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Full Length Research Paper

Import demand function for Bangladesh: A rolling window analysis

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This study aims to estimate aggregate import demand function for Bangladesh economy by using the data of 1980 to 2008. Estimation evidence provided by using autoregressive distributed lag (ADRL) approach to cointegration and rolling window regression method to estimate the coefficient of each observation in the sample by fixing the window size. The estimation result confirms long run relationship between imports, relative price and economic activity, and long run economic growth elasticity is (0.93) positive and relative price elasticity in the long run (-0.29) is negative. In contrast regression results of rolling window method demonstrates that the long run elasticities of national income variable are vary in the range of 0.81 to 0.96 and the relative price elasticities are negative according to the theory except few years.

Key words: Bangladesh, import demand, autoregressive distributed lag.

INTRODUCTION

Empirical literature of international economics shows, that many studies have investigated stability of import demand function in the developed and developing countries. However in the context of Bangladesh few studies have conducted on an aggregate import demand function. Such as, Dutta and Ahmed (1997) found price and income elasticities have theoretical sign and statistically significant in the case of Bangladesh. Dutta and Ahmed (1999) employed Engle Granger and error correction modeling approach to cointegration in order to estimate the aggregate merchandise import demand function for Bangladesh economy. They found long run relationship among real imports, real import prices, real gross domestic product GDP and real foreign exchange reserves. Hussain (2004) estimated both aggregated and disaggregated import demand function by using the Ordinary Least Square (OLS) approach. He concluded positive income elasticity in the case of all commodities (except rice and wheat). In contrast the relative prices elasticity very in the range of –0.73 to -1.66, but relative price of rice and Soya bean oil were only found to be significant. Hoque and Yusop (2010) estimated trade liberalization and aggregate import relationship in the case of Bangladesh by using bound testing analysis and found cointegration between aggregate import demand, price, income, foreign exchange reserves, import duty rate and trade liberalization. They suggested income elasticity greater than one (1.64) and price elasticity less than one (-0.43), other variables trade liberalization coefficient positive (0.27), import duty rate statistically insignificant and foreign exchange reserves negatively (-0.14) associated with imports in the long run.

Now we review empirical studies on aggregate import demand function in the case of developed and developing countries. Oskooee and Niroomand (1998) used the JJ cointegration techniques to estimate import demand functions for various developing countries like Colombia, Mauritius, South Africa Tunisia, Philippines, Greece, Korea, Pakistan and Singapore. They found that there is co-integration relationship between the imports and its determinants in these countries. Tang (2003) estimated import demand function for China by employing the bound testing approach to co-integration and in the long run, the expenditure on import highly correlated with imports (0.51), and followed by investment expenditure (0.40) and final consumption expenditure (0.17). The

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relative price variable appeared with a coefficient of -0.6, implying that an increase in relative prices induces a 0.6% fall in the demand for imports.

Narayan (2005) employed bound testing approach to co-integration to estimate the long-run disaggregated import demand function for Fiji by using relative prices, total consumption, investment expenditure and export expenditure as a determinants of imports. They found long run cointegration relationship among the variables when import demand is the dependent variable. But the imports demand to be inelastic and statistically significant with respect to all the explanatory variables in both long run and short run.

Chang et al., (2005) showed imports, income, and relative prices were co-integrated in the case of South Korea. They projected long-run elasticities of import demand with respect to income and relative price were 1.86 and -0.2 respectively. Hye (2008) found that long run relationship exist between the real quantity of imports, relative prices and real Gross National Product (GNP) in Pakistan. The long run income elasticity is greater than one (1.36) and positive, but the income elasticity in the short run is also positive but less than one (0.59) and the price elasticity in the long run (-0.54) and short run (-0.56) both are negative but less than one.

Ozturk and Acaravci (2009) found volume of imports demand negatively related to relative prices and positively to real income in the case of Latin American and Caribbean Countries. Serge and Yue (2010) empirically examined the import demand function in the case of Cote D'Ivoire and found that investment and exports are the main determinants of imports in the long run.

Thus the purpose of this study is to estimate the import demand function of Bangladesh economy by using the autoregressive distributed lag (ARDL) approach to co-integration and rolling window regression approach to estimate the coefficient of each observation over the sample by fixing the window size. This study is also different from the other studies on the Bangladesh economy because it estimates the imports elasticities with respective to income and relative price of imports of each observation over the sample. With the help of these elasticities the Bangladesh's trade policy makers can develop effective trade policy for future. The remaining paper is organized as follows.

METHODOLOGY AND DATA COLLECTION

Data of all variables, imports; GNP, GDP deflator and unit value of imports are collected from the International Financial Statistics (IFS) and World Development Indicators (WDI). Imports (M) is measured in domestic currency. Unit value of imports is used as a proxy of imports prices (PM), GDP deflator is used as a domestic price (PD) and GNP (Y) is used to measure the impact of national income on imports. This study uses the following Mayes (1981) import demand function.

$$M = \alpha Y^{\lambda}(P)^{\beta} \quad (1)$$

Where volume of imports (M) depends upon the level of national of the importing country(Y) and the relative price of imports to domestic product price $\left(PM/PD\right)$, this is denoted by P. The natural logarithmic transformation of the model as follows,

$$LnM = \alpha_0 + \lambda LnY + \beta Ln(P) + \nu \quad (2)$$

a_0 = natural log of a and ν is the error term. The coefficients λ and β represent the national income and price elasticities of import demand function respectively. It is expected that $\lambda > 0$ and $\beta < 0$.

In empirical research it is vital to determine the order of integration of the variables. For this purpose, present study employs standard unit root tests like Augmented Dickey Fuller (ADF) and Phillips-Perron unit root tests (PP). Augmented Dickey-fuller (ADF) unit root test is based on the following regression model.

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{j=1}^{k} d_j \Delta Y_{t-j} + \varepsilon_t \quad (3)$$

Where ε_t is pure white noise error term, Y_t is a time series, Δ is the first difference operator, α_0 is a constant and k is the optimum number of lags of the dependent variable.

Decision is taken on the basis of following rule: If the t- Statistic associated with estimated coefficient, where α_1, is less than the critical value then we concluded that the series is non-stationary. This study also employs Phillips Perron unit root test (PP) to determine the order of integration. The property of unit root is noticed by estimating the series of Y_t as follows,

$$\Delta Y_t = \alpha + \rho^{*} Y_{t-1} + \varepsilon_t \quad (4)$$

The PP test is also based on the t-value that is associated with the estimated coefficient of ρ^{*}. Unit root is decided same as we are deciding in ADF method.

Autoregressive distributed lag approach to co-integration

ARDL approach is used to determine the long run robustness among the variable. This approach has certain advantages over other old co-integration methods. First, it can be applied irrespective of whether the regressors are I(0) or I(1) or mutually. Second, advantage of this approach is that the model takes sufficient numbers of lags to capture the data generating process in a general- to -specific modeling framework. Third it assumes that all variables in the model are endogenous. Lastly, a dynamic error correction model can be derived through a simple linear transformation in the ARDL model. In general, representation of the ARDL equation is as follows.

$$\Delta Ln(M_t) = \psi_0 + \sum_{i=0}^{n} \psi_1 \Delta Ln(M)_{t-i} + \sum_{i=0}^{n} \psi_2 \Delta Ln(P)_{t-i} + \sum_{i=0}^{n} \psi_3 \Delta Ln(Y)_{t-i} + \varpi_1 M_{t-i} + \omega_2 P_{t-i} + \varpi_3 Y_{t-i} + \mu_i \quad (5)$$

Where Ln(M), Ln(P) and Ln(Y) are the natural log of imports, natural log of relative price and natural log of GNP, respectively,

Δ is the first difference operator and n is the optimal lag length. The overall F-test and W-test are used in order to test the cointegration hypothesis. The null hypothesis $\langle H_0 : \varpi_1 = \varpi_2 = \varpi_3 = 0 \rangle$ for no cointegration among variables in equation (5) is tested against the alternative hypothesis $\langle H_0 : \varpi_1 = \varpi_2 = \varpi_3 \neq 0 \rangle$. When long run relationship exists, F-test and W-test indicate that the variables should be normalized.

Naranyan (2004) has determined the (critical values) values of lower and upper bound of F-statistic, for small sample size between 30 and 80. This study is used as the sample of 37 observations in order to estimate the import demand function for Bangladesh economy. Thus this study considers the Pesaran et al. (2001) and Narayan (2004) estimated critical values for F-statistic in order to make the decision of long run relationship. On the other hand W-statistics critical values that is lower and upper bounds value is only determine by Pesaran et al. (2001), so we used these critical values to take decision of long run relationship through W-statistic. The important long run decision is taken with the help of the following rule. If the F-test statistic and W-statistic exceed their respective upper critical values, we can conclude that there is evidence of a long run relationship between the variables. If the test statistics are below the upper critical value, we cannot reject the null hypothesis of no co-integration and if test statistics are between the bounds, a non-conclusive inference can be made.

EMPIRICAL RESULTS

This empirical investigation is utilized the two most well-known unit root tests that is Augment Dickey Fuller and Phillips Perron unit tests. The results of both unit root tests are reported in Table 1.

The results in Table 1 show that all variables Ln(M*),* Ln(Y) and Ln(P) are integrated order one or I(1). Now, in the next step this study employs ARDL approach to co-integration. ADRL approach is based on a three step producer, in the first step selection of lag order on the basis of Schwartz Bayesian Criterion (SBC) because computation of F-statistic and W-statistic are sensitive with lag length. The two optimum lags are selected on the basis of SBC (Figure 1). In the next step (step two), long run relationship determine by computing the F-statistic and W-statistic. Table 2 represents the results of long run relationship, which indicates F-statistic is 27.02 higher than the upper level of bounds critical value of Pesaran et al. (2001) and Paresh Kumar Narayn (2005). Thus null hypothesis of no co-integration is rejected and therefore is a co-integration relationship among the variables. Lower part of Table 2 shows the results of W-statistic that also confirms the long run relation among the variables.

Next, (step third) this study is estimated the long run and short run coefficients of the variables in the model by using autoregressive distributed lag approach. The valuable results are reported in Table 3, the result shows that national income positively determines the imports and relative price negatively associated to imports. In section B of Table 3 represents the short run coefficients. The national income is positively and relative price (at one year lag) is negatively determined import demand in the short run of Bangladesh economy. The estimated coefficient of ecm (-1) is statistically significant (at the 9% level) and negative sign. This indicates the speed of adjustment from short run fluctuation to long run equilibrium.

Table 1. Unit root test results.

Variables	ADF	pp
Ln(M)	-2.35	-1.23
Ln(Y)	-2.08	-2.71
Ln(P)	-1.61	-1.83
ΔLn(M)	-4.21*	-7.16*
ΔLn(Y)	-2.81***	-3.37***
ΔLn(P)	-6.26*	-7.25*

Note: *:***: 1%:10% level of significance.

Which confirms 13% disequilibrium adjusted every year from short run to long run. Section C in Table 3 represents the result of diagnostic tests. The results confirm the stability of long run and short run results. On the other hand this study also confirms stability of long run and short run functions by using cumulative sum (CUSM) and cumulative sum squares (CUSUMSQ) methods. The graphs of CUSUM and CUSUMSQ are showed Figures A and B (Appendix 1). The figures of CUMSUM and CUSUMSQ statistics for Ln(M) do not cross the critical value lines, so this study securely concludes that aggregate import demand function is stable in the case of Bangladesh economy.

Estimation results of rolling window method

The rolling window estimation model is used in order to evaluate the stability of coefficients of the model in the sample size. Other econometric methods assume that coefficients/ parameters of model remain same over the sample. But in the reality economic condition cannot remain the same and as a result economic variables are fluctuated, than their coefficients and cannot remain same. With the help of rolling regression technique we can estimate the coefficient of each observation of the sample by setting the rolling window size. If the economic variables are changed overtime so this techniques capture this instability. The Figures 1 and 2 shows the result of the rolling window regression method. The solid line graphs in the figures represent the estimated coefficients. These graphs show the two standard deviation bands (upper and lower bands of doted lines) that confirms the coefficients statistical significance. Table 4 shows the values of long run elasticities of national income and relative price from 1985 - 2008. These elasticities are estimated by using the rolling show

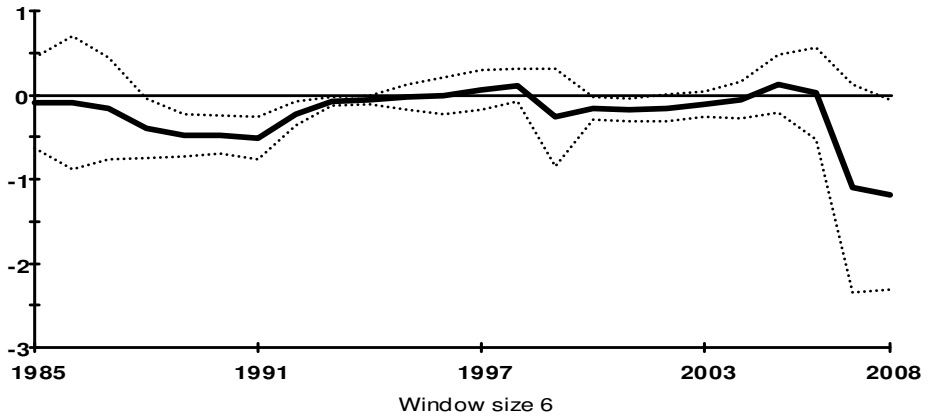

Figure 1. Coefficient of Ln(P) and its two* S.E. bands based on rolling OLS (Dependent variables: Ln(M), total no. of regressores:2.

Table 2. F-statistic and w-statistic for long run association.

Level of significance	Critical values			
	Pesaran et al. (2001)		Paresh Kumar Narayn (2005)	
	Lower bound	Upper bound	Lower bound	Upper bound
Computed F-statistic:		27.02		
5%	3.0385	4.2903	3.10	4.08
10%	2.3520	3.4496	2.59	3.45
Computed W-statistic:		81.04		
	Lower bound		Upper bound	
5%	9.12		12.88	
10%	7.06		10.35	

Table 3. Long run and short run coefficients.

Section: A Long run coefficients		
Dependent variable: Ln (M)		
Regressors	**Coefficient**	**T-ratio [Prob]**
Ln(Y)	0.94	45.49[0.00]
Ln(P)	-0.29	-2.52[0.02]
Section: B Short run coefficients		
Dependent variable : Δ Ln(M)		
Δ Ln(Y)	0.13	1.67[0.10]
Δ Ln(P)	-0.03	- 1.25[0.22]
Δ Ln(P(-1))	-0.06	-2.63[0.02]
ecm(-1)	-0.13	-1.68[0.09]
Section: C Diagnostic tests		
Test statistics	**LM version**	**F version**
Serial correlation	0.02[0.91]	0.01[0.95]
Functional form	0.03[0.86]	0.03[0.88]
Normality	0.39[0.83]	-
Heteroscedasticity	0.01[0.96]	0.01[.95]

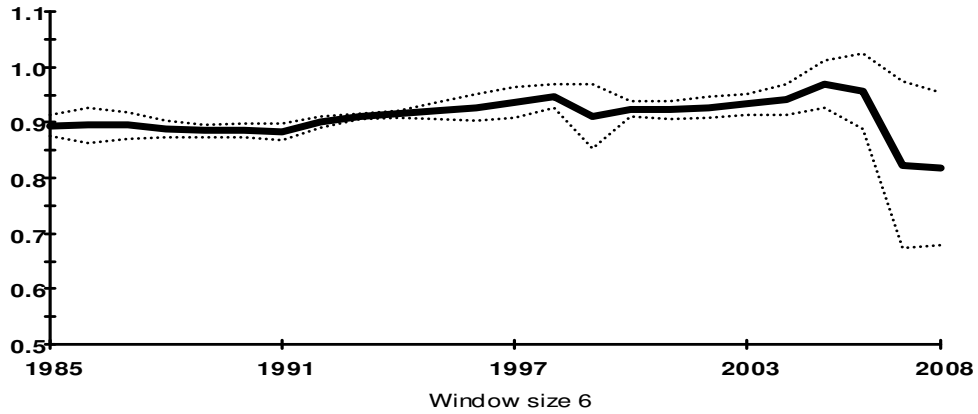

Figure 2. Coefficient of Ln(Y) and its two* S.E. bands based on rolling OLS (Dependent variables: Ln(M), total no. of regressores:2.

Table 4. Long run elasticities from 1985 - 2008.

Year	National income elasticities			Relative price elasticities		
	L_b	λ	U_b	L_b	β	U_b
1985	0.88	0.89	0.91	0.44	-0.09	-0.62
1986	0.86	0.89	0.93	0.70	-0.09	-0.89
1987	0.87	0.89	0.92	0.44	-0.15	-0.76
1988	0.87	0.88	0.90	-0.04	-0.39	-0.75
1989	0.87	0.88	0.90	-0.22	-0.48	-0.74
1990	0.87	0.88	0.90	-0.25	-0.47	-0.70
1991	0.87	0.88	0.90	-0.26	-0.51	-0.77
1992	0.89	0.91	0.91	-0.08	-0.22	-0.36
1993	0.91	0.92	0.92	-0.02	-0.07	-0.12
1994	0.91	0.91	0.92	-0.01	-0.05	-0.11
1995	0.91	0.92	0.94	0.13	-0.02	-0.17
1996	0.90	0.92	0.95	0.21	-0.01	-0.22
1997	0.91	0.93	0.97	0.30	0.05	-0.18
1998	0.92	0.94	0.97	0.30	0.11	-0.07
1999	0.85	0.91	0.97	0.30	-0.26	-0.84
2000	0.91	0.92	0.94	-0.02	-0.15	-0.29
2001	0.91	0.92	0.94	-0.04	-0.17	-0.31
2002	0.91	0.92	0.95	0.01	-0.15	-0.31
2003	0.91	0.93	0.95	0.04	-0.11	-0.27
2004	0.91	0.94	0.97	0.16	-0.05	-0.28
2005	0.92	0.96	1.01	0.47	0.13	-0.21
2006	0.89	0.95	1.03	0.56	0.01	-0.53
2007	0.67	0.82	0.97	0.13	-1.10	-2.34
2008	0.68	0.81	0.95	-0.07	-1.18	-2.31

Note: Lb and Ub are respectively lower band and upper band value of standard deviation.

window regression method[1]. The national income elasticities with respect to imports are fluctuated in the range of 0.81 to 0.96. On the other hand the relative price elasticities are negative according to the theory excepted in the years 1997, 1998, 2005 and 2006. The lower and upper band values (L_b and U_b) of standard deviation

[1] The rolling size is fixed by six observations.

that all coefficients are statistically significant.

Conclusion

The objective of this study is to estimate import demand function of Bangladesh economy by using the time series data of 1980 to 2008. The empirical evidence is provided by using the ADRL approach to co-integration and rolling window regression approach. The ARDL estimation result confirms long run relationship between imports, national income and relative price. The elasticity of national income variable is (0.94) positive and relative price elasticity is (-0.29) negative in the long run. Conversely rolling window based results show that long run elasticities of national income variable is fluctuated in the range of 0.81 to 0.96 and relative price elasticities are varied in the range of 0.13 to -0.51. The findings of this study is guided to the Bangladesh policy makers in this regards to construct effective trade policy for long run by looking the previous per year impact of income and relative prices on imports.

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APPENDIX 1

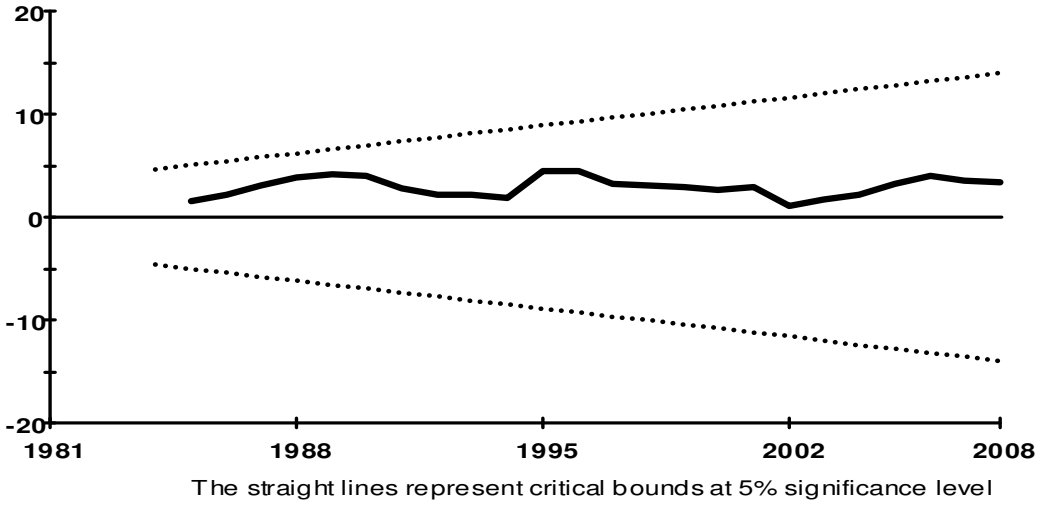

Figure A. Plot of cumulative sum of recursive residuals.

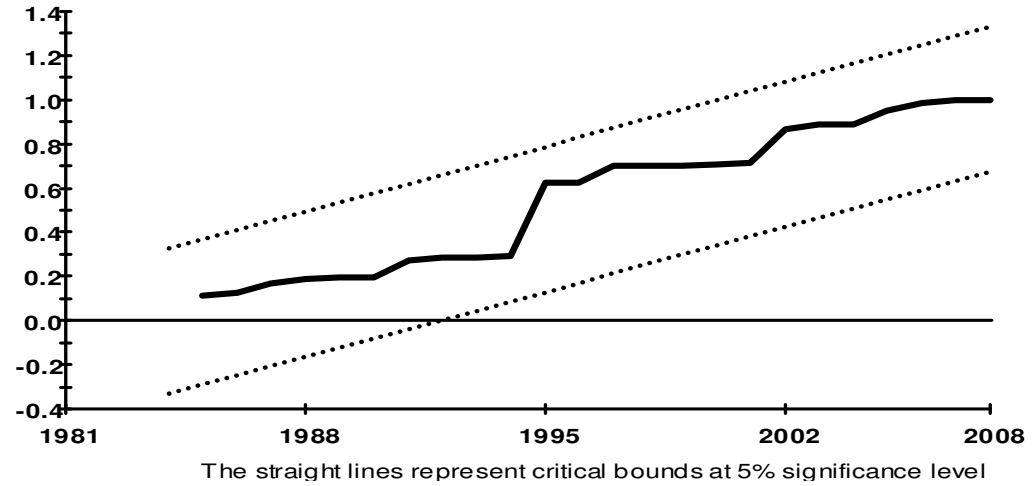

Figure B. Plot of cumulative sum of squares of recursive residuals.