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Import Flows of Bangladesh: Gravity Model Approach under Panel Data Methodology

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Abstract

In counterpoint to export growth, Bangladesh import growth has remained much less strong, despite impressive progress in import liberalization. This study gives an overview of different methodologies related to gravity model analysis in Bangladesh's import flow. A pooled cross section and time series data were analyzed to incorporate the country specific heterogeneity in country pair trading partners. The import flows are justified by the basic gravity model since Bangladesh's imports are positively significant by the economy size and inversely related to trade barrier. Accordingly, we have analyzed pooled ordinary least square, fixed effect, random effect. This study also explores extended gravity model using several variables in the light of gravity model panel data approach. Bangladesh's import is determined by the home and foreign country's gross domestic product and exchange rate. In addition, Cross section results show that regional trade arrangement which is South Asian Association for Regional Co-operation and border are significant for Bangladesh's import implies that Bangladesh should import more from intra regional country and also should import from India.

Key words: Gravity Model, Pooled OLS, Fixed effect, Random effect.

I. Introduction

Trade is an integral part of the total national development and growth of an economy. This is in fact a crucial instrument for industrialization while access to foreign exchange is essential for sustained economic development. Trade policy works by inducing substitution effects in the production and consumption of goods and services through changes in price. Trade liberalization is also seen as expanding economic opportunities by enlarging the market size and enhancing the impact of knowledge spillover.

Import is one of the most important factors in Bangladesh's economy. As a developing country Bangladesh imports more over exports which causes trade deficit. But now a days economist avoid this language because trade deficit is not necessarily harmful. The trade deficit is really a reflection of the imbalance between domestic investment and domestic saving. In addition, the imports of Bangladesh has noticeably high from India 15.7%(2008) compared to Kuwait (8.1%), Singapore (7.6%) and Japan (4.4%).

Therefore, this study is an attempt to find out the major determining factors of Bangladesh's import using panel data estimation technique. We have applied extended gravity model for our analysis. In the last decade, a lot of effort has been produced in empirical international trade to explain the bilateral volume of trade through the estimation of a gravity equation [1]. As a reminiscence of Isaac New-ton's law of gravity, the trade version of the latter represents a reduced form which comprise supply and demand factors (GDP or GNP and population),as well as trade resistance (geographical distance, as a proxy of transport costs and home bias) and trade preference factors (preferential trade agreements, common language, common borders)[2].

Due to its appeal as an empirical strategy its application has become enormously popular. Quoting by Eichengreen and Irwin (1997)[3], the gravity model is nowadays '... the workhorse for empirical studies ...' in international trade. Since the early 1990s, the large availability of international data necessary to fill the standard specification of the model, the relative independence from (or ability to mirror) different theoretical models, and a bandwagoning effect made the gravity model the empirical model of trade flows [4].

The trade gravity framework is for sure one of the most successful models in empirical economics so far [5]. In the basic form of the gravity equation, trade between a pair of countries is modeled as an increasing function of their sizes and a decreasing function of the distance between the two countries. This simple framework explains most of variation in observed volumes of trade flows. For these reasons the gravity model has become one of the standard empirical tools for analyzing trade patterns.

II. Data and Methodology

Classical gravity models generally use cross-section data to estimate trade effects and trade relationships for a particular time period, for example one year. In reality, however cross section data over several time periods (panel data methodology) result in more useful information than cross-sectional data alone[6]. The advantage of this method are first, panel can capture the relevant relationships among variables over time; second, panels can monitor unobservable trading-partner-pairs' individual effects. Our study covers a total of 14 countries. The countries are Bangladesh, India, Nepal, Sri Lanka, Indonesia, Malaysia, Singapore, Thailand, Canada, USA, France, Germany, Kuwait, and Saudi Arabia. The data collected for the period of 1991 to 2007(17 years). We cannot go beyond this period because of data limitation. All observations are annual and a balance panel of 221 observations. Data on the distance (in kilometer) between Dhaka (capital of Bangladesh) and other capital cities of country j has been collected from a distance calculation [7].

GDP, GDP per capita are in constant 2005 million US dollars have been obtained from world development indicator

(national accounts), Bangladesh's imports are measured in million US dollars have been collected from Bangladesh Bank (statistics department).Data on the exchange rates are converted in national currency per US dollar for all countries has been obtained from the Bangladesh Bank economic review.

III. The Fixed Effects Estimator

$$y_{it} = x_{it}\beta + \alpha_i + \varepsilon_{it}; \text{ i=1,2,..,n; t=1,2,..,T} \quad (1)$$

If $\alpha_i = \alpha$ contains only a constant term, then ordinary least squares provides consistent and efficient estimates of the common α and the slope vector β . This is the pooled ordinary least square estimator (OLS).

If α_i is unobserved, but correlated with x_{it}, then the least squares estimator of β is biased and inconsistent as a consequence of an omitted variable. This fixed effects approach takes α_i to be a group-specific constant term in the regression model. It should be noted that the term fixed as used here indicates that the term does not vary over time.

Assumptions about unobserved terms:

Assumption 1: α_i freely correlated with x_{it}.

Assumption 2: E ($x_{it}u_{is}$) = 0 for s = 1,2,…, T (strict exogeneity).

To see how the FE estimator solves the endogeneity problem that would contaminate the OLS estimates, begin by taking the average over time of (1) for each individual - this gives $\bar{y}_i = x_i\beta + \alpha_i + \bar{\varepsilon}_i$ (2)

Now subtract (2) from (1)

$$y_{it} - \bar{y}_i = (x_{it} - \bar{x}_i)\beta + (\varepsilon_{it} - \bar{\varepsilon}_i) \quad (3)$$

This transformation of the original equation, known as the within transformation, has eliminated α_i from the equation.

Hence, we can estimate β consistently by using OLS on (3). This is called the within estimator or the Fixed Effects estimator.

The Random Effects Estimator

$$y_{it} = x_{it}\beta + \alpha_1 + u_i + \varepsilon_{it} \quad \text{i=1, 2,…,n; t=1,…,T} \quad (4)$$

where, there are k regressors including a constant term and now the single constant term is mean of the unobserved heterogeneity. The component u_i is the random heterogeneity specific to the ith observation and is constant through time.

Assumptions:

$$E[\varepsilon_{it} \mid X] = E[u_i \mid X] = 0 \, E[\varepsilon_{it}^2 \mid X] = \sigma_\varepsilon^2,$$
$$E[u_i^2 \mid X] = \sigma_u^2, E[\varepsilon_{it} u_j \mid X] = 0,$$
$$E[\varepsilon_{it}\varepsilon_{js} \mid X] = 0,$$
$$E[u_i u_j \mid X] = 0, \text{for all i, t and j.}$$

IV. Gravity Model

This model originates from the Newtonian physics notion. Newton's gravity law in mechanics states that two bodies attract each other proportionally to the product of each body's mass (in kilograms) divided by the square of the distance between their respective centers of gravity (in meters).The gravity model for trade is analogous to the law. The analogy is as follows: 'the trade flow between two countries is proportional to the product of each country's economic mass, generally measured by GDP, each to the power of quantities to be determined, divided by the distance between the countries respective economic centers of gravity, generally their capitals, raised to the power of another quantity to be determined[7]. This formulation can be generalized to,

$$M_{ij} = k y_i^{\beta} y_j^{\gamma} D_{ij} \delta \quad (5)$$

where, M_{ij} is the flow of imports into country i from country j , Y_i and Y_j are country i's and country j's GDPs and D_{ij} is the geographical distance between the countries capitals.

The linear form of the model is as follows:

$$\log M_{ij} = \alpha + \beta \log Y_i + \gamma \log Y_j + \delta \log(D_{ij}) \quad (6)$$

where, α = logk

This baseline model, when estimated, gives relatively good results. However we know that there are other factors that influence trade levels [8].

Most estimates of gravity models add a certain number of dummy variables to equation (6) that test for specific effects, for example being a member of a trade agreement, sharing a common land border, speaking the same language and so on.

Assuming that we wish to test for p distinct effects, the model then becomes:

$$\log M_{ij} = \alpha + \beta \log Y_i + \gamma \log Y_j + \delta \log(D_{ij}) + \sum_{s=1}^{p} \lambda sGs \quad (7)$$

For the gravity model of Bangladesh's imports, the following model is considered:

$$\begin{aligned} Limp_{ijt} &= \beta_0 + \beta_1 Lgdp_{it} + \beta_2 Lgdp_{jt} + \beta_3 Lpcgdp_{it} \\ &+ \beta_4 Lpcgdp_{jt} + \beta_5 Ldist_{ij} + \beta_6 Lexrate_{ijt} \\ &+ \beta_7 \exp/ gdp_{jt} + \beta_8 tr/gdp_{it} + \beta_9 tr/gdp_{jt} \\ &+ \delta_1 D_{1ijt} + \delta_2 D_{2ijt} + u_{ijt} \end{aligned} \quad (8)$$

where, imp_{ijt} =Import of Bangladesh from country j at time t, gdp_{it} = gdp for country Bangladesh(i), gdp_{jt} = gdp for country j, $pcgdp_{it}$ =per capita gdp for country i $pcgdp_{jt}$ =per capita gdp for country j, $dist_{ij}$ =distance between two country $exrate_{ijt}$ =exchange rate exp/ gdp_{jt} =export gdp ratio tr/gdp_{it} = trade gdp ratio for country i tr/gdp_{jt} = trade gdp ratio for country j D_{1ijt} =dummy for SAARC D_{2ijt} =dummy for border u_{ijt} is log normally distributed with E [ln u_{ijt}]=0 L=natural log.

V. Empirical Results

The Gravity model of Bangladesh's import equation (8) has been estimated taking all explanatory variables except distance and dummy variable. Then we re-run the model regarding only significant variable. The estimated model represents the elasticity of dependent variable with respect to independent variable. According to import model, Table 1 depicts that all estimated coefficients on the levels of GDPs and the distance show highly significant at 1 percent level with the expected sign. The estimated results of basic gravity models of Bangladesh's import represents that if the Bangladesh's (importer) GDP and country J's GDP is increased by 1 percent, import demand of Bangladesh and export supply of foreign country increase by 2.30 and 0.73 percent (ceteris paribus).The coefficient of log (distance) which reflects the trade cost ,shows the estimated value -0.61 percent as a result of 1 percent increase in bilateral distance between these two countries. The R-square in import model 0.47 which means that the model explains 47 percent of the total variation of the Bangladesh's import.

The basic gravity model includes only GDP and distance. But in this study we have used extended gravity model by including more variable rather than GDP and distance.

Table. 1.Gravity variables only

Variables	coefficients	standard error	p value	t-ratio
Importer's GDP	2.304779	0.386788	<.001	5.96
Exporter's GDP	0.7398602	0.0717636	<.001	10.31
Geographic distance	-0.6159683	0.1669934	<.001	-3.69

R-square = 0.4700

The simplest, and possibly naive, approach is to disregard the space and time dimensions of the pooled data and just estimate the usual OLS regression. As the intercept is constant here, it does not represent good estimation.

Table. 2. Pooled OLS without dummy

Variables	coefficients	standard error	p value	t-ratio
Importer's GDP	2.377511	0.3987687	<.001	5.96
Exporter's GDP	0.5462816	0.0506557	<.001	10.78
Exchange rate	0.0179211	0.0392731	0.059	0.46

R-square = 0.4373

We have paid particular attention to the fact that gravity model not only contain time varying variables such as GDPs, exchange rate but also includes time invariant variables namely distance and border. It is worth noting that FEM does not allow for estimating time invariant variables because successful transformation wipes out such variables [6]. However, the random effects treatment does allow the model to contain observed time invariant characteristics [9].

Table. 3. Fixed effect within group

Variables	coefficients	standard error	p value	t-ratio
Importer's GDP	0.954588	0.3911734	0.016	2.44
Exporter's GDP	1.611658	0.3173323	<.001	5.08
Exchange rate	1.847972	0.4009379	<.001	4.61

F test that all u_i =0 F(12, 205) = 44.57 Prob > F = 0.0000

From the results it is also seen that, test of group effect reject the null hypothesis that all the unobserved effects are zero. So fixed effect model is significant.

The estimation results says that with 1% increase of GDP, ,import demand of Bangladesh increases by 0.95% and export supply of country J increases by 1.61%. The positive sign of exchange rate implies currency devaluation does not increase the country export rather 1 percent currency evaluation leads to other things being equal 1.85% percent imports from other country, as a consequence deficit increases.

The within R-square effect explains 46% of the total variation.

R-square: Within country 0.4610, Between country 0.0683, Overall 0.0727, Hausman's specification test=18.51, Prob>chi2=0.0003.

The rejection of null hypothesis prefer fixed effect model that implies there is a correlation between unobserved effects and regressors.

Table. 4.Random effect model for time invariant variable

Variables	coefficients	standard error	p value	z-ratio
Importer's GDP	2.65174	0.2587006	0.016	10.25
Exporter's GDP	0.5684856	0.1941828	<.001	2.93
Exchange rate	0.2119979	0.154148	<.001	1.38
Distance	0.2155618	0.6281812	<.001	0.34
Border	1.800636	1.597533	0.029	1.13

R-square: Within country 0.4171, Between country 0.4680, Overall 0.4486.

From the table 4, it is shown that time invariant variables are significant.

Table 5 summarizes that distance variable is not significant at 5% level of significance but has anticipated sign which means distance does not affect Bangladesh's import. The border dummy is found significant and has positive sign which indicates that Bangladesh tends to import more from its neighboring countries. It is interesting to observe that import between two countries would decrease -97.72% [exp(-3.78)-1*100=-97.72] if there exists a bilateral trade agreement between the countries compared to the country-pairs without having bilateral trade agreement.

Table. 5.Cross section results with country dummy and distance

Variables	coefficients	standard error	p value	t-ratio
SAARC	-3.777371	0.6654545	< .001	-5.68
border	5.361064	0.946138	< .001	5.67
Distance	-0.0000839	0.0000643	0.224	-1.31

VI. Conclusion

The main goal of this study is to focus the influencing factors of import flows of Bangladesh in the light of gravity model panel data approach. An assessment of the empirical evidence has been acquired through pooled OLS model, fixed effect model within group estimator. Further, the study explores the impact of time invariant variable under random effect model and cross section country effects.

From this study we found that import model coincide with the gravity model as GDP is positive and distance negative (ceteris paribus). On the other hand, to focus the impact of regional dummy SAARC, it was found negative influence on import.

In Rahman's (2003) [6] paper exchange rate is found as a determining factor of Bangladesh's export and inflation rate in both countries are playing central role in import model .However this study strongly found opposite of these two findings. Here, exchange rate is significant in import model and states effectiveness of currency devaluation is not so prominent in the context of trade deficit.

Rahman (2003) and Hossain (2009) [6,7] found the regional trade dummy is insignificant in import flows. But in this study we have explored the SAARC dummy is significant. This study has found the regional agreement that is SAARC dummy is significant but has negative impact. The RTA hinders the Bangladesh's import -97.92%.

However the magnitude of the coefficients in pooled and random effect estimation are notably different from those in fixed effect method suggesting that there may be biased results due to ignoring country specific effects in pooled OLS and inconsistent estimates because of correlation between the individual effect and regressors in the random effect method.

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