A Panel Data Analysis of Bangladesh's Trade: The Gravity Model Approach

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Abstract:

Attempts are made to provide a theoretical justification for using the gravity model in the analysis of bilateral trade and apply the generalized gravity model to analyse the Bangladesh's trade with its major trading partners using the panel data estimation technique. We have estimated the gravity model of trade (sum of exports and imports), the gravity model of export and the gravity model of import. Our results show that Bangladesh's trade is positively determined by the size of the economies, per capita GNP differential of the countries involved and openness of the trading countries. The major determinants of Bangladesh's exports are: the exchange rate, partner countries' total import demand and openness of the Bangladesh economy. All three factors affect the Bangladesh's exports positively. The exchange rate, on the other hand, has no effect on the Bangladesh's import; rather imports are determined by the inflation rates, per capita income differentials and openness of the countries involved in trade. Transportation cost is found a significant factor in influencing Bangladesh's trade negatively. Also Bangladesh's imports are found to be influenced to a great extent by the border between India and Bangladesh. The country specific effects show that Bangladesh would do better by trading more with its neighbouring countries. Multilateral resistance factors affect Bangladesh's trade and exports positively.

***Key Words*: Gravity Model, Panel Data, Fixed Effect Model, Bangladesh's Trade.**

***JEL classification*: C21, C23, F10, F11, F12, F14.**

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Trade is an integral part of the total developmental effort and national growth of an economy. This is, in fact, a crucial instrument for industrialisation while access to foreign exchange is essential for sustained economic development.

Although the foreign trade sector of Bangladesh constitutes an important part of its economy, the country suffers from a chronic deficit in her balance of payments. The trade relations of Bangladesh with other countries, especially with SAARC countries, do not show any hopeful sign for the desirable contribution to country's economic development. Therefore this study is an attempt to find out the major determining factors of Bangladesh's trade using panel data estimation technique. We have applied generalised gravity model for our analysis.

The gravity model has been applied to a wide variety of goods and factors of production moving across regional and national boundaries under different circumstances since the early 1940s(Oguledo and Macphee 1994). 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). Latter on an astronomer, Stewart, and a sociologist Zipf transferred this law to the social sciences and attempted to apply it to spatial interactions, such as trips among cities, using the following specification:

(1) $I_{ij} = G\,(pop_i pop_j)/D_{ij}^{\alpha}$

where I_{ij} is number of trips between city i and city j
$pop_{i\,(j)}$ is population in city i (j)

D_{ij} is distance between city i and city j

G is a coefficient.

[Zhang and Kristensen (1995) and Chritie 2002].

The gravity model for trade is analogous to this 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."(Christie 2002:1). This formulation can be generalized to

$$(2) \quad M_{ij} = KY_i^{\beta}Y_j^{\gamma}D_{ij}^{\delta}$$

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:

$$(3) \quad Log(M_{ij}) = \alpha + \beta \log (Y_i) + \gamma \log (Y_j) + \delta \log (D_{ij})$$

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

Most estimates of gravity models add a certain number of dummy variables to (3) 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:

$$(4) \; Log (M_{ij}) = \alpha + \beta \log (Yi) + \gamma \log (Yj) + \delta \log (D_{ij}) + \sum_{s=1}^{p} \lambda sGs$$

In this paper, we would make an attempt, firstly, to provide a theoretical justification for using the gravity model in applied research of bilateral trade, and secondly, to apply this model in analyzing the trade pattern and trade relation of Bangladesh with its major partner countries. So the rest of the paper is organised as follows: section II presents theoretical justification of the model, section III analyses the Bangladesh's trade using panel data and the gravity model, and finally section IV summarizes and concludes the paper.

II. Theoretical Justification of the Gravity Model in Analysing Trade

The Newtonian physics notion is the first justification of the gravity model. The second justification for the gravity equation can be analysed in the light of a partial equilibrium model of export supply and import demand by Linneman (1966) (see Appendix 1 for Linneman approach). Based on some simplifying assumptions the gravity equation turns out to be a reduced form of this model. However, Bergstrand (1985) and others point out that this partial equilibrium model could not explain the multiplicative form of the equation and also left some of its parameters unidentified mainly because of exclusion of price variable. With the simplest form of the equation, of course, Linneman's justification for exclusion of prices is consistent.

Using a trade share expenditure system Anderson (1979) also derives the gravity model (see Appendix 2) which postulates identical Cobb-Douglas or constant elasticity of substitution (CES) preference functions for all countries and weakly separable utility functions between traded and non-traded goods. Here utility maximization with respect to income constraint gives traded goods shares that are functions of traded goods prices only. Prices are constant in cross-sections; so using the share relationships along with trade (im) balance identity, country j's imports of country i's goods are obtained. Then assuming log linear functions in income and population for shares, the gravity equation for aggregate imports is obtained.

The author considers the endogeneity problem of income, and proposes two alternative solutions which follow the Instrumental Variable (IV) approach. Using different instruments: either lagged value of income as instruments can be used or first stage estimation of shares by OLS can be used and income values obtained from estimated shares can be substituted for a second stage re-estimation of the gravity equation. For many goods, the aggregate gravity equation is obtained only by substituting a weighted average for the actual shares in the second stage.

The next approach is based on the Walrasian general equilibrium model, with each country having its own supply and demand functions for all goods. Aggregate income determines the level of demand in the importing country and the level of supply in the exporting country. While Anderson's analysis is at the aggregate level, Bergstrand (1985, 1989) develops a microeconomic foundation to the gravity model. He opines that a gravity model is a reduced form equation of a general equilibrium of demand and supply systems. For each country the model of trade demand is derived by maximizing a constant elasticity of substitution (CES) utility function subject to income constraints in importing countries. On the other hand, the model of trade supply is derived from the firm's profit maximization procedure in the exporting country, with resource allocation determined by the constant elasticity of transformation. The gravity model of trade flows, proxied by value, is then obtained under market equilibrium conditions, where demand for trade flows equals supply of the flows. Bergstrand argues that since the reduced form eliminates all endogenous variables out of the explanatory part of each equation, income and prices can also be used as explanatory variables of bilateral trade. Thus instead of substituting out all endogenous variables, the author treats income and certain price terms as exogenous and solves the general equilibrium system retaining these variables as explanatory variables. The resulting model is termed as a "generalized" gravity equation. Bergstrand's analysis is based on the assumptions of nationwide product differentiation by monopolistic competition and identical preferences and technology for all countries. With N countries, one aggregate tradable good, one domestic good and one internationally immobile factor of production in each country, Bergstrand's (1985) model is general equilibrium model of world trade. Bergstrand's (1989) model is an extension of his earlier work where production is added under monopolistic competition among firms that use labor and capital as factors of production. Firms produce differentiated products under increasing returns to scale.

The micro-foundations approach also alleges that the crucial assumption of perfect product substitutability of the 'conventional' gravity model is unrealistic as evidence in recent times has shown that trade flows are differentiated by place of origin. Exclusion of price variables leads to misspecification of the gravity model. Anderson (1979), Bergstrand (1985, 1989), Thursby and Thursby (1987), Helpman & Krugman (1985) and so on share this view. Their studies show that price variables, in addition to the conventional gravity equation variables, are also statistically significant in explaining trade flows among participating countries (Oguledo and Macphee 1994). Generally a commodity moves from a country where prices are low to a country where prices are high. Therefore, trade flows are expected to be positively related to changes in export prices and negatively related to changes in import prices (Karemera et al 1999). However, price and exchange rate variables can be omitted only when products are perfect substitutes for one another in consumer preferences and when they can be transported without cost between markets. This structure, of course, takes us to the standard Heckscher-Ohlin (H-O) setting (Jakab 2001).

Eaton and Kortum (1997) also derive the gravity equation from a Ricardian framework, while Deardoff (1997) derives it from a H-O perspective. Deardroff proves that, if trade is impeded and each good is produced by only one country, the H-O framework will result in the same bilateral trade pattern as the model with differentiated products. If there are transaction costs of trade, distance should also be included in the gravity equation. It is shown by Evenett and Keller (1998) that the standard gravity equation can be obtained from the H-O model with both perfect and imperfect product specialization. Some assumptions different from increasing returns to scale, of course, are required for the empirical success of the model. They also argue that the increasing returns to scale model rather than the perfect specialization version of the H-O model is more likely candidate to explain the success of the gravity equation. Furthermore, they find that the variations in the volume of trade can be explained better by the models with imperfect product specialization than the models with perfect product specialization (Carrillo and Li 2002).

To test for the relevance of monopolistic competition in international trade Hummels and Levinsohn (1993) use intra-industry trade data. Their results show that much of intra-industry trade is specific to country pairings. So their work supports a model of trade with monopolistic competition (Jakab et. al 2001).

Therefore, the gravity equation can be derived assuming either perfectly competition or monopolistic market structure. Also neither increasing returns nor monopolistic competition is a necessary condition for its use if certain assumptions regarding the structure of both product and factor markets hold (Jakab et. al 2001).

Analysing the theoretical foundations of gravity equations, Evenett and Keller (1998) mention three types of trade models. These models differ in the way specialisation is obtained in equilibrium. They are:

(1) technology differences across countries in the Ricardian model,
(2) variations in terms of countries' different factor endowments in the H-O model,
(3) increasing returns at the firm level in the Increasing Returns to Scale (IRS) model.

These are the perfect specialization models, and are considered as limiting cases for a model of imperfect specialisation. But empirically imperfect product specialisation is important. In real life, though technologies and factor endowments are different in different countries, they change over time and can be transferred between countries. Trade theories just explain why countries trade in different products but do not explain why some countries' trade links are stronger than others and why the levels of trade between countries tends to increase or decrease over time. This is the limitation of trade theories in explaining the size of trade flows. Therefore, while trade theories cannot explain the extent of trade, the gravity model is successful in this regard. It allows more factors to take into account to explain the extent of trade as an aspect of international trade flows (Paas 2000).

Trade occurs because of differences across countries in technologies (Ricardian theory), in factor endowments (H-O theory), differences across countries in technologies as well as continuous renewal of existing technologies and their transfer to other countries (Posner 1961 and Vernon 1966). Quoting from Dreze (1961) Mathur (1999) says that country size and scale economies are important determinants of trade (Paas 2000).

The production will be located in one country if economies of scale are present. They also induce the producers to differentiate their product. The larger the country is in terms of its GDP/GNP, for instance, the larger the varieties of goods offered. The more similar the countries are in terms of GDP/ GNP, the larger is the volume of this bilateral trade. Thus with economies of scale and differentiated products, the volume of trade depends in an important way on country size in terms of its GDP/GNP (Paas 2000:). This is the concept of new theories of international trade, and it provides a better explanation of empirical facts of international trade in terms of their pattern, direction and rate of growth. As a result, the traditional theories are supplemented, if not replaced, by the new trade theories, in recent years, based on the assumption of product differentiation and economies of scale. Among the contributors of these new theories, Krugman (1979), Lancaster (1980), Helpman (1981, 1984, 1987 and 1989), Helpman and Krugman (1985, 1989), and Deardorff (1984) warrant special mention in the context of their explaining trade both empirically and theoretically (Mathur 1999). Assumption of similar technologies and factor endowments across countries are implicit in these theories.

The H-O and Ricardian theories of trade contradict with the trade in real world. In the H-O model the larger the differences in the factor endowments between two countries, the larger will be the trade. Therefore, based on this ground we would expect little trade between west European countries since these countries have more similar factor endowments and a lot of 'North South' trade. This is contrary to empirical facts. This is evident from the international trade statistics that intra-industry trade and ' North-North' trade are conspicuously large.

Linder (1961) hypothesis is related to the trade in real life. This hypothesis suggests that the presence of increasing return in production causes the production of each good to be located in either of the countries but not in both of them. It is also suggested that demand structure will be the similar for the similarities of per capita income. So more similar the countries are in per capita income, larger is their bilateral trade. That is, “absolute value of the difference” of per capita income in any two countries will have a negative effect on their bilateral trade. This should explain the ‘North-North’ trade pattern.

However, Deardorff (1997) argues that certain kinship to Heckscher-Ohlin can be viewed in the gravity model. According to the H-O theory, capital intensive goods are produced by capital-rich countries. So - as Markusen (1986) has already shown- if high- income consumers tend to consume larger budget shares of capital intensive goods, then it follows that (1) capital rich countries will trade more with other capital rich countries than with capital poor countries, and (2) capital poor countries will trade more with their own kind. These are the same predictions as those of the Linder hypothesis (Frankel 1997).

While we are taking GNP as a variable, the reasons for taking ‘per capita GNP’ as a separate independent variable are that it indicates the level of development. If a country develops, the consumers demand more exotic foreign varieties that are considered superior goods. Further, the process of development may be led by the innovation or invention of new products that are then demanded as exports by other countries. Also it is true that more developed countries have more advanced transportation infrastructures which facilitate trade.

Transportation cost is an important factor of trade. Production of the same good in two or more countries in the presence of transport costs is inconsistent with factor price equalization. Moreover, different trade models might behave differently in the presence of transport cost and differences in demand across countries (Paas 2000, quoted from Davis and Weinstein 1996).

Transport costs are proxied by the distance. So distance between a pair of countries naturally determines the volume of trade between them. Studied based on general equilibrium approach, (Tinbergen 1962, Poyhonen 1963, Bergstrand 1985, 1989 etc.) concluded that incomes of trading partners and the distances between them were statistically significant and had expected positive and negative signs, respectively (Oguledo and Macphee 1994, Karemera et al 1999). Three kinds of costs are associated with doing business at a distance: (i) physical shipping costs, (ii) time-related costs and (iii) costs of (cultural) unfamiliarity. Among these costs, shipping costs are obvious (Frankel 1997 quoted from Linnemann 1966).

The majority of the general equilibrium studies found the population sizes of the trading countries to have a negative and statistically significant effect on trade flows (Linnemann 1966, Sapir 1981, Bikker 1987) although a few exceptions was also found in literature (Brada and Mendez 1983 for example). Trade barriers such as tariff have a statistically significant negative effect on trade flows between countries. On the other hand, preferential arrangements are found to be trade-enhancing and statistically significant (Oguledo and Macphee 1994).

III. Application of the Gravity Model in Analysing Bangladesh Trade

A Brief Picture of the Bangladesh's Trade

Trade sector is continuously playing an important role in the Bangladesh economy. The trade-GDP ratio, the export-GDP ratio and the import-GDP ratio have increased to 0.32, 0.13 and 0.19 respectively in 1999 compared to 0.19, 0.03 and 0.15 in 1976. In 1999, compared to 1988, Bangladesh's total trade, total exports and total imports increased by 168%, 204% and 153% respectively. In case of trade with our sample countries, this increase is the highest for the SAARC countries 439% (exports + imports). When separated, the increase of imports is the highest for the SAARC countries (602%), followed by ASEAN (276%) and EEC (107%); the increase of exports is the highest for the EEC countries (363%) followed by the NAFTA countries (323%), the Middle East countries (85%) and the SAARC countries (33%). Individually 20% of Bangladesh's trade of our sample total occurred with the USA in 1999 followed by India (12%), UK, Singapore, Japan (7%), and China, Germany (6%). In the same year the exports figures of Bangladesh are, of our sample total, 39% to the USA, 12% to Germany, 10% to UK, 7% to France, 5% to The Netherlands and Italy, 2% to Japan, Hong Kong, Spain and Canada and 1% to India and Pakistan. On the other hand, the imports figure of Bangladesh, of our sample total, is the highest from India (18%) followed by Singapore (12%), Japan (10%), China (9%) and USA and Hong Kong 8%. The over all trade balance of Bangladesh, of course, gives us disappointing results. Compared to 1988, the total trade deficit of Bangladesh increases by 115% in 1999. This figure is 987% with the SAARC countries, 1098% with India and 108% with Pakistan (Direction of Trade Statistics Yearbook-various issues).

Sample Size and Data Issues

Our study covers a total of 35 countries. The countries are chosen on the basis of importance of trading partnership with Bangladesh and availability of required data. Five countries of *SAARC* (out of seven countries) –Bangladesh, India, Nepal, Pakistan and Sri Lanka- are included. We could not include Bhutan and the Maldives as these countries have no data for most of the years of our sample period. From the *ASEAN* countries, five countries- Indonesia, Malaysia, the Philippines, Singapore and Thailand- are included. From the *NAFTA*, three countries- Canada, Mexico and USA- are considered. Eleven countries are taken from the *EEC (EU)* group. These are Belgium, Denmark, France, Germany, Greece, Italy, the Netherlands, Portugal, Spain, Sweden and the United Kingdom. Six *Middle East* countries such as Egypt, Iran, Kuwait, Saudi Arabia, Syrian Arab Republic and the United Arab Emirates are taken in the sample. Five *other* countries-Australia, New Zealand, Japan, China and Hong Kong- are also included in our sample for the analysis of Bangladesh's trade.

The data collected for the period of 1972 to 1999 (28 years). We cannot go beyond this period because Bangladesh was born as an independent state in December, 1971. Similarly data on these countries after 1999 were not available when these were collected. All observations are annual. Data on GNP, GDP, GNP per capita, GDP per capita, population, inflation rates, total exports, total imports, taxes on international trade (% of current revenue) and CPI are obtained from the *World Development Indicators (WDI*) database of the World Bank. Data on exchange rates, index numbers of export and import prices are obtained from the *International Financial Statistics (IFS),* CD-ROM database of International Monetary Fund (IMF). Data on Bangladesh's exports of goods and services (country i's exports) to all other countries (country j), Bangladesh's imports of goods and services (country i's imports) from all other countries (country j) and Bangladesh's total trade of goods and services (exports plus imports) with all other countries included in the sample are obtained from the *Direction of Trade Statistics Yearbook* (various issues) of IMF. Data on the distance (in kilometer) between Dhaka (capital of Bangladesh) and other capital cities of country j (as the crow flies) are obtained from an Indonesian Website: www.indo.com/distance.

GNP, GDP, GNP per capita, GDP per capita are in constant 1995 US dollars. GNP, GDP, total exports, total imports, taxes, Bangladesh's exports, Bangladesh's imports and Bangladesh's total trade are measured in million US dollars. Population of all countries are considered in million. GNP and per capita GNP of U.K. and New Zealand are always replaced by GDP and per capita GDP of these two countries respectively as the data on the former are not available for some years of the sample period. Data on the exchange rates are available in national currency per US dollar for all countries. So these rates are converted into the country j's currency in terms of Bangladesh's currency (country i's currency).

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 observed over several time periods (panel data methodology) result in more useful information than cross-section data alone. The advantages of this method are: first, panels can capture the relevant relationships among variables over time; second, panels can monitor unobservable trading-partner-pairs' individual effects. If individual effects are correlated with the regressors, OLS estimates omitting individual effects will be biased. Therefore, we have used panel data methodology for our empirical gravity model of trade.

The generalized gravity model of trade states that the volume of trade / exports / imports between pairs of countries, X_{ij}, is a function of their incomes (GNPs or GDPs), their populations, their distance (proxy of transportation costs) and a set of dummy variables either facilitating or restricting trade between pairs of countries. That is,

$$Xij = \beta_0 \, Y_i^{\beta 1} \, Y_j^{\beta 2} \, N_i^{\beta 3} \, N_j^{\beta 4} \, D_{ij}^{\beta 5} \, A_{ij}^{\beta 6} \, U_{ij} \qquad (1)$$

Where Y_i (Y_j) indicates the GDP or GNP of the country i (j), N_i (N_j) are populations of the country i (j) , D_{ij} measures the distance between the two countries' capitals (or economic centers), A_{ij} represents dummy variables, U_{ij} is the error term and βs are parameters of the model. Using per capita income instead of population, an alternative formulation of equation (1) can be written as

$$X_{ij} = \beta_0 \, Y_i^{\beta 1} \, Y_j^{\beta 2} \, y_i^{\beta 3} \, y_j^{\beta 4} \, D_{ij}^{\beta 5} \, A_{ij}^{\beta 6} \, U_{ij} \qquad (2)$$

Where y_i (y_j) are per capita income of country i (j). As the gravity model is originally formulated in multiplicative form, we can linearize the model by taking the natural logarithm of all variables. So for estimation purpose, model (2) in log-linear form in year t, is expressed as,

$$lX_{ijt} = \beta_0 + \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 ly_{it} + \beta_4 ly_{jt} + \beta_5 lD_{ijt} + \sum_h \delta_h P_{ijht} + U_{ijt} \qquad (3)$$

where *l* denotes variables in natural logs. P_{ijh} is a sum of preferential trade dummy variables. Dummy variable takes the value one when a certain condition is satisfied, zero otherwise.

Using our data set, we estimate three gravity models of Bangladesh trade: (a) the gravity model of Bangladesh's trade (exports + imports), (b) the gravity model of Bangladesh's exports, and (c) the gravity model of Bangladesh's imports. For the model (a), we have followed Frankel (1993), Sharma and Chua (2000) and Hassan (2000, 2001). Since the dependent variable in the gravity model is bilateral trade (sum of exports and imports) between the pairs of countries, the product of GNP/GDP and the product of per capita GNP/ GDP have been used as independent variables. We have added some additional independent variables in our model. Thus the gravity model of trade in this study is:

$$\log (X_{ijt}) = \alpha_0 + \alpha_1 \log (GNP_{it}*GNP_{jt}) + \alpha_2 \log (PCGNP_{it}*PCGNP_{jt}) + \alpha_3 \log (Tax_{it}*Tax_{jt}) + \alpha_4 \log (Distance_{ij}) + \alpha_5 \log (PCGNPD_{ijt}) + \alpha_6 (TR/GDP_{it}) + \alpha_7 (TR/GDP_{jt}) + \alpha_8 (Border_{ij}) + \alpha_9 (j\text{-}SAARC) + U_{ijt} \quad \text{(a)}$$

where,

X_{ij} = Total trade between Bangladesh (country i) and country j,
GNP_i (GNP_j) = Gross National Product of country i (j),
$PCGNP_i$ ($PCGNP_j$) = Per capita GNP of Country i (j),
Tax_i (Tax_j) = Trade tax as % of revenue of country i (j),
$Distance_{ij}$ = Distance between country i and country j,
$PCGNPD_{ij}$ = Per capita GNP differential between country i and j,
$TR/GDP_{i(j)}$ = Trade- GDP ratio of country i (j),
$Border_{ij}$ = Land border between country i and j (dummy variable),
j –SAARC= Country j is member of SAARC (dummy variable),
U_{ij} = error term; t = time period, α_s = parameters.

Hypotheses

1. The product of GNPs is considered as the size of the economy. As it is bigger, there will be more trade between the two countries; so we expect a positive sign for the coefficient of GNPs.
2. Per capita GNP provides a good proxy for the level of development and infrastructures that are essential to conduct trade, and as such the more developed the countries are, the more would be the trade between the pairs of countries (Frankel 1993). So we expect a positive sign for the coefficient of PCGNP variable.
3. Trade tax always prevents trade. Also trade flow is inversely related to the transport costs. So we expect negative signs for the coefficients of these variables.
4. According to the H – O theory, the sign of the coefficient of PCGNPD would be positive. On the other hand, based on the Linder hypothesis, the sign would be negative.

5. TR / GDP variable indicates the openness of the country. The more open the country is, the more would be the trade. So we expect a positive sign for this variable.

With regard to the gravity model of Bangladesh's export, we consider the following model:

$$lX_{ijt} = \beta_0 + \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 ly_{it} + \beta_4 ly_{jt} + \beta_5 lD_{ijt} + \beta_6 lyd_{ijt} + \beta_7 lER_{ijt} + \beta_8 lIn_{it} + \beta_9 lIn_{jt} + \beta_{10} lTE_{it} + \beta_{11} lTI_{jt} + \beta_{12}(IM/Y)_{jt} + \beta_{13}(TR/Y)_{it} + \beta_{14}(TR/Y)_{jt} + \sum_h \delta_h P_{ijht} + U_{ijt} \quad \text{(b)}$$

where, X= exports, Y=GDP, y = per capita GDP, D= distance, yd= per capita GDP differential, ER = exchange rate, In = inflation rate, TE = total export, TI =total import, IM/Y = Import-GDP ratio, TR/ Y= trade-GDP ratio, P =preferential dummies. Dummies are: D1= j-SAARC, D2=j-ASEAN, D3= j-EEC, D4 = j-NAFTA, D5= j-Middle East, D6 = j- others and D7= $border_{ij}$, l= natural log.

Hypotheses

1. We expect positive signs for β_1, β_2, β_7, β_9 β_{10}, β_{11}, β_{12}, β_{13} and β_{14}.
2. We expect negative signs for β_5 and β_8.
3. Signs may be positive or negative for β_3, β_4 and β_6. The reasons for ambiguity are: with the higher per capita income if the country enjoys economies of scale effect, then β_3 would be positive; alternatively due to absorption effect if the country exports less, then β_3 would be negative. Similarly, if country j demands more country i's goods due to higher income, β_4 would be positive; on the other hand due to economies of scale effect in country j, if more goods are produced in country j, then β_4 would be negative. β_6 would be positive if the H- O hypothesis holds and negative if the Linder hypothesis holds.

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

$$lM_{ijt} = \beta_0 + \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 ly_{it} + \beta_4 ly_{jt} + \beta_5 lD_{ijt} + \beta_6 lyd_{ijt} + \beta_7 lER_{ijt} + \beta_8 lIn_{it} + \beta_9 lIn_{jt} + \beta_{10}(EX/Y)_{jt} + \beta_{11}(TR/Y)_{it} + \beta_{12}(TR/Y)_{jt} + \sum_h \delta_h P_{ijht} + U_{ijt} \quad \text{(c)}$$

Where, M= imports, EX/Y= export-GDP ratio, and other variables are the same as defined in the Export model.

Hypotheses

1. We expect positive signs for β_1, β_2, β_8, β_{10}, $\beta_{11}$and β_{12}.
2. We expect negative signs for β_5, β_7 and β_9
3. Signs may be positive or negative for β_3, β_4 and β_6. The reasons for ambiguity are: with the higher per capita income if the country i enjoys economies of scale effect, then β_3 would be negative; alternatively due to absorption effect if the country i imports more, then β_3 would be positive. Similarly, if country j demands more country j's goods due to higher income (absorption effect), β_4 would be

negative; on the other hand, due to economies of scale effect in country j, if more goods are produced in country j, then β_4 would be positive. β_6 would be positive if the H - O hypothesis holds and negative if the Linder hypothesis holds.

In our estimation, we have used unbalanced panel data, and individual effects are included in the regressions. So we have to decide whether they are treated as fixed or as random. From the regression results of the panel estimation, we get the results of LM test and Hausman test [in the REM of Panel estimation]. These results suggest that FEM of panel estimation is the appropriate model for our study.

There is, of course, a problem with FEM. We cannot directly estimate variables that do not change over time because inherent transformation wipes out such variables. Distance and dummy variables in our aforesaid models are such variables. However, this problem can easily be solved by estimating these variables in a second step, running another regression with the individual effects as the dependent variable and distance and dummies as independent variables,

$$IE_{ij} = \beta_0 + \beta_1 Distance_{ij} + \sum_h \delta_h P_{ijh} + V_{ij} \qquad (d)$$

where IE_{ij} is the individual effects.

Estimates of Gravity Equations, Model Selection and Discussion of results

Estimation and Model selection

Equation (a) above is estimated taking all variables except distance and dummy variables for 463 observations. The variables- per capita GNP, and tax- are found to be insignificant. The variable trade-GDP ratio is also not so robust. Another estimate has been taken substituting population variable instead of per capita GNP. Tax variable has also been dropped from the estimation. Trade variable has been regressed on GNP, population, trade-GDP ratio and per capita GNP differential. Covering all countries the number of observations is 910. All variables except the population are found to be significant. So dropping the population variable from the model, another estimate has been taken. This time all explanatory variables-GNP, trade-GDP ratio and per capita GNP differential- are found to be significant with expected signs. So our selected estimated gravity model for Bangladesh trade is:

$$\log(X_{ijt}) = \alpha_0 + \alpha_1 \log(GNP_{it}*GNP_{jt}) + \alpha_5 \log(PCGNPD_{ijt}) + \alpha_6(TR/GDP_{it}) + \alpha_7(TR/GDP_{jt}) \qquad (a_1)$$

To test the heterscadasticity in the model we have run a separate regression considering the heteroscadasticity for every observation and all observations within groups. Hetero corrected regression results are shown in Table 1. Regression results are very similar with significance levels and expected signs. Our FEM has also been estimated with an autocorrelated error structure. Results are shown in Table 5. All coefficients are still significant with the correct signs though the robustness is slightly lower for variables. All variables are tested for multicollinearity. To check whether there is multicollinearity in our model, we regress each independent variable of the model on the remaining independent variables and compute R_i^2's. If any of these R_i^2's is greater than the original R^2, then we can conclude that there is severe multicollinearity in the model. The results for multicollinearity test are noted in Table 3. From the results we observe that the model does not have any multicollinearity problem. The estimation results of unchanged variables for equation (a) above -that is equation (d)- are noted in Table 2.

The gravity model of Bangladesh's exports-equation (b) above- has been estimated taking all explanatory variables except the distance and dummy variables for 785 observations of 31 countries. Many variables are found to be either insignificant or possessed wrong signs. In the process of model selection, we have found only GDP_i, exchange $rate_{ij}$, total $import_j$, $import/GDP_j$, $trade/GDP_i$ are found to be significant. When tested for the multicollinearity of the variables, GDP_i is found to have multicollinearity problem. Dropping this variable if we re-estimate the model on the remaining four variables, it is found that the variable import/GDP_j is insignificant. So our estimated desired model is now:

$$lX_{ijt} = \beta_0 + \beta_7 lER_{ijt} + \beta_{11} lTI_{jt} + \beta_{13}(TR/Y)_{it} \qquad (b_1)$$

Now all explanatory variables are found to be significant with expected signs. The results of the heteroscedasticity corrected model is shown in Table 1. The autocorrelated error structured model is also noted in Table 5.

The results for multicollinearity test are noted in Table 3. From the results we observe that the model does not have any multicollinearity problem. The estimation results of unchanged variables for equation (b) above -that is equation (d)- are noted in Table 2.

The gravity model of Bangladesh's imports, the equation (c) above, has been estimated taking all variables except distance and dummy variables. The model covers all countries of our sample constituting 899 observations. In the estimation process only GDP_j, per capita GDP $differential_{ij}$, $inflation_i$, $inflation_j$, trade/GDP_i, trade/GDP_j are found to be significant. All other variables are found either insignificant or have wrong signs. While multicollinearity of these variables is being tested, GDP_j variable is found to have problem. So omitting this variable from the model we are left with the five explanatory variables, where all variables are found to be significant with the correct signs. Therefore, our preferred estimated gravity model of imports is:

$$lM_{ijt} = \beta_0 + \beta_6 lyd_{ijt} + \beta_8 lIn_{it} + \beta_9 lIn_{jt} + \beta_{11}(TR/Y)_{it} + \beta_{12}(TR/Y)_{jt} \qquad (c_1)$$

The detail results of the heteroscedasticity corrected model are shown in Table 1. The autocorrelated error structured model and multicollinearity tests of the variables are also shown in Table 5 and Table 3 respectively. The model does not have any multicollinearity problem. The estimation results of unchanged variables for equation (c) above -that is equation (d)- are noted in Table 2.

The country specific effects of these 3 heteroscedasticity corrected models are shown in Table 1(A). The test for the appropriateness of the FEM in our analysis is shown in Table 4. Table 6 shows the descriptive statistics of the 3 models; Table 7 presents the correlation matrices of these models and Table 8 gives the results of the gravity variables only.

Discussion of Results

As mentioned earlier, our all three gravity models suggest [see REM in Table 4] that, based on the LM and Hausman tests, FEM of Panel estimation is the appropriate strategy to be adopted. So the results of FEM would be discussed here for the said three models. The estimation uses White's heteroskedasticity-corrected covariance matrix estimator.

In these models, the intercept terms α_{0i} and β_{0i} are considered to be country specific, and the slope coefficients are considered to be the same for all countries. The intercept terms in REMs, of course, are considered to be random variables, instead of fixed country specific variables, and the slope coefficients are considered to be the same for all countries.

In our trade model (Table 1), the coefficient of product of GNP is positive and highly significant as expected. This implies that Bangladesh tends to trade more with larger economies. Bangladesh's bilateral trade with country j increases by 0.88% (almost proportional) as the product of Bangladesh's GNP and country j's GNP increases by 1%.

The coefficient of per capita GNP differential between Bangladesh and country j is also significant at 1% level and has positive sign. The coefficient value is 0.23 which implies that bilateral trade with country j increases as the per capita GNP differential_{ij} increases but less than proportionately. From the positive sign of this coefficient we can have an indication that the H - O effect (differences in factor endoments) dominates the Linder effect in case of Bangladesh trade.

The trade-GDP ratio is the proxy of openness of countries. The coefficient of this variable for country j is found large, significant at 1% level and have expected positive sign. This implies that Bangladesh's trade with all other countries under consideration is likely to improve very significantly with the liberalization of trade barriers in these countries. Our estimate suggests that a 1% increase in the openness of trade in j countries could increase Bangladesh's trade with these countries by as much as 1.30% [exp(0.27)=1.30]. The coefficient of this variable for country i is also found to be significant at 5 % level and is very large. A 1% increase in the openness of trade of Bangladesh could increase Bangladesh's trade with these countries by as much as 2.03% [exp(0.71)=2.03].

With regard to the country specific effects, we observe that these effects are strongly significant for all countries. Of these effects Mexico followed by Spain, Greece, Portugal, France, etc. appear to have the lowest propensity to trade with Bangladesh, and Nepal then followed by India, Pakistan and Sri Lanka have the highest [see Table 1(A)].

The model has R^2 = 0.84, and F [37, 872]= 120.53. Also there is no multicollinearity problem among the variables. The autocorrelated error structured model (Table 5) also supports the above analysis though the coefficient values are slightly lower for some variables. The magnitude and the sign of the coefficients are very similar.

The distance variable (see Table 2) is significant even at 1 % level and has anticipated negative sign which indicates that Bangladesh tends to trade more with its immediate neighbouring countries. The coefficient value is –1.23 which indicates that when distance between Bangladesh and country j increases by 1%, the bilateral trade between the two countries decreases by 1.23%. Border dummy (D1) is found to be insignificant with a negative sign, and SAARC dummy (D2) is also insignificant but with positive sign.

For our export model (Table 1), as mentioned earlier, only the variables exchange rate, total import of country j and the trade- GDP ratio of Bangladesh are found to be highly significant (even at 1% level). The positive coefficient of exchange rate implies that Bangladesh's exports depend on its currency devaluation. From the estimated results it is evident that 1% currency devaluation leads to, other things being equal, 0.34% exports to j countries.

Total imports of country j may be considered as target country effect. The coefficient value of this variable is found large and carries an anticipated positive sign. The estimated results show that the exports of Bangladesh increase slightly higher than proportionately with the increase of total imports demand of country j. (The coefficient is: 1.01).

The trade-GDP ratio of Bangladesh, the openness variable, has an expected positive sign. The coefficient of this variable is very large and indicates that Bangladesh has to liberalise its trade barriers to a great extent for increasing its exports. The estimated coefficient is 2.27 which implies that Bangladesh's exports increase 9.68% [exp (2.27) = 9.68] with 1% increase in its trade-GDP ratio, other things being equal.

As per as country specific effects are concerned, all effects are highly significant [Table 1(A)]. Our results show that Mexico followed by Sweden, Canada, New Zealand, France, the Netherlands, etc., have the lowest propensity to Bangladesh's exports, and Nepal followed by Pakistan, Iran, Syrian, A.R., Italy, Sri Lanka, India, etc., have the highest propensity to Bangladesh's exports.

The model has R^2 = 0.79, and F [32, 752]= 88.78. Also there is no multicollinearity problem among the variables. Almost similar results are obtained from the autocorrelated error structured model (Table 5) in terms of magnitude and the sign of coefficients.

Interestingly the distance variable is found to be insignificant but have expected negative sign (see Table 2). All dummy variables are fond to be insignificant.

In the import model (see Table 1), per capita GDP differential has positive sign which again supports the H – O hypothesis. With 1% increase of this variable, imports of Bangladesh increase by 0.69%. Imports of Bangladesh are also positively responsive with the inflation of Bangladesh and negatively responsive with the inflation of country j. The inflation elasticities of imports are 0.08 and –0.15 respectively for Bangladesh and country j. The openness variables of Bangladesh and country j are also major determining factors of Bangladesh's imports. Both variables are highly significant and have positive influences on Bangladesh 's imports. The estimated results show that with 1% increase of trade-GDP ratio of Bangladesh, other things being equal, has an effect of 29.37% increase of its imports [exp(3.38)=29.37]. An increase of 1% trade-GDP ratio of country j leads to increase of 1.79% imports of Bangladesh [exp (.58) = 1.79]. So liberalization of trade barriers from both sides is essential.

In terms of country specific effects, all effects except China are significant [see Table 1 (A)]. From the estimated results it is observed that Bangladesh's import propensity is the lowest from Portugal followed by Greece, Singapore, Belgium, Spain, etc., and it is the highest from India followed by China (not significant), Nepal, Pakistan, USA, Indonesia, etc.

The goodness of fit of the model, R^2 = 0.79, and F [38, 860]= 87.37. Also there is no multicollinearity problem among the explanatory variables. The autocorrelated error structured model (Table 5) also gives more or less similar results with regards to magnitudes and signs. However, inflation of country j variable is now insignificant though it gives expected negative sign.

Table 2 refers to the effects of distance and dummy variables on the Bangladesh's imports. Only border dummy is found to be significant at 5% level. The coefficient value is 1.68 which indicates that Bangladesh's import trade with India is 5.37 times higher just because of common border [exp(1.68) = 5.37].

Comparison among the *three* models

From the empirical evidences of the three models, it is observed that openness of the economies of Bangladesh and its trading partners is the crucial factor for enhancing Bangladesh's trade. This variable is found largely significant in all three models. More liberalization of trade restrictions, especially in Bangladesh, is utmost important. Per capita GNP differential, which supports the H - O effect, is found common as the determinant of trade both in the trade model and the import model. The exchange rate is found as a determining factor of Bangladesh's exports, where as for imports it is not. For imports, the inflation rate in both countries are playing central role instead of the exchange rate. Bangladesh's export is also greatly determined by the target countries' import demand. The country specific effects for all three models are more or less similar. With regard to the distance effect, all models supports that transportation costs are inversely related to the Bangladesh's trade although this variable is found to be insignificant for the export and import model when estimated separately. When we estimate the models taking only the gravity variables, distance is found highly significant (see Table 8) for all three models though the goodness of fit is not reasonably high. Adjacency dummy is found significant only for the import model.

Multilateral Resistance Factors

Bilateral trade may be affected by the multilateral resistance factors. Anderson and Wincoop (2003), Baier and Bergstrand (2003), and Feenstra (2003) have recently considered these factors in their works. Assuming identical, homothetic preferences of trading partners and a constant elasticity of substitution utility function Anderson and Wincoop (2003) define the multilateral trade resistance as follows:

$$P_j = \left[\sum_i (\beta_i p_i t_{ij})^{1-\sigma} \right]^{1/(1-\sigma)}$$

where P_j is the consumer price index of j. β_i is a positive distribution parameter, p_i is country i's (exporter's) supply price, net of trade costs, t_{ij} is trade cost factor between country i and country j, σ is the elasticity of substitution between all goods. For simplification they assume that the trade barriers are symmetric, that is, $t_{ij}=t_{ji}$. They refer to the price index (P_i or P_j) as multilateral trade resistance as it depends positively on trade barriers with all trading partners.

High trade barriers for country i, reflected by high multilateral resistance Pi, lower demand for country i's goods, reducing its supply price p_i. Assuming σ >1, consistent with empirical results in the literature, it is easy to see why higher multilateral resistance of the importer j raises its trade with i. For a given bilateral barrier between i and j, higher barriers between j and its other trading partners will reduce the relative price of goods from i and raise imports from i. Trade would also be increased for the higher multilateral resistance of the exporter i. For a given bilateral barrier between i and j trade would increase between them as higher multilateral resistance leads to a lower supply price p_i.

The authors also opine that trade between countries is determined by *relative* trade barriers. Trade volume between two countries depends on the bilateral barrier between them relative to average trade barriers that both countries face with all their trading partners (t_{ij} / P_iP_j). A rise in multilateral trade resistance implies a drop in relative resistance t_{ij} / P_iP_j. Multilateral trade resistance is not much affected for a large country because the increased trade barriers do not apply to trade within the country, but for a very small country increased trade barriers lead to a large increase in multilateral resistance.

To calculate t_{ij} (unobservable) the authors hypothesize that t_{ij} is a log linear function of observables: bilateral distance d_{ij} and whether there is an international border between i and j. Language variable can also be used as dummy variables to determine the trade costs.

Baier and Bergstrand (2003) note that nonlinear estimation technique for multilateral resistance factor in Anderson and van Wincoop (2003) is complex. Because accounting for the roles of multilateral price terms such as p_i^g, p_j^g, P_i^g, and P_j^g has always been a difficult issue empirically, as no such data exist. They have used proxies for these multilateral terms. GDP weighted average of distance from trading partners can be used as a proxy for multilateral resistance term.

Feenstra (2003) mentions that once transportation costs or any other border barriers are introduced then prices must differ internationally. Therefore, overall price indexes in each country must be taken into account. This could be done in three ways. (1) Using published data on price indexes, (2) using the computational method of Anderson and van Wincoop (2003) or (3) using country fixed effects to measure the price indexes.

Application of Multilateral Resistance in the Bangladesh Trade

We have tried to see the effects of multilateral resistance on the Bangladesh trade. Following the Baier and Bergstrand (2003) and Feenstra (2003) we have considered the GDP weighted average of distance from trading partners and Consumer Price Indices (CPI) of trading partners as multilateral resistance variables (data on commodity prices or commodity price indexes for Bangladesh are not available). Adding CPI as multilateral resistance when we re-estimate the gravity model for Bangladesh trade [equation (a_1)] we see that GNP_{ij} variable and $(Trade / GDP)_j$ are insignificant but CPI_{ij} is found to be significant. The insignificant results for the GNP_{ij} and $(Trade / GDP)_j$, which were significant in equation a_1, may be due to small sample in this case [Here number of observations is 448 only compared to 910 in equation a_1. Data on CPI of Bangladesh are not available for many years].

We have also re-estimated the gravity model for Bangladesh export (equation b_1) adding CPI of trading partners as multilateral resistance variable. Here total observations are only 408 [Earlier the number of observations was 785]. Here also multilateral resistance variables are found to be significant though two other variables- total import of country $_j$ and trade-GDP ratio of country i-are found to be insignificant. The reason for these two variables to be insignificant may be due to small sample as stated above.

However, when GDP weighted average of distance is taken as a multilateral resistance variable, we find the opposite (insignificant) result of this variable in our Export Model. McCallum (1995) considers remoteness as multilateral resistance. His definition for remoteness for country i, which we consider for estimation, is as follows:

$$REM_i = \sum_{m \neq j} d_{im} / y_m$$

This variable tends to reflect the average distance of region i from all trading partners other than $_{j.}$ This result has been obtained from OLS as we cannot estimate the FEM for distance and dummy variables.

Taking GDP weighted average of distance as a multilateral resistance variable if we re-estimate the gravity equation of trade model we find that this variable is insignificant in determining the Bangladesh trade. The same results we have obtained in our export model as described above. The estimated results of the trade model and export model, when we consider multilateral resistance variable in alternative ways, are noted in Table 9 and Table 10. From the F–value and R^2-value, we can say that models in Table 9 are satisfactory, and hence CPI is the acceptable multilateral resistance variable for our analysis of Bangladesh trade, and this variable has positive effect on Bangladesh's export and Bangladesh's trade. This is expected as the more is multilateral resistance, the more will be the bilateral trade.

IV. Summary and Conclusion

The objectives of this paper were to provide a theoretical justification for using the gravity model in the analysis of bilateral trade and apply the gravity model to analyse the Bangladesh's trade with its major trading partners using the panel data estimation technique. We have established that the application of the gravity model in applied research of bilateral trade is theoretically justified. There are wide ranges of applied research where the gravity model is used to examine the bilateral trade patterns and trade relationships [see Bergstrand (1985, 1989), Koo and Karemera (1991), Oguledo and Macphee (1994), Zhang and Kristensen (1995), Le et. al (1996), Frankel (1997), Rajapakse and Arunatilake (1997), Karemera et. al (1999), Mathur (1999), Sharma and Chua (2000), Paas (2000), Hassan (2000, 2001), Jakab et. al (2001), Kalbasi (2001), Martinez-Zarzoso and Nowak-Lehmann D (2002), Soloaga and Winters (2001), Christie (2002), Carrillo and Li (2002), Egger and Pfaffermayr (2000), and Mátyás et. al (2000)].

We have estimated the generalized gravity models of trade, export and import. Our results show that Bangladesh's trade (sum of exports and imports) is positively determined by the size of the economies, per capita GNP differential of the countries involved and openness of the trading countries. The major determinants of Bangladesh's exports are: the exchange rate, partner countries' total import demand and openness of the Bangladesh economy. All three factors affect the Bangladesh's exports positively. The exchange rate, on the other hand, has no effect on the Bangladesh's import; rather imports are determined by the inflation rates, per capita income differentials and openness of the countries involved in trade. Transportation cost is found a significant factor in influencing the Bangladesh's trade negatively. This implies Bangladesh would do better if the country trades more with its neighbours. This is also evident from the country specific effects. Also Bangladesh's import is found to be influenced to a great extent by the border between India and Bangladesh. However, per capita income differential, both in the trade and the import models, supports the H-O hypothesis over the Linder hypothesis though this variable was found insignificant in the export model. This is somewhat contradictory result obtained from the distance and country specific effects. It may be the case that per capita income differential is not the proper representation of the factor endowment differential. Also the H-O hypothesis assumes zero transportation cost and perfect competition which are unrealistic. Bangladesh's bilateral trade and exports are also positively related to multilateral resistance factors.

The policy implications of the results obtained are that all kinds of trade barriers in countries involved, especially in Bangladesh, must be liberalized to a great extent in order to enhance the Bangladesh's trade. It seems that Bangladesh's currency is overvalued. Necessary devaluation of the currency is required to promote the country's exports taking other adverse effects, such as domestic inflation, of devaluation into account. Proper quality of the goods and services must be maintained as well as the varieties of goods and service must be increased as the Bangladesh's exports largely depend on the foreign demand. All partner countries' propensities to export and import must be taken into account sufficiently and adequately when trade policy is set as the Bangladesh's trade is not independent of country specific effects.

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Appendix 1:

The Trade Flow Model: Linnemann Approach

Factors contributing to trade flow between any pair of countries-say, the exports from country A to country B-may be classified in three categories. For example,

1. factors that indicate total potential supply of country A- the exporting country-on the world market;

2. factors that indicate total potential demand of country B- the importing country- on the world market;

3. factors that represent the "resistance" to a trade flow from potential supplier to potential buyer B.

The "resistance" factors are cost of transportation, tariff wall, quota, etc.

The potential supply of any country to the world market is linked systematically to

(i) the size of a country's national or domestic product (simply as a scale factor), and
(ii) the size of a country's population.

The level of a country's per capita income may also be considered as a third factor though its influence will be very limited, at most. If the third factor indeed had no effect at all, then the factors (i) and (ii) would obviously be completely independent of each other as explanatory variables, on theoretical grounds. On the other hand, if the third factor did have an effect, then the three explanatory factors would not be independent of each other, as a change in one of the three would necessarily be associated with a change in at least one of the other two variables. For statistical exercises this has important implications because it would imply certain problems of identification.

The Price Level

Potential supply and potential demand, in the equilibrium situation, on the world market have to be equal. For this, a prerequisite must be that the exchange rate has been fixed at a level corresponding with the relative scarcity of the country's currency on the world market.

Equality of supply and demand on the world market also implies that every country has a moderate price level in the long run. If the price level is too high or too low, there would be a permanent disequilibrium of the balance of payments. Adjustment through a change in the exchange rate will necessarily take place. Therefore, the general price level will not influence a country's potential foreign supply and demand except in the short-run.

A Formula for the Flow of Trade Between Two Countries

Let E^p = Total potential supply

M^p = Total potential demand

R = Resistance

Apparently the trade flow from country i to country j will depend on E_i^p and M_j^p . We assume a constant elasticity of the size of the trade flow in respect of potential supply and potential demand. Indicating the trade flow from country i to country j by X_{ij}, the trade flow equation would then combine the three determining factors in the following way:

$$Xij = \beta o \frac{(E_i^p)^{\beta 1} (Mj^p)^{\beta 2}}{(R_{ij})^{\beta 3}} \qquad (1)$$

In its simplest form, all exponents equal to 1.

The above three explanatory factors in (1) should now be replaced by the variables determining them. Therefore we now introduce the following notations.

Y= Gross national product

N= Population size

y = Per capita national income (or product)

D = Geographical distance

P = Preferential trade factor

E^p is a function of Y and N, and possibly of y. Thus we may write

$$E^p = \gamma_0 \, Y^{\gamma}{}_1 N^{\gamma}{}_2 \qquad (2)$$

In which $\gamma_1 = 1$ and γ_2 is negative. If we include per capita income, in spite of its limited significance, as one of the explanatory variables, we have

$$E^p = \gamma_0 \, Y^{\gamma 1} \, N^{\gamma 2} \, y^{\gamma 3} \qquad (3)$$

However, as y = Y/N, the coefficients of this equation would be dependent. So per capita income will not be introduced as an individual variable. If its effect is at all significant, that would be incorporated "automatically" in the exponents of the two other variables:

$$E^p = \gamma_0{}' \, Y^{\gamma}{}_1{}' \, N^{\gamma}{}_2{}' \qquad (4)$$

The same is true for the potential supply, M^p, which is determined by identical forces.

$$M^p = \gamma_4{}' \;\; Y^{\gamma}{}_5{}' \, N^{\gamma}{}_6{}'$$

We have argued that potential supply and potential demand are, in principle, equal to each other. Therefore, $\gamma_0{}' = \gamma_4{}'$, $\gamma_1{}' = \gamma_5{}'$, and $\gamma_2{}' = \gamma_6{}'$. This obviously has to be realized in an equilibrium situation.

The trade resistance factor R can be replaced by two variables D with a negative exponent and P with a positive exponent. For the latter variable several other variables may be substituted if we want to distinguish between various types of preferential trading areas. Here we disregard this complication for the sake of simplicity of the model. The trade flow equation, then, would run as follows:

$$X_{ij} = \delta_0 \frac{Y_i^{\delta 1} Y_j^{\delta 3} P_{ij}^{\delta 6}}{N_i^{\delta 2} N_j^{\delta 4} D_{ij}^{\delta 5}} \qquad (5)$$

Or

$$X_{ij} = \delta_0 Y_i^{\delta 1} N_i^{-\delta 2} Y_j^{\delta 3} N_j^{-\delta 4} D_{ij}^{-\delta 5} P_{ij}^{\delta 6} \qquad (6)$$

Appendix 2:

A Theoretical Foundation of the Model: Anderson's Approach

Generally the gravity equation is specified as

$$(1) \quad M_{ijk} = \alpha_k Y_i^{\beta 1k} Y_j^{\beta 2k} N_i^{\beta 3k} N_j^{\beta 4k} d_{ij}^{\beta 5k} U_{ijk}$$

Where M_{ijk} is the dollar flow of good or factor k from country or region i to country or region j, Y_i and Y_j are incomes in i and j, N_i and N_j are population in i and j, and d_{ij} is the distance between countries (regions) i and j. The U_{ij} is a log normally distributed error term with E (ln Uijk) = 0. Most often the flows are aggregated across goods. Ordinarily the equation is run on cross section data and sometimes on pooled data. Typical estimates observe income elasticity not significantly different from one and significantly different from zero and population elasticity around -.4 usually significantly different from zero.

Assumptions: (1) identical homothetic preferences across regions, (2) products are differentiated by place of origin, (3) pure expenditure system by specifying that the share of national expenditure accounted for by spending on tradeables is a stable unidentified reduced form function of income and population.

I. The Pure Expenditure System Model

Suppose, each country is completely specialized in the production of its own good. So there is one good for each country. There are no tariffs or transport costs. The fraction of income spent on the production of country i is denoted by bi and is the same in all countries. This implies identical Cobb-Douglas preferences everywhere. Prices are constant at equilibrium values and units are chosen such that they are all unity with cross-section analysis,. Consumption of good i (in value and quantity terms) in country j (imports of good i by country j) is thus

(2) $M_{ij} = b_i Y_j$

where Yj is income in country j.

The requirement that income must equal sales implies that

(3) $Yi = bi (\sum_j Yj)$

Solving (3) for bi and substituting into (2), we get

(4) $M_{ij} = Y_i Y_j / \sum Y_j$

This is the simplest form of "gravity" model. If error structure is disregarded, a generalization of equation (4) can be estimated by OLS, with exponents on Yi ,Yj unrestricted. In a pure cross section, the denominator is an irrelevant scale term. The income elasticity produced should not differ significantly from unity.

II. The Trade-Share-Expenditure System Model

This section adds to the Cobb-Douglas expenditure system for traded goods a differing traded-non traded goods split and produces an unrestricted (non-unit income elasticity) gravity equation.

Traded goods shares of total expenditure differ widely across regions and countries. Per capita income is considered as exogenous demand side factor, and population (country size) is considered a supply-side factor. Trade share "should" increase with per capita income and decrease with size. Taking the trade-share function as stable, the expenditure system model combines with it to produce the gravity equation.

Suppose, all countries produce a traded and a non-traded good. The overall preference function assumed in this formulation is weakly separable with respect to the partition between traded and non-traded goods: U = u (g (traded goods), non traded goods). Then given the level of expenditure on traded goods, individual traded goods demand are determined as if a homothetic utility function in traded goods alone g( ) are maximized subject to a budget constraint involving the level of expenditure on traded goods. The individual traded goods shares of total trade expenditure with homotheticity are functions of traded goods prices only. To make it simple, it is assumed g( ) has the Cobb-Douglas form. Since preferences are identical, expenditure shares for any good are identical across countries within the class of traded goods. So for any consuming country j, θ_i is the expenditure in country i's tradeable good divided by total expenditure in j on tradeables; i.e. θ_i is an exponent of g ( ). Let Φ_j be the share of expenditure on all traded goods in total expenditure of country j and $\Phi_j = F(Y_j N_j)$.

Demand for i's tradable good in country j (j's imports of i's good) is

(5) $M_{ij} = \theta_i \Phi_j Y_j$

The balance of trade relation for country i implies

(6) $Y_i \Phi_i = (\sum Y_j \Phi_j)\theta_i$

j

The left- hand side of equation (6) implies the value of imports of i plus domestic spending on domestic tradeables. The right-hand of equation (6) implies the value of exports of i plus domestic spending on domestic tradeables.

Solving (6) for θi and substituting into (5), we have

$$(7) \quad M_{ij} = \frac{\Phi_i Y_i \Phi_j Y_j}{\sum_j \Phi_j Y_j} = \frac{\Phi_i Y_i \Phi_j Y_j}{\sum_i \sum_j M_{ij}}$$

With F (Y_i, N_i) taking on a log-linear form, equation (7) is the deterministic form of the gravity equation (1) with the distance term suppressed and a scale term added. In fact, if trade imbalance due to long term capital account transactions is a function of (Y_i,N_i), we may write the basic balance $Y_i\Phi_i m_i = (\sum_j Y_j\Phi_j)\theta_i$, with $m_i = m(Y_i, N_i)$, and substitute into (6) and (7).

This yields

$$(8) \quad M_{ij} = \frac{m_i \Phi_i Y_i \Phi_j Y_j}{\sum_i \sum_j M_{ij}}$$

With log-linear forms for m and F, (8) is again essentially the deterministic gravity equation.

III. Estimation Efficiency

The trade –share model of section II provides some legitimacy to the gravity model. Ultimately many tradeables will be allowed for each country, with tariffs and transport costs present, but initially, as before, assume only one tradeable in each and no barriers to trade. The system to be estimated is

(5′) $M_{ij} = \theta_i \Phi j Y_j U_{ij}$

(6′) $m_i \Phi_i Y_i = \theta i \sum \Phi_j Y_j$

where U_{ij} is a log-normal disturbance with $E(\ln U_{ij}) = 0$. Note that (6′) states that planned expenditures (reduced or increased by the capital account factor) = planned sales, and has no error term. For efficient estimation we need that the information in (6′) be utilized. Since the constraint is highly non-linear in the Y's, the most equivalent way to do this is to substitute out θ_i and estimate the gravity equation:

$$(8) \quad M_{ij} = \frac{m(Y_i, N_i)\, F(Y_i, N_i) Y_i\, F(Y_j, N_j) Y_j}{\sum_j F(Y_j N_j) Y_j} U_{ij}$$

With the log-linear form for m ( ) and F ( ),

$m(Y_i, N_i) = K_m Y_i^{my} N_i^{mN}$

and $F(Y_j, N_n) = K_\Phi H_j^{\Phi y} N_j^{\Phi N}$

and the denominator made a constant term we have

$$(8') \quad M_{ij} = \frac{(K_m Y_i^{my} N_i^{mN})(K_\Phi Y_i^{\Phi y} N_i^{\Phi N}) Y_i (K_\Phi Y_j^{\Phi y} N_j^{\Phi N}) Y_j U_{ij}}{k'}$$

$$(K_m K_\Phi^2) Y_i^{my+\Phi y+1} N_i^{mN+\Phi N} Y_j^{\Phi y+1} N_j^{\Phi N} Uij$$

= --

K′

This is the aggregate form of equation (1) with the distance term omitted. Ordinarily it can be fitted on a subset of countries in the world. Exports to the rest of the world are exogenous and imports from it are excluded from the fitting. If this is done, the denominator is still the sum of world trade expenditures, and (6′) implies that (8) and (8′) assume that θ_i is the same in the excluded countries as in the included countries.

At last, form the set of estimated values for traded-goods expenditures:

$$(9) \qquad \hat{\Phi}_j Y_j = \hat{K}_\Phi Y_j^{\hat{\Phi}y+1} N_j^{\hat{\Phi}N}$$

The individual traded-goods shares θ_i can be estimated using the instruments $\hat{\Phi_j Y_j}$ (which are asymptotically uncorrelated with U_{ij}):

$$(10) \qquad M_{ij} = \theta_i \hat{\Phi}_j Y_j U_{ij}$$

Which is estimated across countries for country i’s exports (including the rest of the world’s exports to included countries), with the restriction that $\sum \theta i = 1$.

Table 1: Hetero Corrected Fixed Effects Models with Group Dummy Variables.

Variables	Tr. Model	Exp. Model	Imp. Model
$Log(GNP_i*GNP_j)$	0.88 (11.18)		
$Log(PCGNPD_{ij})$	0.23 (2.73)		
$(TR/GDP)_i$	0.71 (2.02)	2.27 (6.65)	3.38 (9.40)
$(TR/GDP)_j$	0.27 (3.99)		0.58 (6.97)
$Log\ (Exc.Rate)_{ij}$		0.34 (6.78)	
$Log\ (To.Imp_j)$		1.01 (11.41)	
$Log\ (PCGDPD_{ij})$			0.69 (6.87)
$Log\ (Infl_i)$			0.08 (2.46)
$Log\ (Infl_j)$			-0.15 (-3.24)
R^2	0.84	0.79	0.79
F	120.53 [37, 872]	88.78 [32, 752]	87.37[38,860]
Observations	910	785	899

t-ratios are noted in parentheses.

Table 1 A: Country Specific Effects:

(a) Trade Model

Estimated Fixed Effects

Country	Coefficient	t-ratio
India	-6.81824	-10.27896
Nepal	-6.54828	-11.67462
Pakistan	-6.88978	-11.96425
Sri Lanka	-7.27290	-14.15099
Indonesia	-7.78997	-13.06644
Malaysia	-7.74979	-14.23632
The Philippines	-8.58557	-15.03335
Singapore	-7.79166	-14.76914
Thailand	-7.69913	-13.35951
Canada	-8.10379	-12.99081
Mexico	-9.32731	-15.22791
USA	-8.26734	-11.67072
Belgium	-8.45751	-14.31077
Denmark	-8.15332	-13.61176
France	-8.68119	-13.18840
Germany	-8.35272	-12.26950
Greece	-8.97821	-15.39550
Italy	-8.49800	-13.12173
The Netherlands	-8.24464	-13.61331
Portugal	-8.96138	-15.65949
Spain	-9.08238	-14.41849
Sweden	-8.35963	-13.95009
U.K.	-8.07404	-12.48785
Egypt	-7.58901	-13.56338
Iran	-7.46865	-12.87785
Kuwait	-8.04523	-15.12939
Saudi Arabia	-7.81812	-13.58675

Syrian A.R.	-7.31586	-14.10710
U.A.E.	-7.45300	-13.78551
Australia	-7.97474	-12.98971
New Zealand	-8.38219	-14.93611
Japan	-8.41267	-12.09502
China	-7.35236	-10.89071
Hong Kong	-8.08309	-14.74297

(b) Export Model.

Estimated Fixed Effects

Country	Coefficient	t-ratio
India	-3.98161	-11.35915
Nepal	-3.18347	-15.06288
Pakistan	-3.19659	-10.12779
Sri Lanka	-3.71255	-13.46857
Indonesia	-4.12012	-10.67744
Malaysia	-4.88221	-14.30029
The Philippines	-4.79015	-14.41902
Thailand	-4.39164	-12.51778
Canada	-4.80324	-12.09441
Mexico	-5.92536	-16.38100
USA	-4.34713	-9.60586
Belgium	-4.04340	-9.75353
Denmark	-4.39586	-11.72100
France	-4.72039	-11.04269
Germany	-4.47119	-9.70940
Greece	-4.27493	-12.30002
Italy	-3.44276	-7.62768
The Netherlands	-4.67158	-11.39545
Portugal	-4.35928	-12.29574
Spain	-4.37484	-10.94045
Sweden	-4.93010	-13.01129
United kingdom	-4.51311	-10.73042
Egypt	-4.07449	-12.66137
Iran	-3.15882	-8.69149
Syrian A.R.	-3.39184	-11.65424
Australia	-4.39423	-12.12841
New Zealand	-4.78578	-14.75875
Japan	-4.02982	-8.92404
China	-4.60817	-12.35827
Hong Kong	-4.54601	-12.02473

(c) Import Model:

Estimated Fixed Effects

Country	Coefficient	t-ratio
India	.59693	3.75412
Nepal	-.63586	-4.92411
Pakistan	-.86768	-3.91459
Sri Lanka	-2.02300	-8.22451
Indonesia	-1.45216	-5.55482
Malaysia	-2.37158	-7.26383
The Philippines	-2.73135	-9.42516
Singapore	-3.59527	-8.33553
Thailand	-1.80805	-5.94157
Canada	-2.07663	-5.04592
Mexico	-3.07308	-8.81888
USA	-1.44102	-3.34354
Belgium	-3.53605	-8.49176
Denmark	-2.84402	-6.40894
France	-2.45038	-5.75066
Germany	-2.09445	-4.69577
Greece	-3.60681	-9.15776
Italy	-2.74619	-6.67274
The Netherlands	-2.65128	-6.36544
Portugal	-3.91391	-10.21942
Spain	-3.30586	-8.21573
Sweden	-2.70006	-6.34331
United Kingdom	-1.89176	-4.61686
Egypt	-2.46892	-8.95812
Iran	-2.04850	-6.52422
Kuwait	-3.12937	-7.74684
Saudi Arabia	-2.16190	-5.74465
Syrian A.R.	-2.85223	-9.91274
U.A.E	-2.45280	-5.74590
Australia	-2.04959	-4.92444
New Zealand	-3.19077	-7.73325
Japan	-1.55073	-3.50440
China	.00304	.02090
Hong Kong	-3.13849	-

Table 2: Cross-Section Results of the Distance and Dummy Variables. Dependent Variable is Country Specific Effect.

Variables	Tr. Model	Exp. Model	Imp. Model
Distance	-1.23 (-3.42)	-0.44 (-0.80)	-0.56 (-0.71)
ijBorder	-0.077 (-0.14)	-0.62 (-1.25)	1.68 (1.89)
J-SAARC	0.57 (1.57)	-1.98 (-1.14)	0.75 (0.30)
J-ASEAN		-3.05 (-1.62)	0.47 (0.02)
J-EEC		-2.68 (-1.26)	-0.27 (-0.09)
J-NAFTA		-3.21 (-1.42)	0.48 (0.15)
J-Middle East		-1.92 (-0.94)	-0.84 (-0.03)
J- others		-2.84 (-1.39)	0.53 (0.18)
R^2	0.58	0.62	0.47
F	13.62 [3,30]	5.09[7,22]	3.24[7,26]
Observations	34	30	34

t-ratios are shown in the parentheses.

Table 3: Multicollinearity Test.

(a) Trade Model:
Original R^2 = 0.52 (from OLS)
When log ($GNPi* GNP_j$) is the dependent variable, R^2 = 0.48
When log ($PCGNPD_{ij}$) is the dependent variable, R^2 =0.43
When $(Trade/GDP)_i$ is the dependent variable, R^2 = 0.18
When $(Trade/GDP)_j$ is the dependent variable, R^2 = 0.27

(b) Exp. Model:
Original R^2 = 0.44 (from OLS)
When Log(ER_{ij}) is the dependent Variable, R^2=0.01
When Log(TI_j) is the dependent Variable, R^2=0.07
When $(Trade/GDP)_i$ is the dependent Variable, R^2=0.07

(c) Imp. Model:
Original R^2 = 0.26 (from OLS)
When log ($PCGDPD_{ij}$) is the dependent variable, R^2 = .09
When log ($Infl_i$) is the dependent variable, R^2 = 0.18
When log ($Infl_j$) is the dependent variable, R^2 = 0.14
When $(Trade/GDP)_i$ is the dependent variable, R^2 = 0.24

When (Trade/GDP)$_j$ is the dependent variable, $R^2 = 0.09$

IMPLICATIONS: Above three models are free from the multicollinearity problem.

Table 4: Model Selection Test- Fixed vs Random Effect Models

(a) Trade Model:

```
+--------------------------------------------------------------------+
| Least Squares with Group Dummy Variables                           |
| Ordinary    least squares regression    Weighting variable = none  |
| Dep. var. = LTRADE   Mean=   1.482689067    , S.D.=   .7905461696  |
| Model size: Observations =     910, Parameters =  38, Deg.Fr.=   872 |
| Residuals:  Sum of squares= 92.91235404    , Std.Dev.=        .32642 |
| Fit:        R-squared=  .836448, Adjusted R-squared =         .82951 |
| Model test: F[ 37,    872] =  120.53,    Prob value =         .00000 |
| Diagnostic: Log-L =   -253.0205, Restricted(b=0) Log-L =   -1076.8554 |
|             LogAmemiyaPrCrt.=   -2.198, Akaike Info. Crt.=       .640 |
| Estd. Autocorrelation of e(i,t)     .437407                        |
+--------------------------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
LGNP	.8774362252	.76482026E-01	11.472	.0000	9.5195167
TRGDPI	.7053726318	.36387876	1.938	.0526	.20919209
TRGDPJ	.2671468725	.72780914E-01	3.671	.0002	.71513829
LPCGNPD	.2298100073	.58013467E-01	3.961	.0001	3.4871186

(Note: E+nn or E-nn means multiply by 10 to + or -nn power.)

Note: Country specific effects are not shown due to space consideration.

```
+--------------------------------------------------+
| Random Effects Model: v(i,t) = e(i,t) + u(i)     |
| Estimates:  Var[e]              =   .106551D+00  |
|             Var[u]              =   .197170D+00  |
|             Corr[v(i,t),v(i,s)] =   .649182      |
| Lagrange Multiplier Test vs. Model (3) = 4692.24 |
| ( 1 df, prob value =  .000000)                   |
| (High values of LM favor FEM/REM over CR model.) |
| Fixed vs. Random Effects (Hausman)     =   26.00 |
| ( 4 df, prob value =  .000032)                   |
| (High (low) values of H favor FEM (REM).)        |
| Reestimated using GLS coefficients:              |
| Estimates:  Var[e]              =   .107580D+00  |
|             Var[u]              =   .332939D+00  |
|             Sum of Squares          .365823D+03  |
+--------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
LGNP	.8364712644	.63623850E-01	13.147	.0000	9.5195167
TRGDPI	1.027258509	.33406194	3.075	.0021	.20919209
TRGDPJ	.3231311707	.61534328E-01	5.251	.0000	.71513829
LPCGNPD	.1012136361	.47778915E-01	2.118	.0341	3.4871186
Constant	-7.279862185	.49261834	-14.778	.0000	

(Note: E+nn or E-nn means multiply by 10 to + or -nn power.)

(b) Export Model:

```
+-----------------------------------------------------------------------+
| Least Squares with Group Dummy Variables                              |
| Ordinary    least squares regression    Weighting variable = none     |
| Dep. var. = Log (Exp_i)   Mean=   .9540221643  , S.D.=  .8153025069    |
| Model size: Observations =     785, Parameters =  33, Deg.Fr.=    752 |
| Residuals:  Sum of squares= 109.0757636    , Std.Dev.=         .38085 |
| Fit:        R-squared=  .790697, Adjusted R-squared =          .78179 |
| Model test: F[ 32,    752] =   88.78,    Prob value =          .00000 |
| Diagnostic: Log-L =   -339.2127, Restricted(b=0) Log-L =    -953.0725 |
|             LogAmemiyaPrCrt.=   -1.890, Akaike Info. Crt.=       .948 |
| Estd. Autocorrelation of e(i,t)     .484127                           |
+-----------------------------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
log(ER_{ij})	.3382378886	.53452284E-01	6.328	.0000	.33723167
Log(TI_j)	1.010957387	.88021420E-01	11.485	.0000	4.5868303
$(TR/Y)_i$	2.267862566	.37026738	6.125	.0000	.21044804

(Note: E+nn or E-nn means multiply by 10 to + or -nn power.)

Note: Country specific effects are not shown due to space consideration.

```
+--------------------------------------------------+
| Random Effects Model: v(i,t) = e(i,t) + u(i)     |
| Estimates:  Var[e]              =   .145048D+00  |
|             Var[u]              =   .225598D+00  |
|             Corr[v(i,t),v(i,s)] =   .608662      |
| Lagrange Multiplier Test vs. Model (3) = 3494.80 |
| ( 1 df, prob value =  .000000)                   |
| (High values of LM favor FEM/REM over CR model.) |
| Fixed vs. Random Effects (Hausman)     =   14.42 |
| ( 3 df, prob value =  .002381)                   |
| (High (low) values of H favor FEM (REM).)        |
| Reestimated using GLS coefficients:              |
| Estimates:  Var[e]              =   .145684D+00  |
|             Var[u]              =   .336853D+00  |
|             Sum of Squares          .351580D+03  |
+--------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
log(ER_{ij})	.2690241714	.46589817E-01	5.774	.0000	.33723167
Log(TI_j)	.9240199227	.74454770E-01	12.410	.0000	4.5868303
$(TR/Y)_i$	2.578612997	.34193336	7.541	.0000	.21044804
Constant	-3.922643965	.30927545	-12.683	.0000	

(Note: E+nn or E-nn means multiply by 10 to + or -nn power.)

(c) Import Model:

X3=Log($Import_i$), X8= log(yd_{ij}), X11=log(In_i), X12=log(In_j), X14=$(TR/Y)_i$, X15=$(TR/Y)_j$

```
+----------------------------------------------------------------------+
| Least Squares with Group Dummy Variables                             |
| Ordinary    least squares regression    Weighting variable = none    |
| Dep. var. = X3       Mean=   1.184798985    , S.D.=    .9076153955   |
| Model size: Observations =     899, Parameters =  39, Deg.Fr.=    860 |
| Residuals:  Sum of squares= 152.1885807    , Std.Dev.=         .42067 |
| Fit:        R-squared=  .794268, Adjusted R-squared =          .78518 |
| Model test: F[ 38,    860] =   87.37,    Prob value =          .00000 |
| Diagnostic: Log-L =   -477.2407, Restricted(b=0) Log-L =   -1187.9813 |
|             LogAmemiyaPrCrt.=   -1.689, Akaike Info. Crt.=      1.148 |
| Estd. Autocorrelation of e(i,t)     .390481                          |
+----------------------------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
X8	.6883732415	.63723166E-01	10.803	.0000	3.4886454
X11	.7510617841E-01	.31108434E-01	2.414	.0158	.83136181
X12	-.1452552468	.41826632E-01	-3.473	.0005	.78147372
X14	3.375149848	.35404040	9.533	.0000	.20818777
X15	.5832949152	.94488062E-01	6.173	.0000	.70568741

(Note: E+nn or E-nn means multiply by 10 to + or -nn power.)

Note: Country specific effects are not shown due to space consideration.

```
+--------------------------------------------------+
| Random Effects Model: v(i,t) = e(i,t) + u(i)     |
| Estimates:  Var[e]              =   .176963D+00  |
|             Var[u]              =   .434575D+00  |
|             Corr[v(i,t),v(i,s)] =   .710626      |
| Lagrange Multiplier Test vs. Model (3) = 4170.74 |
| ( 1 df, prob value =  .000000)                   |
| (High values of LM favor FEM/REM over CR model.) |
| Fixed vs. Random Effects (Hausman)     =   45.08 |
| ( 5 df, prob value =  .000000)                   |
| (High (low) values of H favor FEM (REM).)        |
| Reestimated using GLS coefficients:              |
| Estimates:  Var[e]              =   .178596D+00  |
|             Var[u]              =   .909179D+00  |
|             Sum of Squares          .850548D+03  |
+--------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
X8	.5371321774	.54594828E-01	9.839	.0000	3.4886454
X11	.7102968399E-01	.31092780E-01	2.284	.0223	.83136181
X12	-.1282004130	.41292744E-01	-3.105	.0019	.78147372
X14	3.789043731	.34318649	11.041	.0000	.20818777
X15	.4894154958	.84095857E-01	5.820	.0000	.70568741
Constant	-1.797297331	.22028584	-8.159	.0000	

(Note: E+nn or E-nn means multiply by 10 to + or -nn power.)

Table 5: Autocorrelated Error Structured Fixed Effect Model:

Variables	Tr. Model	Exp. Model	Imp. Model
Log(GNP_i*GNP_j)	0.72 (7.21)		
Log($PCGNPD_{ij}$)	0.23 (3.07)		
$(TR/GDP)_i$	0. 82 (2.06)	1.85 (4.07)	2.93 (7.10)
$(TR/GDP)_j$	0.21 (2.19)		0.48 (3.85)
Log $(Exc.Rate)_{ij}$		0.31 (3.63)	
Log ($To.Imp_j$)		1.02 (7.90)	
Log ($PCGDPD_{ij}$)			0.60 (7.41)
Log ($Infl_i$)			0.93 (3.41)
Log ($Infl_j$)			-0.24 (-0.58)
R^2	0.69	0.57	0.67
F	49.72 [37, 838]	30.45 [32, 722]	43.27[38,826]
Observations	**876**	**755**	**865**

t-ratios are noted in parentheses.

Note: Country effects are not shown because of space consideration.

Table- 6: Descriptive Statistics

Descriptive Statistics of the Trade Model [Model (a)]

Series	Observation	Mean	Stan Dev.	Minimum	Maximum
Ltradeij	910	1.48	0.79	-0.30	3.27
LGNPij	910	9.52	0.78	7.38	11.61
Ldisij	910	3.68	0.31	2.83	4.18
TR/GDPi	910	0.21	0.05	0.09	0.32
TR/GDPj	910	0.72	0.67	0.05	4.39
LPCGNPDij	910	3.49	1.14	0	4.64
ij border	910	0.03	0.17	0	1
J SAARC	910	0.12	0.33	0	1

Descriptive Statistics of the Export Model [Model (b)]

Series	Observation	Mean	Standard Deviation	Minimum	Maximum
log (BD's Exp.)	785	0.954022164	0.815302507	-1	3.149527
log (dist)	785	3.688857745	0.322530148	2.826075	4.179063
Log(Exc.Rate)	785	0.337231669	0.968771228	-2.32932	2.982994
Log(T.Imp_j)	785	4.58683031	0.670836758	2.264374	6.095859
(Trade/GDP)i	785	0.21044804	0.054185706	0.090705	0.318445
D1(j-SAARC)	785	0.142675159	0.349964251	0	1
D2(j-ASEAN)	785	0.142675159	0.349964251	0	1
D3(j-EEC)	785	0.347770701	0.476566427	0	1
D4(j-NAFTA)	785	0.107006369	0.309318427	0	1
D5(j-M.East)	785	0.100636943	0.30103919	0	1
D6(j- 0ther)	785	0.159235669	0.366128987	0	1
D7(border)	785	0.03566879	0.18558125	0	1

Descriptive Statistics of the Import Model [Model (c)]

Series	Observation	Mean	Standard Deviation	Minimum	Maximum
log (BD's Imp.)	899	1.184799	0.907615396	-1	3.07144
log(PCGDPdiff)	899	3.488645	1.148262107	0	4.9
log(Distance)	899	3.678608	0.305172855	2.826075	4.179063
Log(Infl Ratei)	899	0.831362	0.501990989	-0.54216	1.872019
Log(Infl Ratej)	899	0.781474	0.457576706	-1.16277	2.211678
(Trade/GDP)i	899	0.208188	0.053123643	0.090705	0.318445
(Trade/GDP)j	899	0.705687	0.651019471	0.050221	4.390288
D1(j-SAARC)	899	0.124583	0.330429158	0	1
D2 (j-ASEAN)	899	0.152392	0.35960006	0	1
D3 (j- EEC)	899	0.319244	0.46644307	0	1
D4 (j NAFTA)	899	0.093437	0.291206077	0	1
D5 (j-M.East)	899	0.171301	0.376981886	0	1
D6 (j- other)	899	0.139043	0.346184383	0	1
D7(border)	899	0.031146	0.173808127	0	1

Table 7: Correlation Matrices

Correlation Matrix of Trade Model (a1)

	Ltradeij	*LGNPij*	*TR/GDPi*	*TR/GDPj*	*LPCGNPDij*
Ltradeij	1				
LGNPij	0.614429	1			
TR/GDPi	0.387645	0.339606	1		
TR/GDPj	0.180924	-0.18243	0.092504	1	
LPCGNPDij	0.276294	0.514015	0.086055	0.27775	1

Correlation Matrix of Distance and Dummies of the Trade Model

	IndEffect	*Ldist*	*ij Border*	*J-SAARC*
IndEffect	1			
Ldist	-0.73396	1		
ij Border	0.290893	-0.32449	1	
J-SAARC	0.641551	-0.68066	0.476731	1

Correlation Matrix of the Export Model (b1)

	Log(BD's Exp.)	Log(Exc.Rate)	Log ($T.Imp_j$)	(Trade/GDP)i
log (BD's Exp.)	1			
Log(Exc.Rate)	0.13346523	1		
Log($T.Imp_j$)	0.622063324	0.113451808	1	
(Trade/GDP)i	0.384046956	0.057624011	0.25481981	1

Corrrelation Matrix of Distance and Dummies for the Export Model

	Ind.effect	Ldist	D1-bor	D2-j SA	D3-j ASE	D4-jEE	D5-j NAF	D6-J-M.E	D7-j other
Ind.effect	1								
Ldist	-0.49518	1							
D1-border	0.093312	-0.32012	1						
D2-J SAARC	0.502597	-0.67617	0.473432	1					
D3-J ASEAN	-0.1741	-0.34241	-0.07284	-0.15385	1				
D4-J EEC	-0.12513	0.432291	-0.14129	-0.29844	-0.29844	1			
D5-J NAFTA	-0.41317	0.444371	-0.0619	-0.13074	-0.13074	-0.25363	1		
D6-J-Meast	0.415028	-0.00735	-0.0619	-0.13074	-0.13074	-0.25363	-0.11111	1	
D7-other	-0.13933	0.018322	-0.08305	-0.17541	-0.17541	-0.34028	-0.14907	-0.14907	1

Correlation Matrix of the Import Model (c1)

	Bd's Imp	*ydij*	*Ini*	*Inj*	*(TR/Y)I*	*(TR/Y)j*
Bd's Imp	1					
ydij	0.257346	1				
Ini	-0.11033	-0.04383	1			
Inj	-0.43507	-0.18791	0.196763	1		
(TR/Y)I	0.310937	0.072005	-0.42834	-0.32898	1	
(TR/Y)j	0.197346	0.273326	-0.03107	-0.16215	0.061914	1

Correlation Matrix of Distance and Dummies of the Import Model

	IndEffect	*Ldist*	*D1*	*D2*	*D3*	D4	*D5*	*D6*	*D7*
IndEffect	1								
Ldist	-0.44895	1							
D1	0.524184	-0.68066	1						
D2	-0.03189	-0.11679	-0.15162	1					
D3	-0.39376	0.383306	-0.25252	-0.28716	1				
D4	0.031391	0.423504	-0.11359	-0.12917	-0.21514	1			
D5	-0.1069	-0.10096	-0.16903	-0.19221	-0.32013	-0.144	1		
D6	0.165083	-0.00081	-0.15162	-0.17241	-0.28716	-0.12917	-0.19221	1	
D7	0.488537	-0.32449	0.476731	-0.07228	-0.12039	-0.05415	-0.08058	-0.07228	1

Note: D1= border, D2= j-SAARC, D3= j-ASEAN, D4= j-EEC, D5= j-NAFTA, D6= j-M. East, D7= j- Other.

Table 8. Three Models with the Gravity Variables Only

Variables	Tr.Model	Exp. Model	Imp. Model
GNP	0.72 (27.61)*		
GDPi		-0.48 (-.08)	0.50 (8.66)*
GDPj		0.71 (17.48)*	0.96 (24.87)*
Distance	-1.45 (-21.55)*	-0.73 (-8.36)*	-1.62 (-19.04)*
R^2	0.45	0.31	0.44
F	740.30[1, 908)	175.25[2, 782]	349.23[2, 896]
Observation	910	785	899

t-ratios are in parentheses.
** denotes significant at 1% level.*

Table 9: Fixed Effects Models with Multilateral Resistance Variables.

Variables	Tr. Model	Exp. Model
$Log(GNP_i*GNP_j)$	**0.17 (0.72)**	
$Log(PCGNPD_{ij})$	**0.45 (2.43)**	
$(TR/GDP)_i$	**1.35 (2.83)**	**-0.49(-0.65)**
$(TR/GDP)_j$	**0.61 (0.06)**	
$Log (Exc.Rate)_{ij}$		**0.46 (2.79)**
$Log (To.Imp_j)$		**0.16 (0.76)**
$Log(CPI_i)$		**1.53(2.90)**
$Log(CPI_j)$		**0.46 (1.90)**
$Log(CPI_{ij})$	**0.25 (2.46)**	
R^2	**0.92**	**0.86**
F	**129.93 [37, 410]**	**65.77[34, 373]**
Observations	**448**	**408**

t-ratios are noted in parentheses.

Table 10: Cross-Section Results of the Multilateral Resistance and Dummy Variables. Dependent Variable is Country Specific Effect.

Variables	Tr. Model	Exp. Model
Rem_i	**25.57 (1.04)**	**0.42 (0.18)**
Rem_j	**-0.16 (-0.30)**	**0.42 (0.18)**
ijBorder	**8.86 (3.15)**	**1.13 (0.77)**
J-SAARC	**-16.07 (-1.59)**	**-0.27(-0.19)**
J-ASEAN		**0.76 (0.68)**
J-EEC		**-0.71 (-0.49)**
J-NAFTA		**1.03(0.68)**
J- others		**-0.89 (-0.39)**
R^2	**0.10**	**0.12**
F	**1.12** [3,30]	**0.34** [8,21]
Observations	**34**	**30**

t-ratios are shown in the parentheses.