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ESTIMATING INDIA'S AGGREGATE IMPORT DEMAND FUNCTION

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ABSTRACT

The present paper investigates the determinants of India's import demand within the framework of an advanced co-integration technique. The ADF statistics shows that all the variables are non-stationary in level, but stationary in first difference. Pesaran recommended bound test shows that India's import demand and its determinants are co-integrated in the long run. Income is the major determinant of India's import demand. Further, the response of import demand to change in exchange rate is more sensitive than to change in relative import price. The model has been checked in terms of diagnostic test and the structural stability. The results reveal that the import demand model performs very well. The ex-post forecasting exercise shows that the ARDL method has performed better than the OLS method.

KEYWORDS

ADF, ARDL, cointegration, exchange rate, error correction model.

JEL CLASSIFICATION CODES

C22, C32, F14.

INTRODUCTION

In the present global economic scenario, the role of trade in economic growth and development of a country is increasing over time. After independence, India's trade policy was relatively liberal. However, there was the foreign exchange crisis in 1956-1957. As a result, the restriction was imposed on India's import till 1966. Indian currency was devaluated from 4.7 to 7.5 rupees per dollar in 1966. Some liberalisation efforts were made on trade in terms of relaxation on import licences and tariff rates. However, the liberalisation initiatives were reversed in 1968. After 1985, a new era of trade liberalisation was started. The rupee was allowed to depreciate in response to market situation. The significant trade liberalisation measures were taken in 1991 under the policy of economic reform. However, India's trade deficit is widening in absolute term over time. In this background, the present paper has made an attempt to measure the determinants of import demand which are crucial for policy decision makings. In Section II, a brief review has been made on existing literature while in Section III, the research methodology in terms of database and the model specification has been discussed. The results and finding from this paper have been analysed in Section IV. The final section makes some summary and conclusions.

REVIEW OF LITERATURE

Khan (1974) had estimated the import demand function for 15 developing countries including India. He expressed the demand for imports as a function of real income and relative import price. He employed the OLS method using annual data ranging from 1951-1969. According to his study, the relative price did not play an important role in the determination of imports of developing countries. Melo and Vogt (1984) estimated the import demand function for Venezuela using sample period from 1962-1979. Import demand was specified as a function of income and relative import price using disaggregated model. The total imports demand was elastic with respect to both income and relative import price.

Sinha (2001) has made an attempt to measure the price and income elasticities of trade equations for five countries including India. Using the sample period 1950-1996, the method of Cochrane-Orcutt was applied for estimation of import demand for India. The income elasticity of import demand had negative sign, and was not statistically significant. But, the relative import price bears expected negative sign and statistically significant. The determinants of India's import demand have been studied by Tang (2002). Using annual data (1970-1999), he applied Johansen-Jesulies method (1990) in order to establish the co-integration relation between import demand and income, relative import price. The import demand was found to be elastic with respect to income, but inelastic with respect to relative import price. Dutt and Ahmed (2004) have studies the aggregate import demand for India using GDP and relative import price as explanatory variables. Using sample period 1971-1995, they applied the Johansen-Juselius (JJ) co-integration technique to determine the long-run relationship. Import demand was found to be inelastic with respect to income and price. It should be noted here that the conventional cointegration like Johansen-Jesulies method is not reliable for small sample (Mah, 2000).

The import demand equation for Thailand was estimated by Sinha (1997) using the co-integration approach. The import demand function was specified as a function of income, absolute import price and the domestic price. The result shows that the import demand was inelastic with respect to import price and domestic price. However, it was elastic with respect to domestic income in the long run. Using the sample period from 1968-1997, the similar model has been estimated for Nepalese import demand by Rijal et.al.(2000). The import function has been specified in terms of income, absolute import and domestic prices. In both long run and short run, Nepalese import demand was elastic with respect to income but inelastic with respect to import price and substitute price. The method chosen for estimation was Johansen-Juselius co-integration technique (1990).

Warner and Kreinin (1983) have estimated the import equations for industrial countries using quarterly data for the sub-samples 1957-1970 under the fixed exchange rate regime; and 1972-1990 under the floating exchange rate regime separately. The exchange rate variable was introduced in the model under the floating exchange rate regime. From the OLS estimates, the study reveals that the volume of imports was sensitive to the change in exchange rate in the majority of countries. Bahmani-Oskooee (1986) has estimated the determinant of import demand for seven developing countries including India. The import equation has been specified as a function of income, the relative import price and the nominal effective exchange rate. He applied first order autoregressive method using quarterly data ranging from 1973 to 1980. In case of India, the import demand was inelastic in respect of relative price. Further, the income variable was not significant statistically in explaining import demand.

NEED OF THE STUDY

There are lot of study estimating import demand function for industrial countries. In the standard import demand model, income and the relative price are most important factors to judge the behaviour of import flows (Houthakker and Magee, 1969). One need of such study is to find the determinants of import demand in order to measure the elasticities of the demand for imports with respect to its determinants.

STATEMENT OF THE PROBLEM

As the time series data suffers from the problem of non-stationarity, the application of OLS method of estimation will lead the spurious relation among variables with a high value of R^2 and a low value of Durbin-Watson statistics (Granger and Newbold, 1974). The estimated parameters are inconsistent and less efficient (Engle-Granger, 1987). The two econometric techniques like Engle-Granger two steps procedure (1987), Johansen-Juselius (JJ) multivariate method (1990) are mostly used in applied economics in the cases of non-stationarity time series data. However, the above mentioned two techniques suffer from small sample bias (Mah, 2000). Recently developed the ARDL based bound test procedure overcomes this problem (Pesaran *etal,* 1999).

OBJECTIVES

The objectives of the present studies are:

1. To examine the existence of long-run equilibrium relationship between India's import demand and its determinants. The existence of a cointegration is tested using the recently developed bound test approach.
2. To estimate an error correction model to integrate the short-run dynamics with the long-run through the inclusion of lagged level of error term.
3. To estimate the elasticities of India's import demands using the advanced econometric method.
4. To examine the structural stability of India's import demand function for the sample period.
5. To measure the effect of depreciation of the India's rupees on the imports demand.

RESEARCH METHODOLOGY

It has been assumed that India is a small buyer in the world import market. This implies that the import price is exogenous in the model. This assumption allows us to specify only the demand equation for India's imports. It has been specified as a function of domestic economy activity, the relative import prices and the exchange rate. In the present study, the economic activity has been measured in terms of real GDP. The import price is expressed in relative term using implicit assumption of imperfect substitution between imported goods and domestically produced substitute goods. For the present purpose, the import demand function has been mentioned in the following manner:

M= f (Y, PM, ER) -----------Equation (1)

Where, M= Real quantity of India's import; Y =Real gross domestic product, PM=Relative import price; ER= Nominal exchange rate (rupees per US dollars).

The above functional form has been expressed in log linear form in order to obtain the direct measures of import demand elasticities in the following way:

$M_t=\alpha_0+ \alpha_1.Y_t+ \alpha_2.PM_t+ \alpha_3.ER_t+ U_t$-----------Equation (2)

where, the expected sign of $\alpha_1>0$; $\alpha_2<0$ and $\alpha_3<0$.

For the bound test procedure, the following unrestricted error correction model (UECM) model has been formulated:

$DM_t = \beta_0 + \beta_1M_{t-i}+ \beta_2Y_{t-1} + \beta_3PM_{t-1} + \beta_4ER_{t-1} + \sum\gamma_1DM_{t-i} + \sum\gamma_2Y_{t-i}+ \sum\gamma_3PM_{t-i} + \sum\gamma_4ER_{t-i} + u_{t.}$ -Equation (3)

Where, D represents the variables in first difference form. In the above equation, the coefficients 'γ' represent the short-term dynamism while the coefficients 'β' represent the long-term mechanism. In the bound testing approach to co-integration, at first, the null hypothesis of zero restriction is imposed on all lagged variables in equation 3 using F-statistics. Under the null hypothesis, there does not exist any long-run equilibrium relation among the variables in the model as mentioned in equation 2. The F-statistics has the asymptotic distribution which is non-standard. Pesaran et al (2001) have tabulated the critical values of F-statistics for lower as well as upper bounds

In the second step, the long-run equation is derived from the restricted version of ARDL model. A conditional ARDL long-run model for import demand can be specified in the following manner:

$M_t = \beta_0 + \sum \beta_1M_{t-i}+ \sum \beta_2Y_{t-1} + \sum \beta_3 PM_{t-1} + \sum\beta_4 ER_{t-1} + \zeta_{t.}$ --- (4)

Where, all variables are as previously defined.

For the policy purpose, it is important to know the short-run adjustment of import demand to the changes in its determinants. The error correction representation is expressed using the regression of variables in the difference form with the lagged error term (ECM-1). The coefficient of one period lagged term reveals the speed of adjustment towards the long-run equilibrium when a shock affects the existing equilibrium situation (equation-5).

$DM_t = \alpha_2 + \sum\gamma_1DM_{t-i} + \sum\gamma_2Y_{t-i}+ \sum\gamma_3PM_{t-i} + \sum\gamma_4ER_{t-i} + \mu\ ECM\text{-}1+ \varepsilon_{t.}$ --- (5)

DATA ANALYSIS

All the data series have been collected from IMF's International Financial Statistics. The value of India's imports is available in US dollars. It has been converted in real term by deflating unit value index of import with base year 2010. The relative import price has been derived deflating unit value of imports by the GDP deflator. The overall sample period ranges from 1970- 2013.

As we deal with time series data on the variables of the import demand model, there is the chance of non-stationarity implying the spurious relationship among the variables from the OLS estimates. The issue of non-stationarity has been dealt with the augmented dickey-fuller (ADF) test for unit root. The ADF test has been performed both with intercept and no trend, and with an intercept and trend. This test assumes the null hypothesis of non-stationarity of the time series against the alternative hypothesis of stationarity. Table1 shows that the estimated value of ADF-statistics with, and without trend in absolute terms does not exceed the critical value for all variables. Therefore, the hypothesis of non-stationarity in data series have been accepted for all variables in level form. In such situation, the application of OLS method to the model will result the spurious relation between import demand, and it's determinants. However, when the ADF test is applied for all the variables in first difference form, the hypothesis of non-stationarity in data series have been rejected.

TABLE 1: ADF-STATISTICS UNIT ROOT TEST FOR VARIABLES IN IMPORT DEMAND

Variables	Level/First Difference	Without Trend	I (r)	With Trend	I (r)
M_t	Level	0.146	I (1)	-2.254	I (1)
	First Difference	-4.356	I (0)	-4.290	I (0)
Y_t	Level	2.820	I (1)	-1.602	I(1)
	First Difference	-4.049	I (0)	-5.308	I (0)
PM_t	Level	0.793	I (1)	-1.929	I (1)
	First Difference	-4.974	I (0)	-4.905	I (0)
ER_t	Level	-0.453	I (1)	-1.517	I (1)
	First Difference	-3.084	I (0)	-3.042	I (0)

Note: (1). 95% Critical value for ADF statistics without trend = -2.932; (2). 95% Critical value for ADF statistics with trend = -3.518; and (3). I(r): r is the order of integration.

RESULTS AND FINDINGS

BOUND TEST

The bound test implies the test for zero restrictions on the coefficients of all lagged variables in the following form as per Equation 3.

Null Hypothesis H_0: $\beta_1=\beta_2=\beta_3=\beta_4=0$

Alternative Hypothesis H1: $\beta_1=\beta_2=\beta_3=\beta_4\neq0$

However, the F statistics in such case is non-standard. Therefore, the critical value of standard F statistics is not applicable in order to test the zero restriction on the lagged variables as mentioned in Equation 3. Pesaran et al. (2001) have reported the critical values of F statistics, but for very large samples. Hence, the bound test for the present study relies on the tabulated critical values of F statistics for small sample as reported by Narayan (2004). From the table 2, it can be said that the calculated value of F-statistics (6.90) is significantly higher than the critical upper bound values of F-statistics at all significance level. Therefore, India's import demand, and its determinants are cointegrated in the long-run. Hence, there exists a long-run equilibrium relation as mentioned in equation.

TABLE 2: BOUNDS TEST FOR COINTEGRATION ANALYSIS (IMPORT DEMAND)

F-Statistic (Wald test) for Import Demand: F(4, 29)= 6.904 (for H0 : $\beta_1 = \beta_2 = \beta_3 = 0$)			
Critical Bounds# at	1%	5%	10%
Lower bounds, *I*(0):	5.018	3.548	2.933
Upper bounds, *I*(1):	6.610	4.803	4.020

*Note: Critical values of F-statistics are extracted from Narayan (2004), Table A1 (p.26), A2 (p.27) & A3 (p.28) for n (sample size) =33, k (parameters)=3.

LONG-RUN ELASTICITIES

The long-run elasticities of import demand (using equation 4) have been provided in Table 3. All the explanatory variables are statistically significant with expected sign. The demand for real imports is elastic with respect to real income and the nominal exchange rate. However, the demand for import is price inelastic. One per cent increase in domestic income would increase India's import by 2 per cent. On the other hand, one per cent increase in relative import price would reduce India's import by 0.9 per cent. As expected, one per cent depreciation of India's rupee would reduce India's imports by 1.26 per cent.

TABLE 3: LONG RUN COEFFICIENTS USING THE ARDL APPROACH @

Dependent variable: M_t; Period: 1975-2013.		
Regressors	Coefficient	t-Ratio
Intercept	3.794	4.7589*
Y_t	2.038	15.4831*
PM_t	-0.905	-4.7621*
ER_t	-1.263	-5.1890*

@ Note: (1) *: significant at 5 % level; (2) ARDL (1,0,0,0) selected based on Schwarz Bayesian Criterion.

SHORT-RUN ELASTICITIES

As there exists a long-run relationship between import demand; and its determinants, the long-run relationship must be transformed into short-run dynamics as per ARDL approach. As per Equation 5, the estimated short-run parameters have been mentioned in the following Table 4.

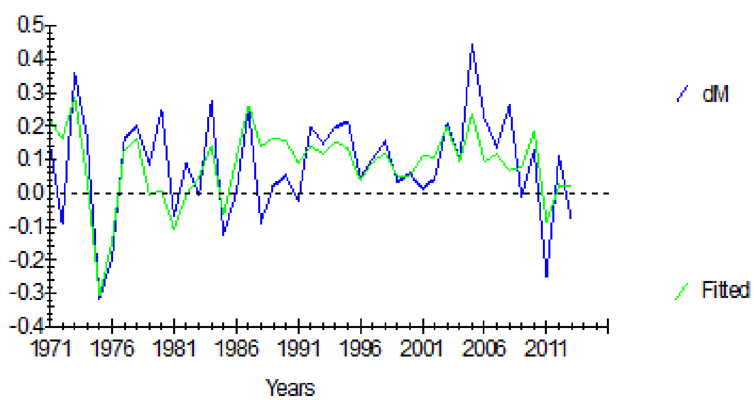
TABLE 4: ERROR CORRECTION MODEL @

Dependent variable: DM_t; Period: 1971-2013.		
Regressors	Coefficient	t-Ratio
Intercept	2.2449	5.6379*
DY_t	1.2058	4.6607*
DPM_t	-0.52965	-5.5744*
DER_t	-0.74752	-4.8793*
ECM(-1)	-0.60156	-4.9148*
R-Squared =0.52075 ; R-Bar-Squared = 0.47030; S.E. of Regression =0.11275; F-stat. F(4, 38) 10.3225; Akaike Info. Criterion = 30.4938; Schwarz Bayesian Criterion= 26.0908; DW-statistic = 1.5120		

@ Note: (1) *: significant at 5 % level;.(2) ARDL (1,0,0,0) selected based on Schwarz Bayesian Criterion.

It shows that the elasticity of import demand with respect to income (1.205) in the short-run is lower than that in the long-run. The same is true for relative import price elasticity (-0.529) and the exchange rate elasticity (-0.747) of import demand. This reveals that the import demand is more sensitive to income/price/ex-change rate changes in the long-run. The co-efficient of error correction term (ECM-1) is negative and statistically significant at 1 per cent level which again reveals the existent of long-run equilibrium relation between the import demand and it's determinants (Engle-Granger, 1987). As the coefficient of the error correction term is 0.60, it can be said that the speed of adjustment towards equilibrium is quite high. About 60 per cent adjustment towards equilibrium is completed within a year. The performance of error correction model has been judged inter terms of line diagram (Graph 1). It shows the model performs fairly well.

Graph 1. Plot of Actual and Fitted Values



DIAGNOSTIC TEST

The error correction model has also been checked by the several diagnostic tests like serial correlation of error terms, normality of error terms, functional form for the model, and heteroscedasticity of error terms. Table 5 shows that the results from all diagnostic tests. It can be said that the model selected in this paper passes all the diagnostic tests quite well.

TABLE 5: DIAGNOSTIC TEST

Test Statistics	Test Statistics
A:Serial Correlation	CHSQ(1)= 1.4962
B:Functional Form	F(1, 37)= 0.0085
C:Normality	CHSQ(2)= 0.0226
D:Heteroscedasticity	F(1, 41)= 0.0077

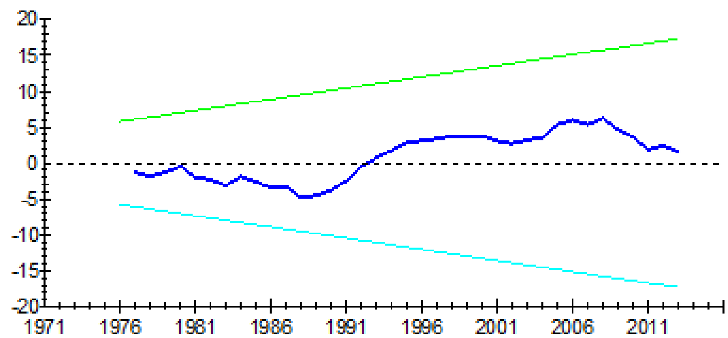
A: Lagrange multiplier test of residual serial correlation, Critical value CHSQ (1)=3.84 at 5 % level.B: Ramsey's RESET test using the square of the fitted values, Critical F(1,30) = 4.17 at 5 % level.C: Based on a test of skewness and kurtosis of residuals, Critical CHSQ (2)=5.99 at 5 % level. D:Based on the regression of squared residuals, Critical F(1,41) = 4.08 at 5 % level.

Source: Greene (2003), Appendix G.3, pp. 955 (for critical value of CHSQ) & Appendix G.4, pp.956 (for critical value of F-statistics).

STABILITY TEST

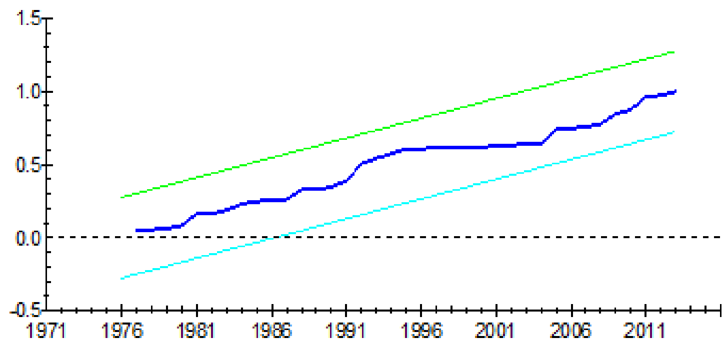
The structural stability of the import demand model has been verified both in terms of cumulative sum of recursive residuals (CUSUM), and cumulative sum of square of recursive residuals (CUSUMQ). Both the statistics confirms that the parameters of the model were quite stable over the sample period (Graphs 2 & 3).

Graph 2. Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Graph 3. Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

EX-POST FORECASTING

One of the objectives in any model building exercise is to evaluate the model performance in terms of forecasting ability. There are various statistics measuring forecasting errors like mean value of absolute errors, mean value of square errors, root-mean-square errors etc. A model is said to be good if it has smaller prediction error compare to others. The ARDL based dynamic model is compared with the OLS-based static model. The model has been re-estimated using the sample period 1970-2010. Both the models generated prediction error statistics for the period 2011-2013 have been provided in Table 6. In terms of above mentioned statistics, it can be said that the dynamic model has better prediction power than the static one.

TABLE 6: SUMMARY STATISTICS OF PREDICTION ERRORS (PERIOD: 2011 TO 2013)

Statistics	OLS Static Model	ARDL Dynamic Model
Mean Sum Absolute Error	0.245	0.195
Mean Sum Squares Error	0.066	0.042
Root Mean Sum Squares	0.257	0.206

SUMMARY AND CONCLUSIONS

The present paper investigates the determinants of India's import demand within the framework of advanced co-integration technique. The ADF statistics shows that all the variables are non-stationary in level, but stationary for first difference. The present paper employs the advance econometric technique to this issue. As the conventional techniques of co-integration suffer from small sample bias, the present paper employs Pesaran recommended auto-regressive distributed lag model to find the co-integration relationship among variables in the import demand function.

Pesaran recommended bound test shows that India's import demand and it's determinants are well co-integrated in the long run. The results also reveal that the nominal exchange rate, income and relative import price are significant determinants of import demand in India. The domestic income is the major variable in explaining India's import demand. The high value of income elasticity implies that the higher economic growth in the country would create pressure on the import demand, and thereby on trade balance. As the value of price elasticity of import demand is less than unity, there is little degree of substitution between imported goods and domestically produced substitute goods. Further, the import demand is more sensitive to the change in exchange rate than to the change in import price.

The stability test shows that the selected model was structurally stable during the sample period. The ex-post forecasting exercise reveals that the ARDL method of estimation has better prediction power than that of the OLS method.

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