly data from 2002:Q1 to 2012:Q1 examined the determinants of inflation in India using Granger Causality test and Ordinary Least Square (OLS) technique. They included exchange rate as an explanatory variable along with money supply, prime lending ratio, deposit rate, trade volume and crude oil prices in the regression model. Their findings, however, revealed that impact of exchange rate on inflation was insignificant during the study period. In the context of Nigeria, Onyekachi and Onyebuchi (2016) investigated the relationship between exchange rate depreciation and inflation using yearly time series data for the period 1980-2013. The Johansen Cointegration test and Vector Error Correction Model (VECM) were used to examine the long-run relationship between the variables. Contrary to other studies, this study provided evidence that the exchange rate has a negative and significant impact on Nigerian inflation in the long-run.

3. METHODOLOGY

3.1 Theoretical framework
To investigate the dynamic relationship between exchange rate depreciation and inflation in India, variables like inflation, exchange rate, money supply, import prices and gross domestic product are included in the analysis. The dependent variable inflation is measured in terms of the wholesale price index. The depreciation of the exchange rate of a national currency is expected to increase the price level in the domestic economy. In this study, the nominal exchange rate of Indian Rupee per US Dollar (INR/USD exchange rate) has been used and its increase implies a depreciation of the Rupee and vice-versa; therefore it is expected to have a positive relationship with the domestic price level. The domestic inflation rate is greatly influenced by domestic monetary policy decisions. Money supply, as early economic literature suggests and as evident from the findings of empirical studies (1989; Laryea and Sumalia, 2001; Imimole and Enoma, 2011) is an important determinant of inflation in many economies. It is expected to have a positive relationship with the inflation as an increase in the money supply would increase factor incomes in the economy and rising income would lead to increase in aggregate demand accompanied by increasing price level. Further, the import price is also expected to have a positive relationship with inflation in the analysis. A rise in import price leads to a rise in the demand for import-substitutes. This leads to demand-pull inflation in the domestic economy. Besides, the rise in prices of imported inputs raises the cost of production and ultimately leads to a rise in the prices of final goods. Thus, in either direct or indirect way domestic price level increases due to an increase in import prices. Gross Domestic Product (GDP) is expected to have a negative relationship with inflation as an increase in GDP will add more goods in the domestic market; therefore supply gap will be reduced and pressure on domestic price level will come down. In its simplest form, the functional relationship between inflation, exchange rate, money supply, import price and gross domestic product can be expressed as:

$$\mathrm{WPI} = \mathrm{f}\,(\mathrm{EXR}, \mathrm{MS}, \mathrm{IMP}, \mathrm{GDP}) \qquad (1)$$

3.2 Specification of the model
The model to be estimated in this analysis can be specified in its logarithmic form as:

$$ln\mathrm{WPI_t} = \beta_o + \beta_1 ln\mathrm{EXR_t} + \beta_2 ln\mathrm{MS_t} + \beta_3 ln\mathrm{IMP_t} + \beta_4 ln\mathrm{GDP_t} + \xi_t \qquad (2)$$

Where,
$\ln WPI_t$ = Inflation in period't' measured in terms of Wholesale Price Index
$\ln EXR_t$ = Nominal exchange rate of the Indian Rupee per US Dollar in period 't'
$\ln MS_t$= Nominal money supply in period't'
$\ln IMP_t$ = Import price in period't'
$\ln GDP_t$=Gross Domestic Product at constant prices in period't'
ξ_t = the disturbance term in period't'
t = Current period

3.3 Econometric Methods
The application of an inappropriate econometric method of evaluation has high chances of giving misleading results. However, the selection of an appropriate method of evaluation primarily depends on the order of integration of variables. The Augmented Dickey-Fuller (ADF) unit root test was used to test the order of integration of the individual time series included in this analysis. The study used Auto Regressive Distributed Lag (ARDL) approach to cointegration test which is also known as the Bounds Test. The Bounds test, developed by Pesaran et al. (2001), has two important advantages over other tests for cointegration. Firstly, it allows the explanatory variables under consideration to be stationary in level, I(0) or in first differenced form, I(1) whereas other popular cointegration tests put the restriction that all the individual time series included in the analysis must be integrated of the same order. Secondly, unlike most of the cointegration tests which are suitable for large sample-based studies, the bounds test can be easily applied in small sample studies.

The ARDL (m, n, o, p, q) specification of the model to cointegration testing can be expressed as:

$$\begin{aligned}\Delta ln\mathrm{WPI_t} = \delta_0 &+ \sum_{i=1}^{m} \beta_{1i}\, \Delta ln\mathrm{WPI_{t-1}} + \sum_{i=0}^{n} \beta_{2i}\, \Delta ln\mathrm{EXR_{t-i}} \\ &+ \sum_{i=0}^{o} \beta_{3i}\, \Delta ln\mathrm{MS_{t-i}} + \sum_{i=0}^{p} \beta_{4i}\, \Delta ln\mathrm{IMP_{t-i}} \\ &+ \sum_{i=0}^{q} \beta_{5i}\, \Delta ln\mathrm{GDP_{t-i}} + \delta_1 ln\mathrm{WPI_{t-1}} \\ &+ \delta_2 ln\mathrm{EXR_{t-1}} + \delta_3 ln\mathrm{MS_{t-1}} + \delta_4 ln\mathrm{IMP_{t-1}} \\ &+ \delta_5 ln\mathrm{GDP_{t-1}} \\ &+ \xi_t \qquad (3)\end{aligned}$$

In "(1)" m, n, o, p and q represent the optimum lag length of WPI, EXR, MS, IMP and GDP respectively. β_1, β_2, β_3, β_4, and β_5 represent the short-run dynamic coefficients. δ_1, δ_2, δ_3, δ_4, δ_5 represents the long-run multipliers of the underlying ARDL model. At the first step, by applying the bounds cointegration test the null hypothesis of no cointegration among the variables was tested against the alternative hypothesis of the existence of cointegration. The null hypothesis implies that the value of long-run multipliers is equal to zero i.e. $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$ while the alternative hypothesis implies that $\delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq 0$. The existence or non-existence of cointegration among the variables is determined based on the computed Bounds F-statistic. Pesaran et al. provided two sets of asymptotic critical values, "one when all regressors are purely I (1), and the other if they are all purely I (0)" (Pesaran et al. 2001, p.1). The first set of values represents the upper bound while the second set of values represents the lower bound. As a rule, the null hypothesis of no cointegration cannot be rejected if the computed F-statistic is lower than the critical F value for lower bound while the null hypothesis is rejected in case the computed F-statistic is greater than the critical value of F for upper bound. According to Pesaran et al., "If the F-statistic falls inside these two bounds, the inference is inconclusive and knowledge of the order of the integration of the underlying variables is required before conclusive inferences can be made" (Pesaran et al. 2001, p.290).

The short-run dynamics of exchange rate depreciation and inflation rate along with other macroeconomic variables in India was studied with the help of the Error Correction Model (ECM). The ECM can be specified as;

$$\Delta ln\mathrm{WPI_t} = \delta_0 + \sum_{i=1}^{m} \beta_{1i}\, \Delta ln\mathrm{WPI_{t-1}} + \sum_{i=0}^{n} \beta_{2i}\, \Delta ln\mathrm{EXR_{t-i}} + \sum_{i=0}^{o} \beta_{3i}\, \Delta ln\mathrm{MS_{t-i}} + \sum_{i=0}^{p} \beta_{4i}\, \Delta ln\mathrm{IMP_{t-i}} + \sum_{i=0}^{q} \beta_{5i}\, \Delta ln\mathrm{GDP_{t-i}} + \lambda\mathrm{ECM_{t-1}} \quad (4)$$

Where ECM is the error correction term indicating the speed of adjustment or feedback effect and the coefficient of ECM, 'λ' must be negative and statistically significant for the existence of long-run equilibrium relationship among the variables included in the model. It indicates how fast the time series can come back to its long term equilibrium. The optimum lag length for the ARDL model was selected based on the Akaike Information Criterion (AIC). The diagnostic tests like the LM test for serial correlation and Auto Regressive Condition Heteroscedasticity (ARCH) Test were performed to test the acceptability of the estimated model. Moreover, graphical representation of cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) estimates were made to express the stability of the model.

3.4 Data Base

This study covers the period from 1980-81 to 2018-19. To examine the relationship between exchange rate depreciation and inflation in the case of India, data on wholesale price index, INR/USD exchange rate, M_3, rupee price based unit value index of imports and gross domestic product at constant (2004-05) prices have been extracted from the Handbook of Statistics on Indian Economy, Reserve Bank of India, Mumbai and Ministry of Statistics and Programme Implementation, Government of India. Here, the Wholesale Price Index (WPI) is used as the indicator of inflation. It is an index that represents the price of goods that are sold in bulk i.e. at the wholesale stage. The exchange rate used here is the bilateral exchange rate between the Indian Rupee and the US Dollar. It is the value of Indian Rupee in terms of the US Dollar. Further, the money supply is the total quantity of money in circulation in the economy in a given period. The broadly defined measure of money supply in India, i.e. M_3 is used in the study to represent money supply in the model. To represent the import price, the rupee price based unit value index of imports is employed in the study. The import unit value index characterises the price of imported goods. The base year for the data on the import unit value index is 1999-2000=100.

4. EMPIRICAL RESULTS

4.1 Stationarity Analysis: Unit Root Test Results

The analysis begins with the transformation of the variables into logarithmic values and the implementation of the ADF test to check for the existence of a unit root in the level data of the variables. Table 1 summarises the results of the unit root tests. The application of the ADF test on level values of the variables revealed that for lnWPI the null hypothesis of the presence of unit root in the series cannot be rejected. Similarly, the exchange rate (lnEXR), import prices (lnIMP) and gross domestic product (lnGDP) were also revealed to be non-stationary in level. However, the money supply (lnMS) series does not contain a unit root as per the ADF test result. Money supply, as shown in Table 1 was revealed to be stationary at 5 per cent level of significance. However, for the first difference of lnWPI, lnEXR, lnIMP and lnGDP, the ADF test results state that all are stationary. From this, it can be concluded that the order of integration of the variables is mixed. The lnWPI, lnEXR, lnIMP and lnGDP are integrated of order one, i.e. I (1). The lnMS, on the other hand, is integrated of order zero, i.e. I (0).

TABLE 1
UNIT ROOT TEST RESULTS

Variables	Level	First Difference	Order of Integration
lnWPI	-1.464	-4.212***	I(1)
lnEXR	-2.562	-4.478***	I(1)
lnMS	-2.953**		I(0)
lnIMP	- 0.075	-5.550***	I(1)
lnGDP	1.610	-5.995***	I(1)

Note: ***, and ** denotes significant at 1% and 5% level

4.2. Bounds Cointegration Test Results

The unit root test results indicated that independent variables under investigation in the analysis were integrated of different orders. Therefore, the ARDL Bounds test approach to cointegration proposed by Pesaran et al. (2001) was used in this study to examine the long-run relationship between exchange rate depreciation and inflation along with money supply that may have a significant impact on the variation of the inflation rate. The result of the bounds test is presented in Table 2.

TABLE 2
***ARDL BOUNDS TEST RESULT FOR** COINTEGRATION*

K	F	Critical values of F at 5% level of significance		Critical values of F at 10% level of significance	
		Lower Bound	Upper Bound	Lower Bound	Upper Bound
5	5.9170	3.2779	4.6055	2.7026	3.8720

Table 2 shows that the computed F-statistic (5.9170) is greater than the F-critical values at 5% and 10% level respectively. Therefore, the null hypothesis of no cointegration among the variables included in the model is rejected. It, thus, establishes that there is a long-run relationship among lnWPI, lnEXR, lnM3, lnIMP and lnGDP.

4.3 Relationship Dynamics of Exchange Rate Depreciation and Inflation

Based on the ARDL (1, 0, 0, 1, 0) model, the long-run and short-run estimates are presented in Table 3 and Table 4 respectively. The presence of serial correlation in time series data may severely affect the efficiency of the estimators and the model become unreliable in such case. Therefore, the LM test for serial correlation of residuals was conducted to check for the presence of serial correlation in the time series. The LM test results confirmed the absence of the problem. The results are presented in Table 3. The Auto Regressive Conditional Heteroscedasticity (ARCH) test was also carried out to test the presence of heteroscadasticity, the results of which are also presented in Table 3. The ARCH test results also ensured the absence of heteroscadasticity in the time series under investigation. The Lagrange Multiplier (LM) Statistic in both tests turned out as insignificant. The Ramsey RESET test result also showed that the F-statistic is F = 0.15546 with p-value 0.696, which implies that the hypothesis of no misspecification cannot be rejected at 5% level. Thus, there is no problem related to the functional form of the model. Based on the results of the diagnostic tests, the model can be said a reliable one and is accepted for the study of long-run relationship among the variables. The chief objective of this study was to examine the relationship dynamics of exchange rate depreciation and inflation in India for the period 1980-81 to 2018-19. While studying this, some other macroeconomic variables that may have a significant impact on the inflation rate were also taken into consideration. The estimated long-run coefficient of EXR indicates the positive and significant relationship between exchange rate depreciation and inflation in the country. The positive elasticity coefficient of lnEXR (0.19455) indicates that a 1 per cent increase in the exchange rate of the INR increases the domestic price level by about 0.19 per cent in the long- run. Exchange rate depreciation in India in the long run, thus, has an inflationary effect in the economy. Money supply and inflation rate have a statistically significant positive relationship in the long-run. It can be seen from Table 3 that the long-run elasticity coefficient of 0.20090 for lnMS has a positive sign and it is significant at 1 per cent level. Thus, it follows that for every 1 per cent increase in money supply in the economy price level increases by about 0.20 per cent. Similarly, the long-run impact of import price on the price level is found to be positive. The statistically significant positive elasticity coefficient of lnIMP (0.48350) indicates that the price level increases by about 0.48 per cent with every 1 per cent increase in import prices. On the other hand, gross domestic product (lnGDP), an indicator of output growth, has a negative relationship with inflation. The statistically significant negative elasticity coefficient of 0.24242 for lnGDP indicates that a 1 per cent increase in GDP is responsible for approximately 0.24 per cent decrease in the price level.

TABLE 3

ESTIMATED LONG - RUN COEFFICIENTS OF THE SELECTED
ARDL (1, 0, 0, 1, 0) MODEL

Dependent Variable: lnWPI (Inflation)			
Variables	Coefficients	't' Statistics	p-value
lnEXR	0.19455	3.1328	[0.004]
lnMS	0.20090	3.7932	[0.001]
lnIMP	0.48350	4.0888	[0.000]
lnGDP	-0.24242	-2.1350	[0.041]
C	2.2078	1.7506	[0.090]

LM test statistic = 0.10215[0.749]
Ramsey RESET test statistic = 0.15546[0.696]
ARCH test = 0.10078[0.751]
DW-Statistic = 1.9138

The short-run dynamics of exchange rate depreciation and inflation in India is explained by the Error Correction representation of the ARDL model. The error correction model (ECM)-based results are presented in Table 4. It represents the variables in their first differenced form. Cointegration or long-run relationship exists only if the coefficient of the error correction term, ECM (-1), has a negative sign and is statistically significant. This negative coefficient of ECM (-1) implies that the variables will converge towards the long-run equilibrium while a positive coefficient implies divergence. It is observed from Table 4 that the coefficient of ECM (-1) is negative and significant at 1 per cent level of significance. This confirms that there is a long-run equilibrium relationship between the variables included in the model. The coefficient of 0.45659 for ECM (-1) indicates that 45.6 per cent of deviation from the long-run equilibrium in the short-run will be corrected in the next year.

TABLE 4

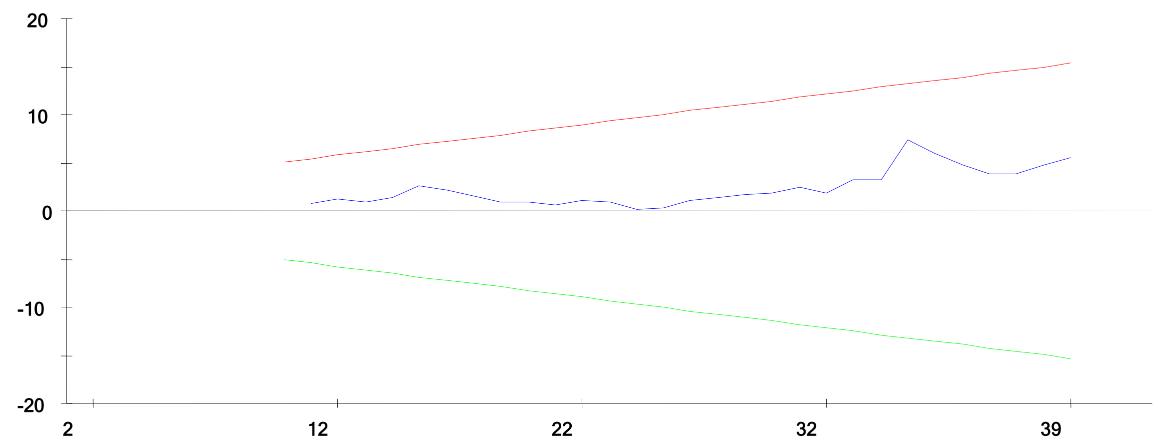
ERROR CORRECTION REPRESENTATION OF THE SELECTED
ARDL (1, 0, 0, 1, 0) MODEL

Dependent Variable: dlnWPI (Inflation)			
Variables	Coefficients	't' Statistics	p-value
dlnEXR	0.088830	2.0766	[0.046]
dlnMS	0.091728	2.7176	[0.011]
dlnIMP	0.11467	2.3411	[0.026]
dlnGDP	-0.11069	-3.1507	[0.004]
ECM(-1)	-0.45659	-3.8156	[0.001]

R-squared = 0.59055
Adjusted R-squared = 0.51130
F(5,32)= 8.9421[0.000]
AIC= 75.4476
SBC=69.7161

The short-run coefficient of dlnEXR (0.088830) indicates that depreciation of exchange rate by 1 per cent causes the price level to increases by about 0.09 per cent in the short-run. From this, it can be deduced that in the short-run depreciation of EXR has an inflationary impact on the economy. In the short-run, depreciation of the national currency makes imports costlier and it further pushes up the domestic prices over time. The money supply variable is found to have a positive and significant impact on inflation just like it has in the long-run. The coefficient of dlnMS in Table 4 shows that the price level increases by about 0.09 per cent with every 1 per cent increase in money supply in the economy. Import prices as expected positively influences the price level. The variable GDP, like in the long-run, also found to have a negative relationship with inflation in the short-run. An increase in India's GDP by 1 per cent causes the price level to decrease approximately by 0.11 per cent in the short-run. The results of the cumulative sum (CUSUM) test and cumulative sum of squares (CUSUMQ) test are shown using Fig. 1 and Fig. 2. The CUSUM and CUSUMQ tests assess the stability of parameters in a regression model. The CUSUM test intends to identify systematic changes in the regression coefficients; the CUSUMQ test, on the other hand, intends to identify any sudden changes from the constancy of the regression coefficients (Pesaran and Pesaran, 1997). In both figures, the two boundary lines represent 5 per cent level of significance for parameter stability. The line between the two boundaries in Fig. 1 represents the fitted line for CUSUM of recursive residuals, and in Fig. 2 it represents the CUSUMQ of recursive residuals. The plots of CUSUM and CUSUMQ fall within the critical bounds of 5 per cent level of significance which implies that the model is correctly specified and regression coefficients are stable over the sample period in India.

Plot of Cumulative Sum of Recursive Residuals

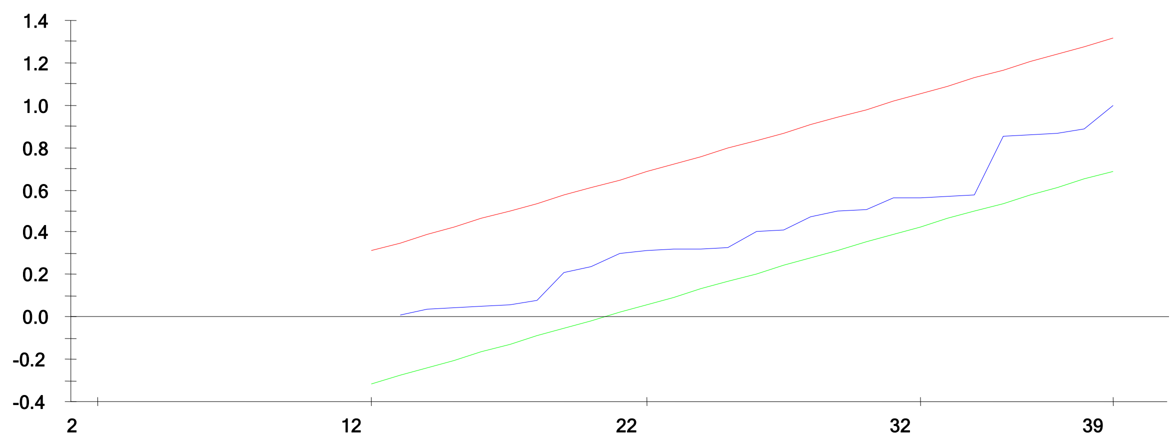


The straight lines represent critical bounds at 5% significance level

Note: Here undated observations 2,12,22,32 and 39 represent financial years 1981-82, 1991-92, 2001-02, 2011-12 and 2018-19 respectively.

Fig. 1 *CUMULATIVE SUM (CUSUM)*

Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Note: Here undated observations 2,12,22,32 and 39 represent financial years 1981-82, 1991-92, 2001-02, 2011-12 and 2018-19 respectively.

Fig. 2 *CUMULATIVE SUM OF SQUARES (CUSUMQ)*

5. CONCLUSION

The paper investigates the relationship between exchange rate depreciation and inflation in India for the period 1980-81 to 2018-19 using the ARDL bounds cointegration approach. For this purpose, wholesale price index as an indicator for inflation has been employed as the dependent variable and the independent variables are INR/USD exchange rate, money supply, import price and gross domestic product. The bounds cointegration test confirmed that a long-run equilibrium relationship exists between inflation and exchange rate along with other macroeconomic variables. In both long run and short run, a positive and significant relationship exists between inflation and exchange rate depreciation in India. It is found that 1 per cent increase in the exchange rate of INR increases the price level by about 0.19 per cent in the long run and 0.088 per cent in the short run. It shows that the exchange rate pass-through to domestic prices in India for the sample period is incomplete. The ECM result shows that 45.6 per cent of the temporary deviation from long term equilibrium adjusts in the next period. In the long run, import price dominates the other factors for inflationary pressure in the economy. However, in the short run, gross domestic product and money supply are the dominant factors for changes in the price level. Exchange rate depreciation although not the dominant factor yet it is one of the significant factor responsible for price rise in India. It implies that depreciation of the exchange rate of INR should be checked to control inflation. Depreciation of the exchange rate of the home currency tends to restructure both export and import prices. Though it is encouraging for the export sector, it should be used as a complementary measure to a judicious mix of other macroeconomic policies such as restrictive monetary policy, import substitution measures and measures for output growth, especially in the export sector.

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