Iranian Economic Review, Vol. 5, No. 5, 2001

The Gravity Model and Iran's Trade Flows

By:
Hassan Kalbasi, Ph.D.*

ABSTRACT

This article has considered the volume and direction of Iran's trade using the gravity model. The major issue in this analysis is to explore why Iran over or under-traded with the 76 countries relative to the predicted trade flows of the model. The study attempts to explore the reasons from the respect of both the model itself and Iran's trade structure. This is done by analysing the performance, like most of the developing countries, lying in natural-resource-based manufactured goods (i.e., hydrocarbons and agricultural products), and labour-intensive products (i.e. textile fibre and carpet). Part of these products (primarily agricultural) face quantitive restrictions imposed by the industrial countries, such as EU countries. What adds to the problem is the existing competition with similar exported products (i.e., textile and carpet) between Iran and other developing countries. However, the advantage of a relatively adaptable labour force gives Iran an opportunity to exploit her labour-intensive products. Having this advantage in this domain does not remove the necessity for a greater effort in improving the quality of the labour force so as to enhance the quantity and quality of the products.

Introduction

This articles aims firstly to employ the gravity model to analyse the

---

*. *University of Isfahan, Department of Economics*

international trade flows between countries and examine the potential of Iran's trade with these countries. In the course of doing this so it will be asked whether there is any difference in the importance of these factors that determine the trade flows among countries in different stages of development, and if there is, what it is and why it exists. The second objective is to use the equations obtained from the gravity model to explore the potential for Iran's trade flows to the rest of the world.

Firstly, empirical survey of the gravity model will be given and then we will analyse the empirical results for the trade flows between different economic groups using the gravity model. The next section explore the predicted level of Iran's trade. Finally, this analysis provides a summary and conclusion of this study.

Analysis

The gravity model has been used frequently to analyse bilateral trade flows between countries. The equation used is similar in all studies and has the following general specification:

$$X_{ij} = \alpha_0 (Y_i)^{\alpha_1} (Y_j)^{\alpha_2} (N_i)^{\alpha_3} (N_j)^{\alpha_4} (D_{ij})^{\alpha_5} (A_{ij})^{\alpha_6} (P_{ij})^{\alpha_7} U_j \quad (1)$$

Where X_{ij} is the value of the trade flow from country i to country j; Y_i and Y_j are the values of the nominal GDP in i and j; N_i and N_j are the size of population in both countries; D_{ij} is the physical distance from the economic center of country i to that of country j; A_{ij} is any other factor either aiding or hindering trade among i and j; P_{ij} is the trade preferences among the countries, and U_{ij} is a log-normally distributed error term with $E(\ln U_{ij}) = 0$.

The GDP of the exporting country measures the productive capacity, while that of the importing country measures the absorptive capacity. These two variables are expected to be positively related to trade. Physical distance and country adjacency dummies are proxies for transportation costs. Among the other variables affecting trade, the most frequently used have dummies for the integration systems in which countries participate; total population of importing and exporting countries as well as their per capital income levels. Population is used as a measure of country size, and since larger countries have more diversified production and tend to be more self-sufficient, it is normally expected to be negatively related to trade. As pointed out by Prewo (1978) and Bergstrand (1986), there is an inconsistency in this arguement, as larger populations allow for economies of scale which are translated into higher exports; therefore, the sign of the coefficient of the exporting country would be indeterminate. This section summarises some of the previous empirical results. The aim is to find similarities and differences

between the trade flow in 1998. To apply the basic gravity model, it is completed with a log-normally distributed error term.

The Aitken estimates are based on a data set of 5 EC countries and 7 EFTA nations, i.e., 132 observations. The equation estimated includes three dummy variables: an adjacency dummy, a dummy for intra-EC trade and a dummy for intra-EFTA trade. The sample used by Aitken, concentrated on the EC and EFTA nations, presenting the distance between the countries' parameter which is low and not very precise. The sample countries are close together. With 42 developed and developing countries (1,722 observations) the Tinbergen sample is a better reflection of world trade flows than the Aitken sample. The model includes one EC preference dummy and one Benelux (PB) preference dummy.

The Linneman sample includes bilateral trade flows of 80 countries accounting for 83 percent of the total world trade in commodities (excluding trade with and within the Communist bloc). The three cases present three variants based on the same data. The model includes estimates for a British Common wealth dummy, a French Community Preference dummy and a Belgian-Portuguese colonial preference dummy variable. Case (a) consists of 3,532 (non-zero) trade flows. The trade flows in the Linneman model are averages over the years 1958, 1959 and 1960.

The Bergstrand estimates are based on a basic gravity model without population variables but including dummy variables for the EC, EFTA and adjacency. The sample consists of 15 OECD countries: Canada, USA, Japan, Belgium-Luxembourg, Denmark, France, West Germany, Italy, Netherlands, UK, Austria, Norway, Spain, Sweden and Switzerland with 210 observations. It is remarkable that the Bergstrand estimate is used for fewer observations than other estimations of the same model.

The model estimated by Van Bergeijk is the traditional gravity model and is based on 25 countries, selected from the West, East and developing countries. The number of observation is 529 for 1970 and 504 for 1985. The composition of the sample is rather broad and also includes Eastern European countries. Both income coefficients are numerically and statistically close to one. The Van Bergeik estimates in 1985 reveal the same pattern as the previous estimates. The estimates of Van Beers and Linnemann in 1991 are based on a sample of 34 developing countries as exporters with, as importers (i.e.two trade), these 34 nations together with 13 developed countries.

The Biessen model includes two dummies accounting for barriers in East-West and West-East trades. The sample consists of 21 countries (8 EC countries, 6 EFTA countries and 7 CACM countries). The number of observations for 1980 is 417 and for 1986 is 354. Biessen's results are remarkably in line with existing results as basec on broadly composed

samples. The estimate of Wang is based on a sample of 75 countries, selected from developed and developing countries. The model estimated by Wang is the basic gravity model. The number of observations is 4057 for non-zero trade flows. The model includes 8 preference dummies and the country's distance variable is divided by three separate variables.

The Empirical Results for the Gravity Model

This section examines the estimated gravity model. In particular, it examines whether the factors indicated in the gravity equation make a significant contribution to an explanation of the world trade flows or not. This analysis has two series of computations: one based on all bilateral trades including zero trade flows with due substitutions[1], and the other excluding all zero trade flows. In each series of computations, the numerical values of the parameters that appear in the relationship explain the size of trade flows between different groupings of countries that will be estimated.

Table 1 to Table 6 show the results of the estimations based on the data with zero trade flows replaced by a small value (0.025 US mil $) as well as the results of estimation without zero trade flows. The results in each table also show the results for:

1) bilateral trade among all the 76 countries;
2) bilateral trade among 19 industrial countries;
3) bilateral trade among 57 developing countries;
4) industrial countries' exports to developing countries;
5) developing countries' exports to industrial countries.;

The economic structure and the level of economic development differs between these different groupings of countries. The difference in the economic structure and the economic development among these countries may cause the effects of the variables such as GDP, population and distance, etc., on trade flows to differ from one group to another. In other words, the estimated coefficients of the explanatory variables may vary in different country groups. First, the results obtained for the trade of the entire group of the countries are reported and followed by an analysis of the results for the four country groups.

Methodological Framework

The characteristic of a cross-section approach is to employ import or export data for many countries at a single point in time. To ensure the widest possible country coverage, data from the years 1990 and 1998 form the basis for our empirical work. The empirical analysis should be based on a

---

1. Values of 0.05, 0.025 and 0.0001 were substituted for countries with zero trade flows.

maximum geographical coverage of world trade flows. Unfortunately, for a variety of reasons, we can not include all the countries of the world and have been obliged to omit some countries in this study. The following countries have been excluded:

a) The former centrally-planned economies.

b) Countries which can only be considered as `market place´. They are usually considered to include free ports offering special tax facilities. Linnemann viewed Hong Kong and Singapore as a `market place´ and thus excluded them from his analysis.

c) Countries where import and export data are either completely lacking, or unreliable.

There are two possibilities for measuring the size of a trade flow: at the point of export or at the point of import. Apart from the well known differences in valuation' exports are valued at free-on-board prices, and imports usually at cost insurance freight prices' and apart from minor differences due to the time lags between the recording of exports by the exporting country and the recording of the same flow as an import by the importing country, these two measurements should produce the same results. As this analysis uses mostly export data, most of them obtained from the UN. International Trade Statistics Yearbook, which more disagreegated data are collected from the Directory of International Trade and also from OECD Statistics for most industrial countries. This study uses domestic products rather than national products as the factor determining a country's potential foreign trade. As Linnemann (1960) pointed out, in respect of exports, domestic product is, no doubt, the more proper concept because all domestically produced goods that leave a country are counted as exports, whether produced by national factors of production or by foreign factors of production. For imports, imports of current producer goods and capital are related to domestic product, but those of consumer goods are probably more related to national product or income. Data on domestic products and population are available for subscribers to Datastream and Purchasing Power Parity on the Penn World Table (PWT 5.5). The distances between each two countries are measured in nautical miles by the shortest navigable distance between the main ports of the respective countries. The navigable distances between the main ports of the respective countries are taken from Reed's Marine Distance Table. The relationship between the trade flows on one hand and the various explanatory variables on the other hand will be estimated by Ordinary Least-Squares (OLS) regression methods. The variables are measured in the following units:

Trade flows (X): in millions of US dollars;
Domestic Product (Y): in million of US dollars;
Population (N): in millions of inhabitants;

Distance (D): in thousands of nautical miles;
Adjacency dummy A_{ij} takes value 2 for the countries which share the same land border, otherwise 1[1];

Preference factor (P) takes value 2 if preferential treatment between the trade partners exists, otherwise it has the value 1. The samples of preferential agreements in the analysis are as follows:

P_{EC} : European Community
P_{EFTA} : European Free Trade Association
P_{ASEAN} : Association of South East Asian Nations
P_{EAPAT} : East African Preference Arrangement of Trade
P_{ACP} : EC preferences to ACP countries
P_{ECO} : Economic Co-operation Organisation.

Estimates Based on the Entire Group Data

The estimates for the entire group of countries confirm the hypothesis put forward in the previous section. All the regression coefficients in Table 1 except for road distance in non-zero flows have the expected sign, and most including the non-dummy variables are statistically different from zero. Significant coefficients for GDP in the first stage of the analysis confirm that international trade is strongly affected by the trading partners' incomes. The negative signs on the population variables (Ne and Ni) indicate that a country with a large population size has a minimum efficients scale and less motivation in international trade, relative to a small country. The three negative and significant coefficients of the distance variables i.e. road distance (DR), see distance (DS), and commercial center distance (DC) indicate the trade barrier impact of transportation costs, but the extent of trade flows between countries can increase if the countries share a land border (i.e. there is a positive sign on the adjacency variable). The negative coefficient on the distance between the port and the economic center imply that on average a country faces higher trading costs if the port is not an the economic center.

The coefficient on road distance is positive, and lower in absolute terms than on sea distance, implying that one unit of road transportation is more expensive than that of sea transportation. However, the difference in the effects of sea transportation costs on trade flows is not economically significant. Most preference variables are statistically significant at the 0.99 confidence level, but the Economic Co-operation Organisation (ECO) and the Andean Group (AG) preferences are not significant even at the 90%

---

1. 1 and 2 are used insted of 0 and 1 because it is not possible to take the log of 0 in a log linear equation.

Table 1
Estimated Gravity Model of Bilateral Exports (Whole Sample)

Variable	Expected Sign	Positive Flows (1)	Excluding Zero Flows
GDPe	+	2.02 (65.81)***	1.65 (59.79)***
GDPi	+	1.62 (53.27)***	1.21 (44.85)***
Ne	-	-0.94 (29.34)***	-0.80 (27.89)***
Ni	-	-0.68 (10.98)***	-0.39 (5.59)***
DR	-	-0.14 (0.46)	0.64 (0.27)
DS	-	-0.10 (1.97)**	-0.98 (1.50)**
DC	-	-0.25 (4.61)***	-0.28 (6.04)***
Adjacency	+	1.99 (8.31)***	1.80 (9.41)***
PN	+	1.06 (1.58)	0.69 (1.44)
PL	+	1.03 (2.53)**	0.26 (1.02)
PF	+	2.66 (7.11)***	2.15 (6.97)***
PB	+	0.42 (2.48)**	0.67 (4.70)***
PO	+	1.30 (1.30)	0.37 (0.52)
PA	+	2.78 (5.12)***	2.37 (6.01)***
PE	+	1.95 (7.95)***	1.69 (9.71)***
PT	+	1.79 (3.14)***	1.34 (3.34)***
Constant		-8.99 (26.99)***	-5.68 (21.89)***
Adjusted R^2		0.6267	0.6348
F - ratio		598.912	443.733
Heteroskedasticity		229.149	163.006
Sample size		5700	4076

Notes: *For all tables, estimates procedure OLS; T-values in parenthesis; ***, ** and * indicate coefficients are significant at 1%, 5% and 10% levels for a two tail test. 1% and 5% critical point of χ^2 (1) are 6.63 and 3.84 respectively. Positive flow is assumed to be 0.025 (US mil $) for export flows.*

level of confidence in both samples. The insignificant coefficients on the dummy variables such as the ECO integration (Iran, Turkey and Pakistan) suggest that this economic integration scheme is not sufficiently deep to influence the mutual trade between member countries significantly. The positive signs of preference coefficients indicate that participation in integration schemes stimulate mutual trade. The significance and size of the coefficients for the ASEAN (PA), EU (PE), and EFTA (PT), suggest that these arrangements are important to these members' performance. The coefficients on the preference dummy variables have the expected sign. The size of the ASEAN preference dummy variable is the highest among all coefficients in both equation 1 and 2 in Table 1. The high value of this coefficient may suggest that the economic integration effects of ASEAN are stronger than other economic integration arrangements among developing countries. This is evidenced by a large share of mutual trade flows in ASEAN. The mutual trade flows among these five countries accounted for 73% of the total trade flows between ASEAN and other developing countries concerned in the analysis. It certainly indicates greater trade dependance for these countries than suggested by the gravitational pulls on their trade. The French ex-colonial dummy variable has a positive effect on trade flows between France and its related developing countries and the coefficient of the dummy variable is significant at the 99% confidence level, but the British ex-colonial dummy variable is significant at the 95% significance level. The insignificant coefficient for the Andean Group (AG) countries confirms the Thoumi (1989) point that these countries have the most ambitious plans for a system of integration. The frequent balance of payment problems in particular for Bolivia and Peru, and in general, suggest that the relevant trade policy as regards integrations is not yet in plan. The statistical results show no relationship between AG membership and intra-regional trade. Garay (1981) gives an analysis of most of the problems encountered in the implementation of the AG provisions, particularly with respect to Colombia. These five countries of AG concerned in this study are members of the LAIA, and AG appears to have no additional effects. Summarising the results of the coefficients of the preference variables, the strongest and best-defined effect concerns a regional grouping of EC countries (Aitken, 1973) and a regional grouping of relatively small countries (ASEAN). Outside the intra-developing country grouping, the French ex-colonial (PF) and British ex-colonial (PB) links are very strong, but the effects of larger preferential schemes are weak. This can be interpreted as meaning that it is difficult and time-consuming to build up effective trade preferences, especially between richer and poorer countries. One problem encountered in estimating the model is heteroscedasticity, which is usually formed in cross-sectional data where there are a large