Examining the Effect of Exchange Rate on Bilateral Trade Balance: The Case of India

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Abstract

India has had a persistent trade deficit in spite of a depreciating rupee. That creates an important research agenda for analyzing the responsiveness of its trade flows to changes in exchange rate. This paper examines the short run and long run responsiveness of India's trade balance with the real exchange rate of six of its main trading partners using Bounds testing and Auto Regressive Distributed Lag Model (ARDL) developed by Pesaran et al. (2001). The result of this analysis found that real exchange rate does not have a significant effect on India's trade balance with three out of six countries in the long run and with five out of six countries in the short run.

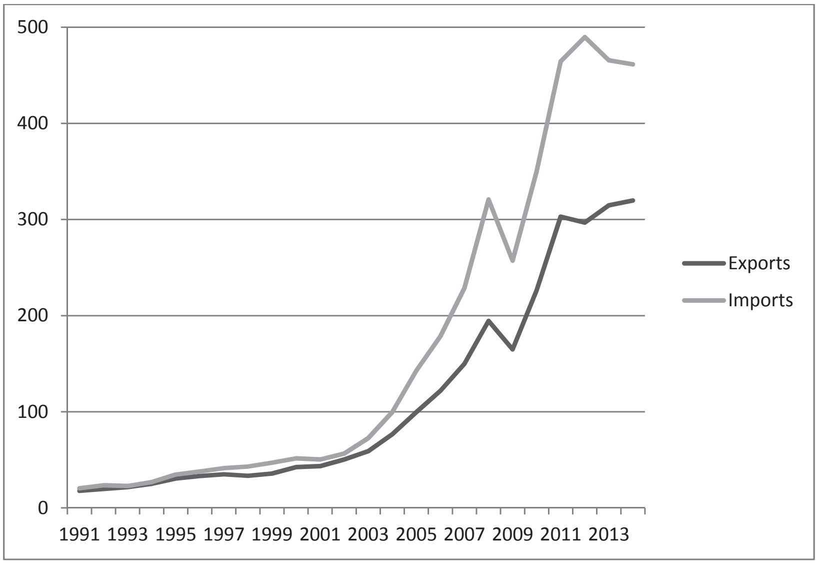
Keywords: Short Run, Long Run, Trade Balance, Exchange Rate, ARDL model

1. Introduction

After gaining independence from the British in 1947, for nearly four decades until 1991 India pursued a policy of inward oriented development with little reliance on external trade. However, the lacklustre growth in those decades combined with a balance of payment crisis in 1991 motivated India to initiate trade liberalization reforms from 1991. Favourable policies of external trade were implemented to meet the needs of its emerging economy. In the years that followed, India saw a significant increase in its exports and imports.

Since the beginning of 2000, India's trade deficit has been persistently increasing. This can be seen from Figure 1 and Table 1. The trade deficit has been increasing in spite of the fact that Indian rupee depreciated against all major currencies. Figure 2 shows the bilateral exchange rate of the Indian rupee vis-à-vis the currency of its main trading partners. In Figure 2, an increase in bilateral exchange rate means depreciation of rupee per unit of foreign currency. Economic theory predicts that in the long run in response to currency depreciation there should be an improvement in trade balance. However, in the short run, there can be deviations from this behaviour. In the short run, currency depreciation does not always lead to an improvement in trade balance because of the J-curve effect. The initial worsening of the trade balance before its eventual improvement is called the J-curve, first propounded by Magee (1974).

The objective of this chapter is to examine the short run and long run relation between trade balance and exchange rate for the case of India. We do this by examining the responsiveness of India's bilateral trade



Source: International Financial Statistics, IMF

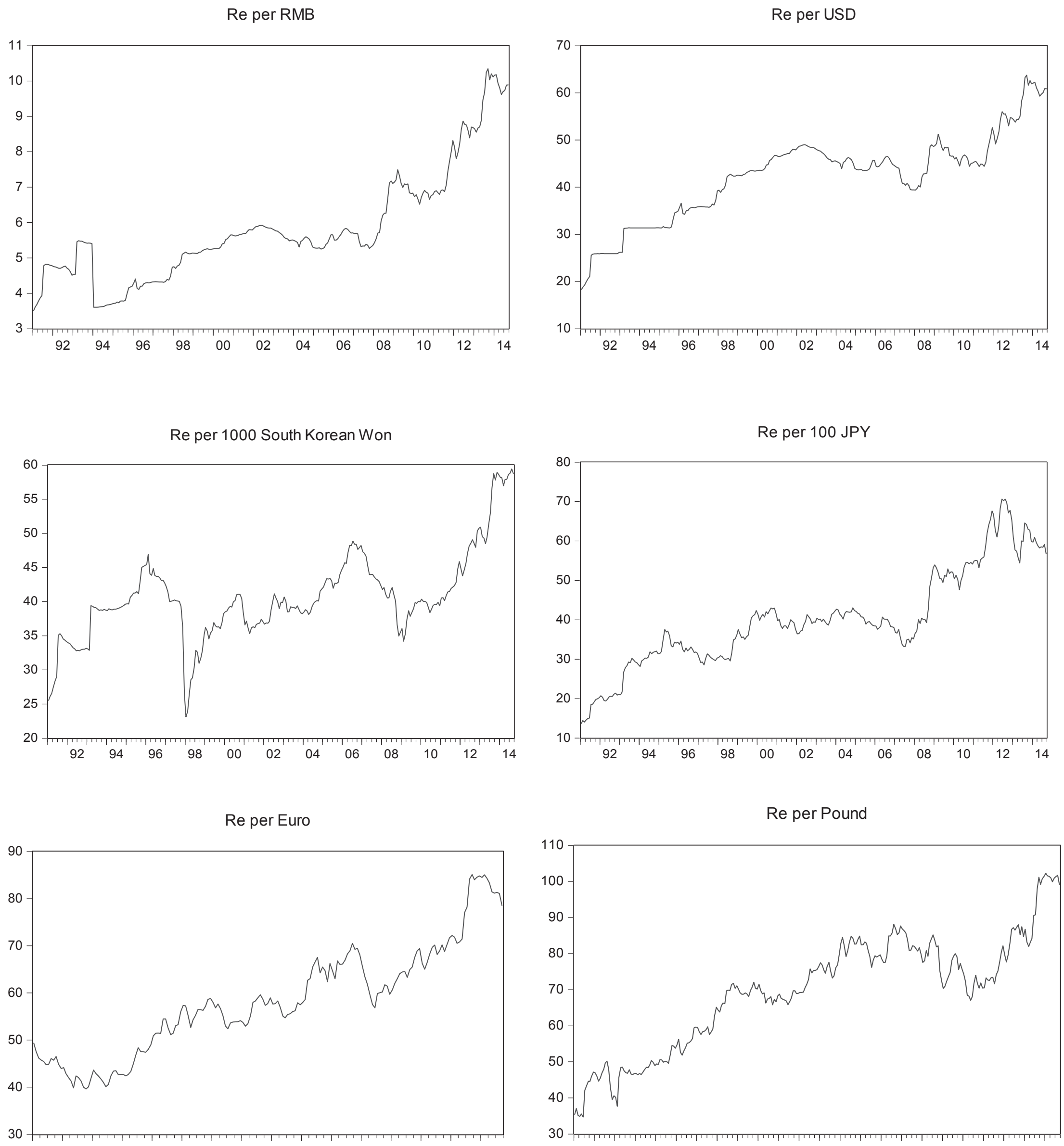
Figure 1 Trade Deficit of India (US$ Billions)

Table 1 India's Aggregate Trade Balance (Merchandise): (US $ Millions)

S.No	Year	Exports	Imports	Trade Balance
1	2004–2005	83,536	1,11,517	−27,981
2	2005–2006	1,03,091	1,49,166	−46,075
3	2006–2007	1,26,414	1,85,735	−59,321
4	2007–2008	1,63,132	2,51,654	−88,522
5	2008–2009	1,85,295	3,03,696	−1,18,401
6	2009–2010	1,78,751	2,88,373	−1,09,621
7	2010–2011	2,51,136	3,69,769	−1,18,633
8	2010–11 (Apr–Dec)	1,72,965	2,69,175	−96,210
9	2011–12 (Apr–Dec)	2,17,664	3,50,936	−1,33,272
10	2013–14 (Apr–Jan)	2,58,721	3,75,253	−1,16,532
11	2014–15 (Apr–Jan)	2,65,037	3,83,411	−1,18,373

Source: Ministry of Commerce and Industry, India

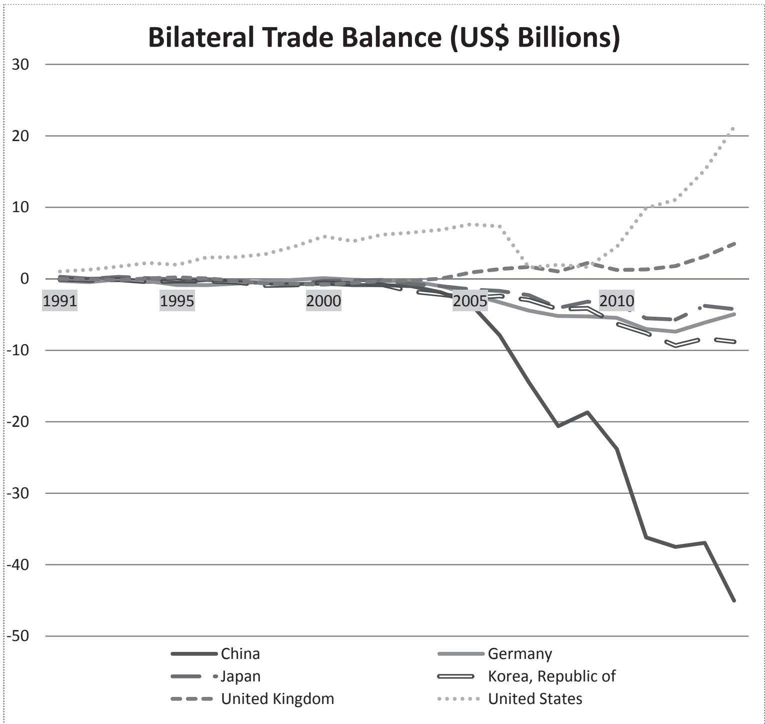
balance to the bilateral exchange rate of Indian rupee to the currency of its main trading partners. We choose to see the responsiveness of bilateral trade balance to exchange rate as against aggregate trade balance to exchange rate because of the following reason. Aggregate trade balance is the difference between sum of exports to all countries and imports from all countries. It fails to take into account differences in trade flows at the bilateral level. Figure 3 makes this point clear. It shows India's bilateral trade balance with six countries,



Source: International Financial Statistics, IMF

Figure 2 Bilateral Exchange Rate of the Indian Rupee vis-à-vis the Main Trading Partner's Currency

the United States (US), Germany, the United Kingdom (UK), Japan, South Korea, and China. From this figure, we can see that India has a trade deficit with all countries except for US and UK. Therefore, the use of bilateral trade balance in this research will be able to show differences in responsiveness of trade to exchange rate at the bilateral level.



Source: Direction of Trade Statistics, IMF

Figure 3 Bilateral Trade Balance of India with its main trading partners

The remainder of this paper is organized as follows. Section 2 presents the literature review. Section 3 explains the empirical model and variables. Section 4 presents the results. Finally, Section 5 concludes and presents scope for future research.

2. Literature Review

The literature that examines the effect of exchange rate on trade flows of a country can be divided into two groups. The first group does this by examining the responsiveness of price and income elasticity of exports and imports to exchange rate. Some of the early literature in this group include Senhadji (1998a, b), Clarida (1994), Reinhart (1995), Rose and Yellen (1989) and Rose (1991).[1] Proponents of this group investigate the relation between exchange rate and trade balance by examining the existence of Marshall–Lerner condition. Marshall–Lerner condition states that if the sum of elasticities of export and import demand is greater than one, then a depreciation of currency will improve the trade balance. Several studies have shown that the

1) All of them look at the responsiveness of export and import demand function to price changes. Clarida (1990) and Reinhart (1995) estimated trade elasticites using cointegeration analysis and error correction terms. Senhadji(1998a,b) used fully modified ordinary least squares method. Rose and Yellen (1989) and Rose (1991) used ordinary least squares and locally weighted regressions method respectively.

Marshal-Lerner condition can hold true in the long run but not necessarily in the short run. This is because in the short run export and import demand functions are not so elastic making them slow to respond to changes in exchange rate. This inelasticity of export and import demand functions in the short run could be because of various reasons, for instance: contract currency invoicing or firms trying to stabilize their prices in the host country or because consumers take time to respond to changes in exchange rate.

The second group of literature examines the effect of exchange rate on trade flows of a country by using the trade balance approach. This paper falls into that group. The earliest study that examines the short run and long run responsiveness of aggregate trade balance to exchange rate of India is Bahmani Oskooee (1986). His study measured trade balance in rupees as the difference between exports and imports and found that a depreciation of Indian rupee worsens the trade balance not only in the short run but also in the long run. On the contrary Himarios (1989) measured the trade balance in dollars rather than rupees and found no evidence of J-curve in the short run, but found devaluation improves India's trade balance in the long run. In contrast to the above results, Buluswar et al. (1996) and Kulkarni (1996), found evidence of J-curve effect. Their results showed that the trade balance worsens in the short run but improves in the long run. While the above studies looked at aggregate trade balance, Oskooee and Mitra (2009) tested the short-run effects of real depreciation of rupee as well as its long-run effects on the disaggregated trade balance of 38 industries. Their results showed that only 22 industries responded significantly to the real value of rupee in the short-run, and only in 8 industries did the J-curve hypothesis receive support. Based on the different results of the above mentioned studies, we can see that it is difficult to reach a decisive conclusion on the effect of exchange rate on trade flows of India. The results of these studies differ because of difference in time series methodology used or difference in sample period or method used to define trade balance (while some authors have defined trade balance as a ratio of exports and imports others define it as the difference between exports and imports).

The above mentioned two groups of literature look at India's aggregate trade balance with the world. However, bilateral response of trade flows to exchange rate can be different from aggregate response of trade flows as mentioned before; hence using aggregate trade flows can yield misleading results. There is a scarcity of literature that examines responsiveness of bilateral trade balance to exchange rate in the case of India. There are only two studies that deal with the responsiveness of bilateral trade flows to exchange rate in the case of India. They are Arora et al. (2010) and Dash (2013). Arora et al. (2010) use ARDL (Auto Regressive Distributed Lag method) bounds testing method on quarterly data from 1977 to 1998 to examine India's bilateral trade with Australia, France, Italy, Germany, Japan, UK and US. Dash (2013) uses Vector Error Correction method on monthly data from 1991 to 2006 for India's bilateral trade with US, UK, Japan and Germany. It is important to note that both these studies do not include in their analysis the recent period from 2003 to 2013 during which India experienced the coexistence of depreciation and trade deficit. Furthermore, none of these studies include China in their analysis inspite of the fact that China has become one of the biggest trading partners of India. Table 2 and Figure 3 show India has a growing trade deficit with China. This implies that not including China in an analysis of Indian trade flows could give an incomplete picture. Based on the above arguments, the objective of this paper is to examine the responsiveness of trade balance to bilateral exchange rate of India with its six main trading partners: United States, China, United Kingdom, Germany, Japan and South Korea.

Table 2 India's Trade Balance with Major Trading Partners 2013

	Trade Balance (US$ Millions)	Percentage Share
China	− 36939.500	24%
Germany	− 6116.596	4%
Japan	− 3777.321	2%
Korea	− 8353.257	5%
United Kingdom	3124.188	2%
United States	15231.110	10%
World	− 152822.777	100%

Source: Direction of Trade Statistics, IMF

3. Model and Variables

3. 1. Model:

The standard theoretical approach to look at responsiveness of exports, imports or trade balance to exchange rate is by using an imperfect substitute model. Utility maximizing consumers choose between a non traded domestic good and an imported good (Krugman and Baldwin, 1987), (Rose and Yellen, 1989), (Rose, 1991).

The model assumes that both exports and imports are imperfect substitutes for domestically produced goods, and provides a theoretical framework to examine the effect of exchange rate, on trade flows. The model is derived from foreign and domestic supply and demand for exports and imports, together with the market clearing condition that equates the domestic demand for imports to the foreign supply of exports.

$$M_d = M_d\,(RP_m, Y) \tag{1}$$

$$M_d^* = M_d^*\,(RP_m^*\,, Y^*) \tag{2}$$

Where M_d (and M_d^*) is the quantity of goods imported by the home (foreign) country;
RP_m is the relative price of imported goods to domestically produced goods measured in home currency;
RP_m^* is the relative price of imported goods for the foreign country, measured in foreign currency.
Y and Y^* are the levels of real income of the domestic and foreign country respectively.

Let 'e' be the nominal exchange rate expressed in terms of domestic currency per unit of foreign currency. The relative price of imported goods in the domestic currency can be expressed as

$$RP_m = e\,P^*_x / P = (e\,P^* / P^*\,P^*_x / P^*) = RER^*\,RP^*_x \tag{3}$$

where P^*_x is the foreign currency price of foreign exports. P and P* are the domestic and foreign price indexes of all goods.
RER is the real exchange rate, defined as $RER = eP^* / P$
and RP^*_x is the real foreign currency price of foreign country's exports.

Substituting RP_m from equation (3) into equation (1), gives the following equation

$$M_d = M_d\,(RP^*_x\,{}^*RER,\ Y) \tag{4}$$

Similarly, the foreign country's demand for imports depends upon foreign income and domestic relative export prices.

$$RP^*_x = l/e * P_x / P^* = l/e * P / P^* * P / P = 1/RER^*\,RP_x \tag{5}$$

$$M^*_d = M^*_d\,(RP_x / RER,\ Y^*) \tag{6}$$

where RP_x is the real domestic currency price of domestic exports. Finally, supplies of home (foreign) exports are taken as functions of the domestic (foreign) currency price received by domestic (foreign) exporters, and the home (foreign) price levels.

$$X_s = X_s\,(P_x, P)$$
$$X^*_s = X^*_s\,(P^*_x, P^*)$$

Equilibrium conditions require that domestic exports are equal to foreign exports and vice versa. Therefore,

$$M_d = X^*_s$$
$$M^*_d = X_s$$

Solving for levels of domestic imports and exports as well as relative price level of imports as a function of the real exchange rate, we can obtain the partial reduced form of the domestic trade balance as

$$TB = TB(RER, Y, Y^*) \tag{7}$$

Based on this theoretical foundation, the trade balance then becomes a function of three explanatory variables real exchange rate (RER), domestic income (Y) and foreign income (Y^*).

$$TB = f\,(RER, Y, Y^*)$$

We use equation (7) as the base of our empirical estimation. Therefore, the long run equilibrium model can be written as

$$\text{InTB}_{j,t} = a + b\text{InY}_{IN,t} + c\text{InY}_{j,t} + d\text{InRER}_{j,t} + \varepsilon_t \quad (8)$$

In equation (8) above,
InTB is the log of trade balance. Trade balance is a unit free measure defined as the ratio of the value of exports over the value of imports,

InY_{IN} is the log of industrial production index of India,

InY_j is the log of industrial production index of foreign country j,

$\text{InRER}_{j,t}$ is the log of real exchange rate. Real exchange rate is defined as $\text{NER}_t * {}^{P_{j,t}}/_{P_{IN,t}}$,

where NER_j is nominal exchange rate defined as Indian rupee per unit of foreign currency. P_j and P_{IN} are the Producer Price Index for the foreign country and India respectively. Therefore, an increase in RER can be interpreted as a depreciation of rupee.

We can incorporate short run dynamics into the above long run model to write it in the ARDL form following Pesaran et al. (2001) as follows:

ARDL Model

$$\Delta\text{InTB}_{j,t} = a + \sum_{i=1}^{n} b_i\, \Delta\text{InTB}_{j,t-1} + \sum_{i=0}^{n} c_i\, \Delta\text{InY}_{IN,t-i} \sum_{i=0}^{n} d_i\, \Delta\text{InY}_{j,t-i} + \sum_{i=0}^{n} e_i\, \Delta\text{InRER}_{j,t-i} + \delta_1\, \text{InTB}_{j,t-1} + \delta_2\, \text{InY}_{IN,t-1} + \delta_3\, \text{InY}_{j,t-1} + \delta_4\, \text{InRER}_{j,t-1} + \mu_t \quad (9)$$

This model is also called an unrestricted error correction model or conditional error correction model. The peculiarity of this conditional error correction model as compared to the usual error correction model lies in the fact that this model incorporates both short run and long run coefficients into a single equation. In equation (9), the short run coefficients are b_i, c_i, d_i and e_i. For each of the short run coefficients, the summation $\sum_{i=1}^{n}$ or $\sum_{i=0}^{n}$ stands for the appropriate lags orders. The lagged level variables represent the long run coefficients. At the long run equilibrium ΔInTB_j, ΔInY_{IN}, ΔInY_j and ΔInRER_j will be equal to zero such that the long run coefficients of InY_{IN}, InY_j, and InRER_j are $\left(\frac{-\delta_2}{\delta_1}\right)$, $\left(\frac{-\delta_3}{\delta_1}\right)$, $\left(\frac{-\delta_4}{\delta_1}\right)$ respectively. Lastly, μ_t shows the speed of adjustment to long run equilibrium.

The coefficient of the above variables can be expected to have the following signs:

The coefficient of ΔInRER_j can be positive or negative. It will be positive, if currency depreciation improves the trade balance in the short run. It will be negative if currency depreciation worsens the trade balance. For J curve to exist one should observe negative relation between exchange rate and trade balance at shorter lags and positive relation between trade balance and exchange rate at longer lags.

As for the long run coefficient of real exchange rate, that is the coefficient of InRER_j we expect it to be positive based on economic theory that currency depreciation will improve trade balance in the long run.

The short run and long run coefficient of domestic income in equation (9) that is log of Y_{IN} (InY_{IN}) can be either positive or negative. The coefficient will be negative if the increase in income increases the demand for imports. However, if the increase in domestic income is due to increase in production of import substitute goods, then the coefficient can be positive implying a reduction in the demand for imports. Similarly, the long run and short run coefficient of foreign income InY_j can also be either positive or negative.

3. 2. Data Description:

Data for all variables was collected from International Financial Statistics, IMF. All variables were seasonally adjusted using Census X12. The rupee per USD exchange rate was readily available. The bilateral exchange rate of all other countries vis-à-vis rupee was obtained by dividing rupee per unit of USD with foreign currency per unit of USD to get the exchange rate in terms of rupee per unit of foreign currency.

Data for the United States, the United Kingdom, Japan and South Korea, is for the period January, 1991 to September, 2014. In the case of Germany, we select the time period from January, 1999 to September, 2014 which is the period after the formation of the European Union. In the case of China, we select from January, 2000 to September, 2014 because of unavailability of data before that period. We start from 1991 as that was the period when India underwent massive trade liberalization reforms. The next section explains the empirical model used in our analysis.

3. 3. Steps in Empirical Method:

The advantage of using Auto Regressive Distributed Lag (ARDL) model developed by Pesaran et al. (2001) over older versions of error correction models is that ARDL model can be used even when the variables include a mixture of I (0) and I (I) variables. This means that the variables need not be integrated in the same order. Therefore, it does not require pre testing for unit root conditions. Nevertheless, a prerequisite for ARDL model is that none of the variables must be I (2) variables. A preliminary data analysis of our variables using ADF unit root tests shows that none of the variables are I (2).

We use the above model and variables to examine the long run and short run relation between trade balance and exchange rate between India and its six trading partners considered in our sample. Therefore, we have six sets of equation (8) and (9). We follow the following steps for our empirical estimation:

Step 1a: We set up the conditional model as in equation (9) with appropriate lags and check for long run cointegeration using different lags for all the variables. We test the null hypothesis of 'non-existence of the long-run relationship' between $TB_{j,t}$, $Y_{IN,t}$, $Y_{j.t}$ and $RER_{j,t}$. Therefore in equation (9), we test the hypothesis. $H_0 : \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$. In others words, we check the joint null hypothesis that the coefficient of all long run variables are equal to zero against the alternate hypothesis that there is at least one case where the coefficient of the long run variable is not equal to zero, implying there is cointegeration. The hypothesis is tested by using Wald test that gives an F-statistic. The calculated F-statistic is then compared with the critical values tabulated in Table CI (iii) on p.300 by Pesaran et al. (2001). If the calculated F-statistic lies above the upper level of the band, the null is rejected, indicating there is cointegeration. If the calculated F-statistic falls below the lower level of the band, the null cannot be rejected, supporting lack of cointegeration. If, however, it falls within the band, the result is inconclusive.

Step 1b: We compare the t-statistic of the lagged dependent variable of the conditional ARDL model in equation (9) with the bounds t-statistic critical value in Table CII (iii) on p.303 of Pesaran et al. (2001). If the calculated t-statistic lies above the upper level of the band of I (0) and I(1), the null is rejected, indicating there is cointegeration. This helps in reconfirming the result of Step 1a in checking for the existence of cointegrating relation.

Step 2: If there is long run cointegeration, we use the residual from the long run model in equation (8) above, to get the residual series. We call the residual series, the error correction term. We now estimate the ARDL model using appropriate lags of short run variables of equation (9) plus the lagged value of the error correction term. The result of this step will be able to show the following:

a) The existence or non existence of the J-curve. For J-curve to exist one should observe negative relation between exchange rate and trade balance at shorter lags and positive relation between trade balance and exchange rate at longer lags.

b) The speed of adjustment to the long run equilibrium. This can be seen by observing the coefficient of the error correction term. The error correction term must be negative and significant.

Step 3: We calculate the long run coefficient of the variables by observing the coefficient of the lagged variables in level of the ARDL model in equation (9). The long run coefficients of $InY_{IN,}$, InY_j, and $InRER_j$ can be calculated as, $\left(\frac{-\delta_2}{\delta_1}\right)$, $\left(\frac{-\delta_3}{\delta_1}\right)$, $\left(\frac{-\delta_4}{\delta_1}\right)$ respectively.

The next section presents the results of above empirical analysis.

4. Empirical Results

In this section, we present the step by step results of the empirical method explained in the previous section.

Following the first step in section 3.3, we begin by checking for cointegeration between the four variables using equation (9) with the appropriate lags. Many authors assert that the result bounds F-test is sensitive to lag selection criteria. The calculated F statistic for different lag lengths imposed on all the first-differenced variables is reported in Table 3. Comparing the calculated F-statistic in Table 3 with the bounds testing critical value presented by Pesaran et al. (2001)[2)] shows that for all countries under consideration, there is long run cointegeration among the four variables at two lags. (To confirm this result, in Appendix 1 of this paper, we check for the existence of cointegeration at two lags using Johansen Cointegeration test as well. The result from Johansen Cointegeration test also confirms that for two lags there is at least one cointegrating equation in long run). The BIC lag selection criterion also selects 2 lags for each set of equation.

Next, we set up our conditional ARDL model using two lags for all variables in equation (9) except

2) Please see Pesaran et al. (2001) Table 2 C (iii) Pg. 303.

Table 3 Calculated F-statistic for different lag length imposed on all the first-differenced variables

	2 lags	4 lags	6 lags	8 lags	12 lags
US	4.56	3.57	3.78	2.88	2.68
Japan	15.8	8.09	6.02	6.24	6.86
UK	7.69	3.46	3.12	2.03	0.78
Germany	5.14	1.95	1.57	1.77	1.67
South Korea	8.79	5.41	4.87	4.2	6
China	5.29	4.14	2.75	1.58	1.39

Note: For our case, where k= 3, the adjacent lower and upper bounds for the bounds F-test statistic at 5% significance level is [3.23, 4.35]. This value is taken from Table CI (iii) on p.300 of Pesaran et al. (2001).

Table 4 Calculated t statistic from conditional ARDL equation

	Calculated t statistic
India- US	−4.19
India-Japan	−6.33
India- UK	−5.28
India- Germany	−3.82
India- South Korea	−5.88
India- China	−4.37

Note: For our case, where k= 3, the adjacent lower and upper bounds for the bounds t-test statistic at 5% significance level is [-2.86, -3.78]. This value is taken from Table CII (iii) on p.303 of Pesaran et al. (2001).

for RER. In the case of RER we use six lags to begin with, and then follow a sequential lag reduction if the coefficient of the longest lag is not statistically significant.

The result of bounds t- statistic of Step 1b is presented in Table 4. The result from bounds t- test also fails to reject the hypothesis that there is cointegeration towards long run equilibrium.

Having confirmed the existence of cointegerating relation among the four variables from Step 1, we now proceed to set up our error correction model as described in Step 2 of Section 3.3. The results of a) and b) of Step 2 i.e. the results of short run coefficients of RER and error correction term are reported in Table 5.

For J-curve hypothesis to find support the sign of the coefficient of RER should be negative for short lags and positive for long lags in the short run and in the long run the coefficient of RER must be positive. Our results based on Table 5 does not support this hypothesis. Infact, there is no clear pattern that emerges from the response of trade balance to exchange rate in the short run for any of the countries. Based on the results of Table 5, we can say that only in the case of South Korea does real exchange rate have a statistically significant effect on trade balance in the short run for all lags under consideration, however a J-curve is not evident.

Table 6 shows the effect of income variables on trade balance in the short run. It is interesting to find that the effect is positive and very significant in the case of China and in the case of US it becomes significant with one lag.

Table 7 shows the long run effect of all the variables in our model on trade balance. The coefficients are

Table 5　Short Run response of Trade Balance to Exchange Rate

	US	Japan	UK	Germany	South Korea	China
$\Delta InRER_t$	0.60 (1.45)	−0.16 (0.16)	−0.07 (0.17)	−0.08 (0.19)	1.56** (2.57)	−0.003 (0.07)
$\Delta InRER_{t-1}$	−0.44 (1.06)	0.15 (0.15)	0.44 (0.99)	0.51 (1.28)	−1.07* (1.68)	−0.03 (0.64)
$\Delta InRER_{t-2}$	0.50 (1.20)	−2.06** (2.10)	−0.79 (1.76)	0.49 (1.21)	1.27** (2.11)	0.04 (0.75)
$\Delta InRER_{t-3}$	0.43 (1.04)		0.88 (−1.97)	−0.14 (0.34)		−0.09* (1.74)
$\Delta InRER_{t-4}$	−0.06 (0.15)		1.25*** (2.81)	−0.75* (−1.85)		0.02 (0.56)
$\Delta InRER_{t-5}$	−0.97** (2.35)					0.07* (1.81)
ECT_{t-1}	0.22*** (−4.02)	−0.64*** (−6.36)		−0.28*** (3.85)	−0.41*** (5.89)	−0.34*** (4.62)

* shows statistical significance at 10% level of significance ** shows statistical significance at 5 % level of significance.
*** shows statistical significance at 1% level of significance.
Figures in parentheses are the absolute value of the t ratios.

Table 6　Short Run response of Trade Balance to Income Variables

	US	Japan	UK	Germany	South Korea	China
$\Delta InY_{j,t}$	2.40 (1.89)	0.66 (0.54)	−0.81 (1.27)	0.12 (0.52)	0.03 (0.07)	0.15*** (3.05)
$\Delta InY_{j,t-1}$	2.72** (2.16)	−0.18 (0.14)	−1.22 (1.54)	0.08 (0.29)	1.42** (2.56)	0.02 (0.39)
$\Delta InY_{j,t-2}$		0.03 (0.02)	−1.00 (1.58)	−0.21 (0.87)	0.37 (0.75)	−0.01 (0.19)
$\Delta InY_{IND,t}$	−0.61 (1.48)	10.55*** (7.12)	0.56 (0.94)	−0.86 (1.61)	−0.22 (-0.27)	0.09 (0.11)
$\Delta InY_{IND,t-1}$	0.07 (0.16)	−1.68 (1.01)	1.58 (2.65)	−0.006 (0.01)	−0.02 (−0.02)	−0.07 (0.07)
$\Delta InY_{IND,t-2}$		2.41 (1.53)		−0.30 (0.54)	0.38 (0.49)	1.69** (2.01)

* shows statistical significance at 10% level of significance ** shows statistical significance at 5 % level of significance.
*** shows statistical significance at 1% level of significance.
Figures in parentheses are the absolute value of the t ratios.

obtained by normalizing the value of δ_2, δ_3 ,δ_4 on the value of δ_1 in equation (9), as mentioned in Step 3.

Based on the results of Table 7, we can say that in the long run there is a positive and significant relation between real exchange rate and trade balance only in the case of United States and South Korea. For Germany, there is a negative and significant relation between real exchange rate and trade balance. For United Kingdom, Japan and China the real exchange rate has no significant effect on trade balance even in the long run.

To summarise, we compare the main results of this chapter to the previous literature in this field. This is

Table 7　Estimated Long Run Coefficients normalized on the coefficient of TB(-1)

	Y ind	Y j	RER
US	− 0.3485 (-1.407)	0.564 (0.805)	2.94** (2.86)
Japan	0.057*** (3.01)	− 1.171 (0.05)	− 0.14 (0.15)
UK	− 0.43 (3.24)	2.41 (2.32)	− 0.45 (0.74)
Germany	− 0.16** (2.34)	− 0.08 (0.47)	− 0.27* (1.92)
South Korea	1 (1.29)	− 0.85(1.25)	1.75** (3.12)
China	− 1.15*** (4.20)	0.41** (2.03)	0.06 (0.84)

* shows statistical significance at 10% level of significance** shows statistical significance at 5 % level of significance.
*** shows statistical significance at 1% level of significance.
Figures in parentheses are the absolute value of the t ratios.

presented in Table 8. Table 8b) compares our results for the short run with results of previous literature. For the short run, our research found that only in the case of South Korea does real exchange rate have a significant effect on trade balance. Table 8c) compares our results for the long run with results of previous literature. Arora et al. (2010) found that in the long run there is a positive and significant relation between real exchange rate and India's trade balance with Germany and Japan. And the effect of real exchange rate was not significant on India's trade balance with United States and UK. Dash (2013) found a statistically significant relation between real exchange rate and trade balance in the long run with all four countries in their sample, US, UK, Japan and Germany. They found this relation to be positive in India's trade with Germany, Japan and UK. But they found a negative long run relation between real exchange rate and India's trade balance with US. Our results found the contrary, for Germany we found that rupee depreciation worsens the trade balance even in the long run. And in the case of Japan, the effect of currency depreciation on trade balance is not statistically significant in the long run. Furthermore, we found that a depreciation will improve India's trade balance with US in the long run. This result finds support in Figure 3 which shows that India's trade balance with United States has improved over the years alongside rupee depreciation implying that a currency depreciation could have had some effect on improving trade balance. We found a similar positive result in the case of South Korea in the long run. For all the other countries, including China, exchange rate has no statistically significant effect on trade balance. This could explain why India's trade balance with these countries has not improved in spite of the depreciation of its currency viz these countries, as seen in Figure 3.

5. Conclusion

Indian current account has persistently seen a trade deficit with some of its main trading partners even though Indian rupee has seen a steady depreciation against the currency of its trading partners. This raises the

Table 8 Comparison of Results across Existing Literature

a) Scope	Arora et al (2010)	Dash (2013)	This Research
Period	Quarterly 1977 to 1998	Monthly 1991 to 2006	Monthly 1991 to 2014
Countries Included	Australia, France, Italy, Germany, Japan, UK and US	US, UK, Japan and Germany	China, Japan, Germany, South Korea, UK and US
Method	Auto Regressive Distributed Lag Model (ARDL)	Vector Error Correction Method (VECM)	Auto Regressive Distributed Lag Model (ARDL)

b) Effect of RER on TB with India in SR (J curve)	Arora et al. (2010)	Dash (2013)	This Research
China	…	….	No
Japan	No	Yes	No
Germany	No	Yes	No
South Korea	….	…	Yes
UK	No	No	No
US	No	No	No

c) Effect of RER on TB with India in Long Run	Arora et al. (2010)	Dash (2013)	This Research
China	…	…	(+) Not significant
Japan	(+) Significant	(+) Significant	(−) Not significant
Germany	(+) Significant	(+) Significant	(−) Significant
South Korea	…	…	(+) Significant
UK	(+) Not significant	(+) Significant	(−) Not significant
US	(−) Not significant	(−) Significant	(+) Significant

question as to how responsive are Indian trade flows to changes in exchange rate. With this background, in this paper we set out to examine the effect of exchange rate on trade balance between India and its six main trading partners including China, Japan, Germany, South Korea, UK and USA. Our results find that in the short run, except in the case of South Korea, bilateral real exchange rate does not have a statistically significant effect on India's trade balance. Furthermore, our results found no evidence to support the J-curve hypothesis in any of the 6 cases. In the long run, currency depreciation can lead to improvement of trade balance only in the case of US and South Korea. In the case of Germany, currency depreciation worsens the trade balance even in the long run. In the case of all other countries, there is no statistically significant effect of real exchange rate on trade balance even in the long run.

The theory of international trade tells us that currency depreciation should improve the trade balance in the long run so long as the Marshall-Lerner condition is met. However, there can be many reasons why changes in real exchange rate fail to have a significant effect on trade balance. One possible reason can be that firms pursue peculiar pricing behaviour in the market such that they do not change their prices in response to relative price changes, making supply relatively inelastic even in the long run. Second possible reason for this could be due to difference in the nature of the traded commodities. Some type of goods may be less responsive to changes in exchange rate than others. For instance, the effect of changes in exchange rate could be different on intermediate goods and final goods. Intermediate goods have less substitutes and this makes demand for them less responsive to changes in exchange rate. For e.g. India trades with China mostly in intermediate goods, this could be one reason why the effect of real exchange rate on bilateral trade balance was not statistically significant in the result of our analysis. Therefore, theoretical and empirical studies on the differential effect of exchange rate on trade balance of different types of commodities can be an interesting topic for future research.

Bibliography

Arora, S., Oskooee, B. M., & Goswami, G. M., (2010) "Bilateral J-curve between India and her trading partners" *Applied Economics*, 35:9, 1037–1041

Buluswar, M., Thompson, H., and Upadhyaya, K., (1996) "Devaluation and the Trade Balance in India: Stationarity and Cointegeration" *Applied Economics*, 28, 429–32

Clarida, R. H., (1994) "Co-integration Aggregate Consumption and the Demand for Imports: A Structural Econometric Investigation" *American Economic Review*" , 84:3, 298–308

Dash, A. K., (2013) "Bilateral J-Curve between India and Her Trading Partners: A Quantitative Perspective" *Economic Analysis & Policy*, 43: 4

Himarios, D. (1989) "Do devaluations improve the trade balance? The evidence revisited" *Economic Inquiry*, 27, 143–68

Krugman, P. R., and Baldwin, R. E., (1987) "The Persistence of the US Trade Deficit" *Brooking Papers on Economic Activity*, 1, 1–43

Kuboniwa, M., (2014) "Bilateral Equivalence between Trade in Value-Added and Value Added Content of Trade" *Hitotsubashi University Discussion Paper Series* A, No. 601

Kulkarni, K. G., (1996) "Balance of Payments Changes and the Exchange Rate Devaluation: A case of India" *The Indian Journal of Economics*, 303, 1–18

Magee, S. P., (1973) "Currency contracts, pass through and devaluation" *Brooking Papers on Economic Activity*, 1, 303–25.

Oskooee, B. M., (1985) "Devaluation and the J-Curve: Some Evidence from LDCs" *The Review of Economics and Statistics*, 67:3, 500–504

Oskooee, B. M., (1986) "Determinants of International Trade Flows: The Case Of Developing Countries" *Journal of Development Economics*, 20, 107–23

Oskooee, B. M., and Kara, O., (2005) "Income and Price Elasticities of Trade: Some New Estimates" *The International Trade Journal*, 19:2, 165–178

Oskooee, B. M., and Mitra, R., (2009) "J-curve at the Industry Level: Evidence from US-India Trade" *Economics Bulletin,* 29, 1520–1529

Pesaran, M. H., Shin, Y. and Smith, R. J. (1996) "Testing for the Existence of A Long-Run Relationship" *DAE Working Paper* No. 9622, Department of Applied Economics, University of Cambridge

Pesaran, H., and Shin, Y., (1998) "An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis" *Centennial Volume of Ragner Frisch*, ed. by S. Strom, A. Holly, and P. Diamon, Cambridge University Press

Pesaran, M. H., Shin, Y., and Smith, R. J., (2001) "Bounds Testing Approaches to the Analysis of Level Relationships" *Journal of Applied Econometrics*, 16:3, 289–326

Reinhart, C. M., (1995) "Devaluation, Relative Prices, and International Trade" *IMF Staff Papers*, 42, 290–312

Rose, A. K., (1991) "The Role of Exchange Rates in a Popular Model of International Trade: Does Marshall-Lerner Condition hold?" *Journal of International Economics,* 30, 301–316.

Rose, A. K., and Yellen J. I., (1989) "Is there a J-curve?" *Journal of Monetary Economics* 24, 53–68

Senhadji, A., (1998) "Time-Series Estimation of Structural Import Demand Equations: A Cross-Country Analysis," *IMF Staff Papers,* 45: 2

Senhadji, A., and Montenegro, C., (1998a) “Time-Series Estimation of Export Demand Equations: A Cross-Country Analysis” *IMF Staff Papers*, 98: 149

Stock, J. H., and Watson, M.W., (1988) “Testing for Common Trends” *Journal of the American Statistical Association*, 83, 1097–1107

Appendix 1: Johansen Cointegeration Test

a. Johansen Cointegeration Test (India-US)

Null Hypothesis	Alternate Hypothesis	Trace Statistics	0.05 Critical Value	Probability
r=0	r>0	78.17	48.85	0.00
r≤1	r>1	21.65	21.79	0.31
r≤2	r>2	6.65	15.49	0.61
r≤3	r>3	1.26	3.84	0.26

Null Hypothesis	Alternate Hypothesis	Max Eigen Statistics	0.05 Critical Value	Probability
r=0	r=1	56.51	26.58	0.00
r=1	r=2	15.00	21.13	0.28
r=2	r=3	5.38	14.26	0.69
r=3	r=4	1.26	3.84	0.26

b. Johansen Cointegeration Test (India-Japan)

Null Hypothesis	Alternate Hypothesis	Trace Statistics	0.05 Critical Value	Probability
r=0	r>0	103.71	47.85	000
r≤1	r>1	36.32	29.79	0.00
r≤2	r>2	10.51	15.49	0.24
r≤3	r>3	0.45	3.84	0.50

Null Hypothesis	Alternate Hypothesis	Max Eigen Statistics	0.05 Critical Value	Probability
r=0	r=1	67.39	27.58	0.00
r=1	r=2	25.81	21.13	0.01
r=2	r=3	10.06	14.26	0.20
r=3	r=4	0.45	3.84	0.50

c. Johansen Cointegeration Test (India-UK)

Null Hypothesis	Alternate Hypothesis	Trace Statistics	0.05 Critical Value	Probability
r=0	r>0	61.56	47.85	0.001
r≤1	r>1	27.32	29.79	0.09
r≤2	r>2	11.35	15.49	0.19
r≤3	r>3	1.344	3.84	0.24

Null Hypothesis	Alternate Hypothesis	Max Eigen Statistics	0.05 Critical Value	Probability
r=0	r=1	34.24	27.58	0.006
r=1	r=2	15.97	21.13	0.22
r=2	r=3	10.00	14.26	0.21
r=3	r=4	1.344	3.84	0.24

d. Johansen Cointegeration Test (India-Germany)

Null Hypothesis	Alternate Hypothesis	Trace Statistics	0.05 Critical Value	Probability
r=0	r>0	60.49	47.85	0.00
r≤1	r>1	29.74	29.79	0.05
r≤2	r>2	7.07	15.49	0.56
r≤3	r>3	1.80	3.84	0.17

Null Hypothesis	Alternate Hypothesis	Max Eigen Statistics	0.05 Critical Value	Probability
r=0	r=1	30.75	27.58	0.01
r=1	r=2	22.66	21.13	0.03
r=2	r=3	5.27	14.26	0.70
r=3	r=4	1.80	3.84	0.17

e. Johansen Cointegeration Test (India-South Korea)

Null Hypothesis	Alternate Hypothesis	Trace Statistics	0.05 Critical Value	Probability
r=0	r>0	67.37	47.85	0.00
r≤1	r>1	30.08	29.79	0.04
r≤2	r>2	10.88	15.49	0.21
r≤3	r>3	1.01	3.84	0.31

Null Hypothesis	Alternate Hypothesis	Max Eigen Statistics	0.05 Critical Value	Probability
r=0	r=1	37.29	27.58	0.00
r=1	r=2	19.19	21.13	0.09
r=2	r=3	9.87	14.26	0.22
r=3	r=4	1.01	3.84	0.31

f. Johansen Cointegeration Test (India-China)

Null Hypothesis	Alternate Hypothesis	Trace Statistics	0.05 Critical Value	Probability
r=0	r>0	73.84	47.85	0.00
r≤1	r>1	36.85	29.79	0.00
r≤2	r>2	15.86	15.49	0.04
r≤3	r>3	1.27	3.84	0.25

Null Hypothesis	Alternate Hypothesis	Max Eigen Statistics	0.05 Critical Value	Probability
r=0	r=1	36.99	27.58	0.00
r=1	r=2	20.98	21.13	0.05
r=2	r=3	14.59	14.26	0.04
r=3	r=4	1.27	3.84	0.25

Note: ‘r’ refers to the number of co-integrating vector which are significant under both tests.

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