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COINTEGRATION APPROACH TO ESTIMATE INDIA'S TRADE ELASTICITIES

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ABSTRACT

The present paper has made an attempt to estimate the import and export demand elasticity for India using sample period 1974-2013. Both the export and import demands has been specified as a function of activity variable, and real effective exchange rate. As the time series data suffers from the problem of non-stationary, the application of ordinary least square method of estimation may lead the spurious relationship among the variables in the models. Therefore, the existence of long-run equilibrium relationship for the models is tested in terms of two alternative cointegration tests, namely the bound test and the error correction test. The results show the existence of long-run equilibrium relationship for the import demand in terms of bound test, and for the export demand model in terms of error correction test. Using the ARDL frame work, the long-run and short-run elasticities have been derived in the present study. In the long-run, both export and import demands are found to be elastic with respect to activity variables. In case of export demand, the coefficient of real effective exchange rate bears expected positive sign. A 10% depreciation of India's rupee would increase India's real export by 4%. In the import demand function, the coefficient of real effective exchange rate although bears expected negative sign, but failed to be statistically significant. In the short run, the elasticities of trade equations are found to be relatively lower than in the long-run. The stability test supports that parameters of the both models were quite stable during the sample period.

KEYWORDS

BDM test, bound Test, cointegration, elasticities, effective exchange rate.

JEL CLASSIFICATION

F14; C32.

INTRODUCTION

India has always experienced a deficit in the current account of the balance of payment except in few years. The huge volume of trade deficit is one of the main reasons behind the persistent deficit in the current account of our country. The fluctuation in exchange rate causes the changes in the trade balance. For example, the depreciation in the exchange rate of rupee makes the imports costly and the export cheaper. The export demand from the foreign countries is likely to increase while the import demand is likely to decrease. As a result, the trade balance is likely to improve for our country. Other factors which might affect the volume of trade balance are domestic income, and the volume of world trade. An increase in the domestic income is likely to raise the volume of import demand implying higher amount of trade deficit. On the other, an increase in world trade is expected to raise world's demand for India's exports implying a reduction in the trade deficit. The investigations of the determinants of trade flows are directed towards the measuring effects of currency depreciation on the trade balance.

In order to measure the effect of devaluation on the trade balance, the price elasticities of export and import demand functions are estimated in the traditional approach. If the sum of price elasticities in absolute term is greater than unity, then it is said that the policy of depreciation will improve a country's trade balance following the Marshall-Lerner condition. Generally, the export demand is specified as a function of world income and relative export prices while the import demand is specified as a function of domestic income and relative import prices. There exists a close linkage between the trade balance and exchange rate policies in any economy. One primary objective of present study is to quantify the direct impact of real effective exchange rate on India's exports and imports.

REVIEW OF LITERATURE

There exists a lot of literature on modelling trade flows. The first noticeable study was made by Orcutt (1950). He estimated the income and price elasticities of trade flows for industrial countries, and found that the trade flows were sensitive to changes in relative price. Khan (1974) estimated the trade equations for fifteen developing countries including India using sample period 1951-1969. In his study, the export demand was specified as a function of world income, and relative export prices while the import demand was specified as a function of domestic income, and relative import prices. Applying OLS method, he found that the price variable was statistically significant in explaining both the import and export demand functions. The most existing studies uses income and relative price variables in export and import demand models (Goldstein and Khan, 1985; Houthakker and Magee, 1969). In those studies, the effect of devaluation on trade balance is evaluated in terms of price elasticities of trade equation via Marshall-Lerner condition.

In a study by Junj and Rhomberg (1973), the trade flows were estimated for thirteen developed countries in terms of partial co relation between trade flows, prices and exchange rate. The result shows that the response of market share of trade flows to the exchange rate and prices have similar result. The trade flows for six develop countries were considered by Wilson and Takacs (1979) for the period 1957-1961. The study estimated export and import demand function in order to measure the relative response with respect to exchange rate and prices. Warner and Kreinin (1983) also included the exchange rate variable in the models for export and import. The main aim of their study was to estimate the effect of exchange rate under the floating exchange rate regime. The study did not highlight the Marshall-Lerner condition. In the study by Reinhart (1995), the effect of devaluation on trade flows was estimated for twelve developing countries, and found that the effect of devaluation was significant in most cases. One study was made by Bahamani-Oskooee (1986) for seven developing countries including India. He estimated both import and export demand functions using quarterly data from 1973-1980. He found that the effective exchange rate had an important effect on imports as well as exports for developing countries. However, this study did not test the Marshall-Lerner condition which is needed for the devaluation to be successful for a country. One limitation of such study is that the time series property of data series was not tested. Sinha (2011) has studied the trade equations for five Asian countries including India. In case of India, he estimated the export demand function using annual data from 1960 to 1996, and the import demand function using annual data from 1950 to 1996. Using Johansen-Julesius method (1990), no cointegration was found both for the export demand as well as import demand. The OLS method was applied for the export demand function while the Cochran-Orcutt autoregressive method was applied for the import demand function. The export demand was inelastic with respect to income and relative price. In explaining the import demand, the coefficient of income was negative and statistically insignificant. Further, the import demand was price inelastic.

Eita (2013) has estimated the export and import demand function for Namibia. He applied J-J multivariate method of co-integration using annual data from 1991-2011. The study has found one co-integration vector for each equation. The export demand has been specified as a function of world income and real effective exchange rate while the import demand function has been specified as a function of domestic income and real effective exchange rate. Both import demand and export demand have been found to be highly elastic. Further, the exchange rate variable has been found to be significant in explaining both import demand and export demand functions. The exchange rate elasticity for export demand is 0.44 and for import demand, it is -0.90. He concluded that the Marshall-Lerner condition is satisfied for Namibia as the sum of absolute values of exchange rate elasticity is greater than unity.

STATEMENT OF THE PROBLEM

There exist the limited studies where the exchange rate variable has been incorporated in the model explicitly. One advantage of such models is that the effect of devaluation on export and import can be measured directly. This kind of study has been made for Chaina by Thorbecke (2006), Japan by Bahamani-oskooee and Goswami (2004), for the USA by Chinn (2005), Mann and Pluck (2005). To the best of my knowledge, this kind of study is scarce for India. The previous studies (Bahamani-Oskooee, 1986, Khan, 1974) on India's trade elasticities did not deal with the issue of non-stationarity of the variables. As the macro variables are likely to be non-stationary in level form, the above study are likely to suffer from the problem of spurious relation (high value of R^2 and significant t statistics). In other words, the cointegration technique was not applied in case of non-stationarity in variables. Sinha (2011) study applied the JJ method of estimation which suffers from small sample bias (Mah, 2000, Pattichis, C., 1999). The present study deals with these issues with the application of recently developed two techniques to cointegration, namely the bound test and the error correction test. Further, the real effective exchange rate has been incorporated in the models in order to assess the direct effect of depreciation on export and import demands.

OBJECTIVES

The objectives of the present studies are:

1. To examine the existence of long-run equilibrium relationship both for the export and import demand functions.
2. To estimates the elasticities of India's export and import demands using the advanced econometric method.
3. To evaluate the policy of depreciation on real exports and imports.
4. To test the Marshall-Lerner condition.
5. To test the parameters stability over the sample period.

ANALYTICAL FRAMEWORK

In the conventional trade models, both the export and import demand is specified as a function of activity variables and the price variables. The activity variable is world income in the case of export demand while the activity variable is domestic income the case of import demand. However, in the present study, the activity variable is world imports in the case of export demand function (Sarkar, 2004)). Further, the real effective exchange rate has been used as proxy for price variables. One advantage of such specification is that the effect of devaluation on exports as well as imports can be measured directly. Secondly, the information on exchange rates is more accurate than those on export and import prices.

THE MODELS

The export demand function (X) is specified as a function of world imports (MW), and real effective exchange rate (REER) while the import demand function (M) is specified as a function of domestic income (Y) and real effective exchange rate (REER). Both the functions are expressed in log-linear form.

The export demand function: $X_t = a_0 + a_1.MW_t + a_2.\ REER_t + U_{1t}$ (1)

Where a_1 and a_2 measure the elasticity of export demand with respect to world imports and real effective exchange rate respectively. The expected signs of $a_1>0$, and $a_2>0$.

The import demand function: $M_t = b_0 + b_1.Y_t + b_2.REER_t + U_{2t}$ (2)

Where, b_1, and b_2 measure the elasticity of import demand with respect to domestic income and real effective exchange rate respectively. The expected signs of $b_1>0$, and $b_2<0$.

Where, X= Log of real India's export; M= Log of real India's imports; MW= Log of world real imports; REER= Log of real effective exchange rate and Y= Log of India's real GDP.

DATABASE

All the data series have been collected from IMF's International Statistics except real effective exchange. The value of India's exports is taken in US dollars. It has been deflated by unit value index of exports to convert it in real term. Similarly, the value of world imports in dollars has been deflated by unit value index of world imports to convert it in real term. The value of India's imports has been deflated by unit value index of import to convert it in real term. The index of real effective exchange rate of India's rupee is based on 36 countries bilateral weights. It is compiled from statistics released by RBI, various issues.

DATA ANALYSIS

As we deal with time series data, there may the problem of non-stationarity implying the spurious relationship among the variables. Therefore, we employ the augmented dickey-fuller (ADF) test for unit root. We perform ADF test both with intercept and no trend, and with an intercept and trend. The test assumes the null hypothesis of non-stationarity of the time series against the alternative hypothesis of stationarity. Table 1 shows that the estimated values of ADF-statistics with, and without trend in absolute terms does not exceed the critical value for all variables in level form. Therefore, the application of OLS method of estimation would lead spurious relationships for the demand models. However, the estimated value of ADF-statistics in absolute terms exceeds the critical value for all variables in first difference. Hence, the cointegration technique has to applied for the long-run relationship.

TABLE 1: AUGMENTED DICKEY-FULLER TEST

Variables /ADF Statistics	Level/First Difference	Constant No Trend	Constant With Trend
M_t (India's imports)	Level	0.233	-2.728
	First Difference	-4.449	-4.514
MW_t (World imports)	Level	0.115	-2.226
	First Difference	-4.931	-4.888
$REER_t$ (Real effective exchange rate)	Level	-1.706	-1.219
	First Difference	-5.038	-5.236
Y_t (India's real GDP)	Level	2.592	-0.626
	First Difference	-4.553	-5.784
X_t (India's exports)	Level	1.229	-1.537
	First Difference	-4.849	-5.275

Note: 1. 95% Critical value for ADF statistics without trend = -2.935,
2. 95% Critical value for ADF statistics with trend = -3.524.

RESEARCH METHODOLOGY

The most widely used two cointegration techniques are Engle-Granger residual based test (1987) and Johansen-Juselius maultivariate test (1990). One limitation of such techniques is that they are not reliable for small sample (Mah, 2000). Further, no conintegration can be found among the variables that are integrated of order one for small sample (Kremers et al., 1992). Another limitation with these tests is that variables within the model must be stationary of equal order of integration.

In the present study, two tests for cointegration are adopted for the export and import demand functions. First one is the ARDL-based bound test (Pesaran et al., 1995), and second one is the error correction test (Banerjee et al., 1998). Pesaran and others have suggested the bound test for cointegration using auto regressive distributed lag (ARDL) model. One advantage of this approach is that this method can be applied even when the variables follows the different orders of integration. Secondly, the bound test is suitable even for a small sample. Thirdly, a dynamic error-correction representation can be derived from the ARDL model through a simple linear transformation (Banerjee et. al., 1998). This approach does not push the short-run dynamics into the residual term as in the case of Engle-Granger technique (Pattichis, 1999). Fourthly, the bound is applicable even when there are some endogenous explanatory variables in the model. Finally, this approach corrects the serial correlation among the residuals. For the bound test towards cointegration, an unrestricted error correction models (UECM) must be specified from the export and import demand functions (equations 1 and 2). Following Pesaran, the above trade equations may be expressed in the following maner:

Export demand function in unrestricted error correction framweork:

$$DX_t = c_0 + c_1.X_{t-1} + c_2.\ MW_{t-1} + c_3.\ REER_{t-1} + c_4.\ \sum DX_t + c_5.\ \sum DMW_t + c_6.\ \sum DREER_t + €_t \quad (3)$$

Import demand function in unrestricted error correction framweork:

$$DM_t = d_0 + d_1.\ M_{t-1} + d_2.\ Y_{t-1} + d_3.\ REER_{t-1} + d_4.\ \sum DM_t + d_5.\ \sum DY_t + d_6.\ \sum DREER_t + £_t \quad (4)$$

Where, D: Ist difference operator.

The bound method test has been applied to the models (3 & 4) imposing joint restrictions of zero coefficient to all lagged variables **(**$H_0 : c_1 = c_2 = c_3 = 0$ for equation 3; & $H_0 : d_1 = d_2 = d_3 = 0$ for equation 4). Under the null hypothesis, it is assumed that there does not exist any long-run equilibrium relationships. In the bound test, the F-test has a non-standard distribution, and is dependent on the number of regressors. The critical values of F-statistics for lower and upper bound have been tabulated by Pesaran et al. (2001). The lower critical value of F has been tabulated using assumption that all variables under consideration are purely stationary in the process. The upper critical value of F has been tabulated using the assumption that all variables under consideration are stationary in the first difference. If the calculated value of F is greater than the upper bound, then the null hypothesis of no-cointegration is rejected. If the calculated value of F is lower than the lower value of F-statistics, then the null hypothesis of no-cointegration is accepted. Finally, if the calculated value of F lies between lower and upper bounds, then the decision is in-conclusive.

Another test of cointegration is BDS (Banerjee-Dolado-Mestre) test which is also applied in the present study. This test is suggested by Banerjee, Dolado and Mestre (1998) within a single equation framework. This test is done in terms of significance of the lagged error term in the error correction models.

RESULTS & FINDINGS

COINTEGRATION TEST

The result of bound-test has been reported in table 2. As the sample size in the present study is relatively small (fourty observations), the critical values of upper and lower bounds of F-statistics have been extracted from Narayan (2005). The null hypothesis of zero restrictions on lagged variables (equation 3 & 4) is tested according to Schwarz Bayesian Criterion. In the case of import demand, the tabulated value of F-statistics (5.361) is greater than the critical values of upper bound of the F-statistics at 5 and 10 per cent significance level. Therefore, there exists a long-run relationship between the import demand and its determinants. However, in the case of export demand, the tabulated value of F-statistics (3.044) is less than the critical value of lower bound even at 10 per cent significance level. Therefore, the null hypothesis of no cointegration cannot be rejected for the export demand function.

TABLE 2: TEST FOR COINTREGATION (SAMPLE: 1974-2013)

Bounds F-test sample size = 40; Parameters=2.				
Critical value bounds of F-statistics: intercept and no trend*				
	5 per cent level		10 per cent level	
	I(0)	I(1)	I(0)	I(1)
	4.133	5.260	3.373	4.377
Calculated F-statistics: Export Demand Function F(X / MW, REER): F(3, 31)= 3.044				
Calculated F-statistics: Import Demand Function F (M/ Y, REER): F(3, 28)= 5.361				

*Note: Critical value of bounds F-statistics are taken from table in appendix, case.III: unrestricted intercept and no trend Narayan (2005, p.1988).

LONG-RUN ELASTICITIES

The long-run elasticities of export and import demand derived from the ARDL models are shown in table 3. In case of export demand, the coefficients of world import and effective exchange rate bear the expected positive sign, and statistically significant. The export demand is elastic with respect to world import, but inelastic with respect to exchange rate. One per cent increase in world import would raise export demand by 1.6 per cent while one per cent increase in India's effective exchange rate would raise her export demand by 0.4 percent. In case of import demand, the coefficients of domestic income and effective exchange rate bear the expected positive and negative signs respectively. Although, income is statistically significant variable, real effective exchange rate is not statistically significant variable in explaining India's import demand. The import demand is elastic with respect to domestic income. One per cent increase in domestic income would raise import demand by 1.7 per cent.

TABLE 3: LONG-RUN ELASTICITIES FROM ARDL FRAMEWORK

Dependent variable: X_t	Export Demand Function: ARDL(1,0,1) selected based on Schwarz Bayesian Criterion	
Regressors	Long-run elasticity	't'-statistics'
MW_t	1.674	20.154
$REER_t$	0.410	1.790
Intercept	-2.282	-1.747
Dependent variable: M_t	Import Demand Function: ARDL(1,0,0) selected based on Schwarz Bayesian Criterion	
Regressors	Elasticity	't'-statistics'
Y_t	1.703	9.800
$REER_t$	-0.288	-0.402
Intercept	-1.498	-0.402

@ Note: (1) all the variables are expressed in logarithm terms. (2) *: significant at 5 % level.

SHORT-RUN ELASTICITIES

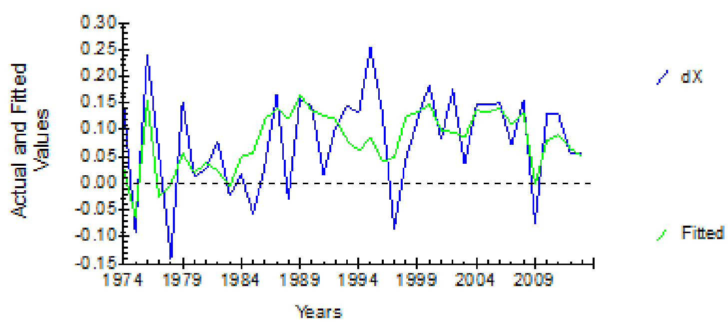
The short-run elasticities derived from error correction models are presented in table 4. It shows that the trade elasticities are lower in the short-run than in the long-run. The export demand is inelastic with respect to world imports while the import demand is inelastic with respect to domestic income. The effect of exchange rate on export demand is negative in the short-run implying J-curve phenomenon. However, it is statistically insignificant variable. The coefficient of error correction term is negative and statistically significant at 1 per cent level for the export demand model. This reveals the evidence of cointegration relationship between export demand, and it's determinants as per BDM approach to cointegration. The speed of adjustment towards equilibrium are 0.31 and 0.26 for export and import demand respectively. The plots of actual and fitted values for the export and import demands are shown in graph. 1 and graph. 2 respectively. It reveals that both the models have performed well; particularly in the main turning points.

TABLE 4: SHORT-RUN ELASTICITIES FROM ERROR CORRECTION MODEL

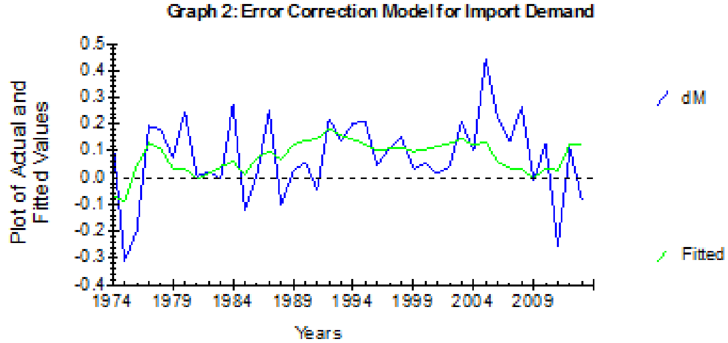
Dependent variable: DX_t	Export Demand Function	
Regressors	Elasticity	't'-Statistics'
DMW_t	0.530	3.248
$DREER_t$	-0.132	-0.947
Intercept	-0.723	-1.371
ECM(-1)	-0.316	-3.179
R-Squared.56297 R-Bar-Squared.49017 S.E. of Regression.077792 F-stat. F(3, 36) 6.6475[.001] Akaike Info. Criterion 43.0615 Schwarz Bayesian Criterion 38.8393 DW-statistic 1.9005		
Dependent variable: DM_t	Import Demand Function	
Regressors	Short-run elasticity	't'-Statistics'
DY_t	0.456	2.484
$DREER_t$	-0.077	-0.491
Intercept	-0.401	-1.833
ECM(-1)	-0.267	-1.591
R-Squared.36302 R-Bar-Squared.303274 S.E. of Regression.14376 F-stat. F(3, 36) 2.3373[.090] Akaike Info. Criterion 18.9336 Schwarz Bayesian Criterion 15.5558 DW-statistic 1.7565		

@ Note: (1) all the variables are expressed in logarithm terms. (2) *: significant at 5 % level.

Graph1:Error Correction Model for Export Demnad



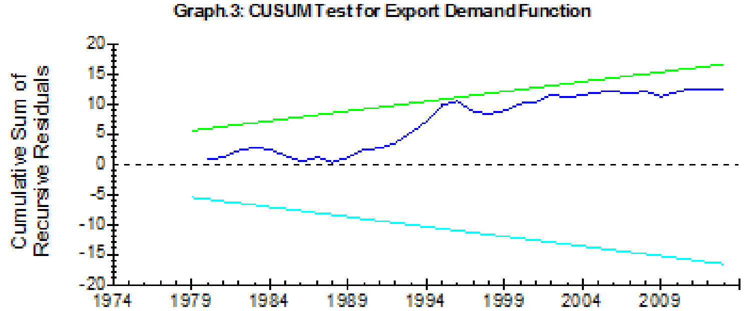
Graph 2: Error Correction Model for Import Demand



STRUCTURAL STABILITY

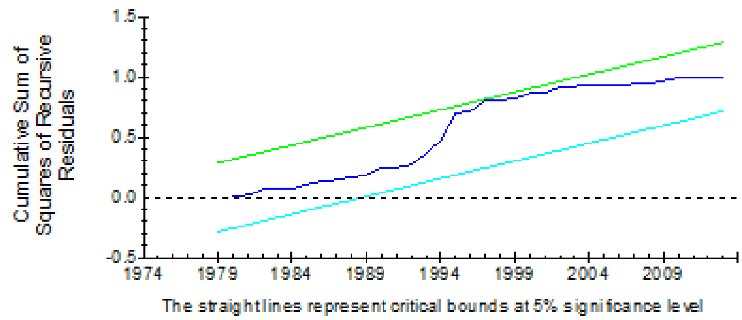
Using the CUSUM and CUSUMQ statistics (Brown et al., 1975), the structural stability of error correction model both for export and import demand functions have been tested within the sample period. Graphs 3 and 4 show the CUSUM and CUSUMQ statistics for export demand function while graphs 5 and 6 show the CUSUM and CUSUMQ statistics stability test for import demand function respectively. These graphs show that the recursive residuals of the import and export demand functions were fluctuated within the ±2 standard error bands. All the statistics fall within the critical lines at 5% significant level. The residual tests show that the models were quite stable during the sample period under estimation.

Graph.3: CUSUM Test for Export Demand Function

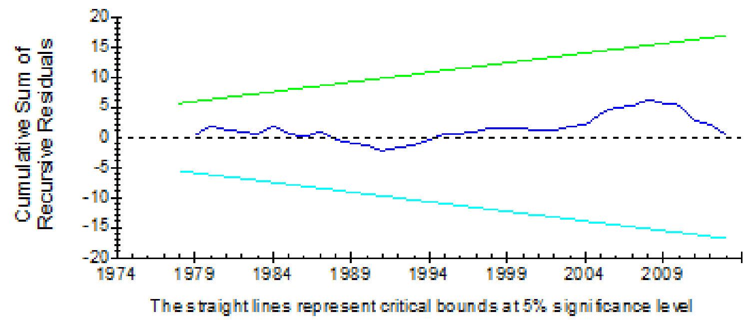


The straight lines represent critical bounds at 5% significance level

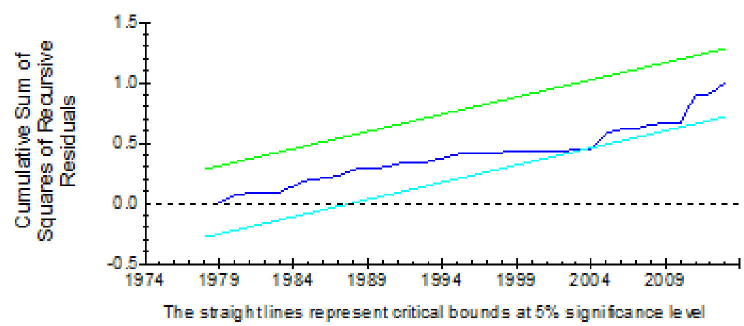
Graph 4. CUSUMQ Test for Export Demand Function



Graph 5. CUSUM Test for Import Demand Function



Graph 6.: CUSUMQ Test for Import Demand Function



SUMMARY & CONCLUSIONS

The present paper analyses the behaviours of import and export demands for the Indian economy during 1974-2013. While the bound test shows the cointegration relationship for import demand, and its determinants, the error correction test test shows the cointegration relationship for export demand, and it's determinants The results show that both exports and imports are elastic in the long-run with respect to world imports and domestic income respectively. However, they are inelastic in the short-run with respect to same variables.

As the coefficient of exchange rate is positive in the export demand function, the depreciation of rupee would encourage county's export demand. However, it would not reduce import demand significantly. As the sum of absolute values of exchange rate elasticities of export and import demands is less than unity, it can be inferred that the Marshall-Lerner condition was not satisfied for our country. In other words, the policy of depreciation would not helpful for reducing the trade imbalance for our country. Finally, the stability test suggests the parameters in both models were quite stable in the sample period.

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