

Does Gravity Model Work for the Selection Trade Partners Among SCO Members? (The Case Study of Iran)Mehdi Taghavi^{*}, Bita Shayegani^{**}, Farhad Gaffari^{***}, Abdolali Monsef^{**} and Ali Niakan Lahiji^{****}^{*} Department of Economics, Allameh Tabataba'i University, Full Professor.^{**} Department of Economics, Payam Noor University, Assistant Professor.^{***} Department of Economics, Azad University, Assistant Professor.^{****} Department of Economics, Payam Noor University, PhD Candidate.a_niakan@yahoo.com

Abstract: The membership in Shanghai Cooperation Organization (as an observer member) and the escalation of challenges between the West and Iran has shifted the trade preferences of this country to the East and south East Asia. Using gravity model and panel data, we will study this new shift toward East and south East Asian countries in Iran's trade relations. Our results confirm high competence of gravity model for explaining the trade trend between Iran and these countries. This study shows that the volume of trade between Iran and those countries will increase through joining that treaty and enjoyment from existing trade complementarity. This fact is compatible with intra-industry trade in Heckscher-Ohlin model; in other words, the trade structure is primarily complementary and not competitive (substitution). The insignificance of political risk parameter in this model shows that we cannot explain the inclination of Iran's trade towards China and Russia with this individual parameter. Furthermore, increasing liberalization of trade has positive effects on trade volume with the members of this treaty.

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1. Introduction

It's near four decades that countries from all over the world try to reach more gains from trade, through regulatory and trade policies like facilitation of trade laws, trade liberalization and making regional preferential trade arrangements. But trade profits are not the sole reason for making these regional arrangements and there are other factors such as political motives, fear of isolation in the international trade environment, boosting and protecting the infant industries, stabilization of economic reforms, and regional security considerations.

There are much long lasting economic-trade cooperation in Asia that ASEAN agreement – based on Bangkok declaration in 1967 – is one of the most lasting and the most successful of them. Then in the early 1980s some other regional organizations – like "Persian Gulf Cooperation Council" (in the middle east), "the Organization of Economic Cooperation (ECO, 1986) - were established in other parts of this continent which have continued their cooperative activities successfully.

Iran is one of the founders of ECO, but this organization has no remarkable achievements in the trade realm. We can see this fact in the volume of trade between the members of this organization which is less than 7 percent of their total trade volume. So it seems necessary for Iran to review her selection of trade partners and to join other international cooperation

organizations that have more similarities with economic and trade conditions of this country.

Shanghai Cooperation Organization (SCO) – as an economic, political and security block – has achieved a successful trend to become an effective center in international politics and especially in economic affairs since 2001. The main members of this treaty – China and Russia – are among the biggest trade partners of Iran. Considering the current situation of Iran's international trade, we expect that economic integration – through regional treaties – leads to growth of trade volume between the member states. This fact is especially true due to export and import of some goods which the members of this treaty – including Iran, China and Russia – have the comparative and competitive advantage in trading them.

This study aims to review Iran's trade approach in relation to other members of SCO. The review is done through gravity model, using panel data. Statistical data of WDI, and international trade center between 2001 to 2009. At first we present a general introduction of SCO. Then – based upon the empirical evidence from gravity model - the literature of economic convergence and trade co-operations will be reviewed. After that we present the methodology of the research and at last, the model will be estimated. We found that due to western sanctions, Iran's trade structure has been inclined to the other countries. The gravity model is satisfactorily capable to explain the trade trend of Iran with member

states of this organization. It was found that the general trade model of Iran follows the intra-industry and the Heckscher-Ohlin model. So joining to SCO – based on complementary intra-industry trade – may expand trade capacity of Iran with the members of this treaty.

General introduction of SCO

SCO is an inter-state organization which was founded by the leaders of China, Russia, Kirgizstan, Kazakhstan, Tajikistan and Uzbekistan at 2001 to boost the multilateral security co operations.

This organization is principally the new configuration of "Shanghai 5" which was founded in 1996. That name was changed to "Shanghai Cooperation Organization" after membership of Uzbekistan in that treaty.

Apart from main members, at first Mongolia in 2004, and Iran, Pakistan and India in 2005 joined the organization as observer members. The framework of economic cooperation between member states and the establishment of a free trade zone was completed and signed at September, 2003 assembly. Then at September 2004, a document – including one hundred definite programs for boosting trade volume between member states – was signed.

The trade volume between member states of SCO has grown five folded after five decades from its beginning. It may be said that the economic, trade and political issues will be the main consideration of this union as before.

Some features such as inclusion of about four-fifth of EURASIA lands, one-third of world population, possession of 25 percent of petroleum and 50 percent of gas and uranium reserves, and high military power (especially in Russia and China), differentiates this organization from some other similar organizations in respects of potential economic, political and security capacities.

2. The Review of Theoretic Foundations of the Gravity Model

The gravity model is an operational tool from physics that is used as a systematic framework to study the traditional trade models between countries, and to assess the subjects as economic integration, evaluation of potential trade capacity, measurement of trade deviation and trade creation, measurement of distance effects on trade volume and consequently, judgment about characteristics of trade partners with respect to their distance from each other.

The equations used in gravity models are generally similar. The key variables in the model include the volume of trade between the two countries, GDP, the distance between the two countries and their similar features. Membership in the organization shows the existence of trade facilities between them which leads to greater trade. Greater distance means greater

transportation costs so that there is a negative relationship between distance and trade volume of those countries. The population of each country is an indicator of national market size and lower need to trade with abroad; so Prewo (1978) and Bergstrand (1989) believe that the relationship of these two variables may be positive or negative, depending on the conditions.

The model has been extended with introduction of dummy variables such as adjacency, membership in a union or group, or signing preferential agreements. The simple gravity model is specified as follows:

$$T_{ij}=A(Y_i, Y_j, D_{ij})$$

Where T_{ij} 's are bilateral trade flows (imports plus exports) between countries i and j , Y_i is the gross domestic product (GDP) of country i , Y_j is GDP of country j , and A is a constant.

3. The Literature of This Study

Tinbergen (1962), Pöyhönen (1963), and then Linnemann (1963) were amongst the pioneers that used the gravity model to study the flow of international trade. The studies of Anderson (1979) and Bergstrand (1985, 1989) showed that it is possible to apply the gravity equation in trade models with distinct goods. This distinction may be from the origin of goods, economic scales, factor production supply, or the technology of production. Though there may be different reasons for production differences, but these reasons can create a gravity force; therefore the gravity equations may be produced relying on all kinds of distinctions.

Helpman and Krugman (1985) used dissimilar goods framework with increasing returns to scale to explain the gravity model. Deardorff (1988) proved that gravity equation gathers the features of various models, so that it may be explained by traditional trade theories. Then Anderson (2001) and Van Wincoop (2003) estimated an applied gravity model which was based on a system of utility function with constant substitution elasticity. That model could help the mystery of borders.

Feenstra et al (1998) also used a gravity model derived from bilateral trade dumping model with homogenous goods. They proved that it is possible to derive another type of product differentiation from difference in factor production supply. Deardorff completed the basics theory of gravity model and showed that this equation is compatible with Heckscher-Ohlin trade model for homogenous goods and perfect competition. Enzo Croce, Hugo Juan-Ramón.V and Feng Zhu (2004) used the nonlinear gravity model to study the performance of trade blocks in the western hemisphere through 1978 to 2001. They found that the geographical size and common language have no important role in explaining the volume of

trade between countries. Bergstrand and Baier (2009) turn the nonlinear models to linear ones using Taylor extension technique. These linear models makes possible to clearly explain bilateral trade flows.

In Iran, there have been some studies based on gravity model since 2001. Through the studies about globalization, economic integration, and the most suitable regional-trade arrangements for Iran economy (opportunities and challenges) – based on gravity model and panel data – Azarbaijani and Karimi Hasnijeh (2003) and Karimi Hasnijeh (2007 and 2008) found that ECO convergence though has some effects on the trade flows, but these effects are not huge. The same results about D-8 convergence shows that this convergence has have no important implication for Iran bilateral trade flows. Haerian Ardekani (2008) used the gravity model to evaluate the extension of ECO trade union (through selection of 10 countries plus China and Russia). They found that this extension does not have any positive effect on trade of the member states. Nonetheless though there is no similar study in Iran, we concentrate our work on the SCO member states.

4. Methodology and Model Representation

4.1 .The Gravity Model

In the main gravity model, trade volume is a function of income (GDP) in the two countries, their population and the distance between them (as the proxy for transportation costs), and at last, a set of dummy variables which facilitate and restrict the trade between them, i.e.:

$$T_{ij} = \beta_0 Y_i^{\beta_1} Y_j^{\beta_2} P_i^{\beta_3} P_j^{\beta_4} D_{ij}^{\beta_5} Z_{kij}^{\beta_6} U_{ij} \quad (1)$$

Where Y_i and Y_j are the respective GDP of countries i and j , P_i and P_j are the population of these countries, and D_{ij} is the distance between them. Z_{kij} is the set of dummy variables, U_{ij} is the disturbance term, and β_s are the parameters of this model. In some papers, per capita income is used instead of population. If so, the equation will be as follows:

$$T_{ij} = \beta_0 Y_i^{\beta_1} Y_j^{\beta_2} y_i^{\beta_3} y_j^{\beta_4} D_{ij}^{\beta_5} Z_{kij}^{\beta_6} U_{ij} \quad (2)$$

Where y_i and y_j are in fact $(\frac{Y}{P})_i$ and $(\frac{Y}{P})_j$. Now with the application of natural logarithm, we can transform this equation to its linear form. Frankle (1997) explains the standard form of the gravity model – with special focus on the role of geographic factors, border divisions, population; together with income (GDI) which is the main factor in trade volume – as:

$$\ln T_{ij} = \beta_0 + \beta_1 \ln [Y_i \cdot Y_j] + \beta_2 \ln [(Y/P)_i (Y/P)_j] + \beta_3 \ln D_{ij} + \beta_4 \text{TCI}_{ij} + \varepsilon_{ij} \quad (3)$$

As mentioned before, Z_{ij} is the vector of dummy variables (ZK) that includes various factors such as adjacency, language, common culture and so on between the i and j countries.

As our goal is to study the inclination of Iran economy towards definite trade partners, so for estimation of the equation for this country, i is constant and $j=1,2,\dots,N$. it must be said that all variable – excluding the dummy variables – have real quantities (based on constant prices of 2000).

β in the last equation represents individual effects or intercepts which are specified for each trade partner. In the group of explanatory variables, GDPs (Y_i and Y_j) are considered as parameters of the size of two countries, their production capacity, and the size of their market. So we expect that in theory, the more is the capacity of each country for absorption and production of goods, the more will be the positive value of estimated coefficient (β_1). The other explanatory variable is per capita GDP, which is considered as an indicator of income value or purchase power of exporting or importing countries. We use this variable to predict if the bilateral trade flows of Iran depend on her trade partners' income. The population variable – which is inserted in this equation as the form of per capita income – affects both variable of the size of the market and economies of scale; so its effect on bilateral trade flows is unknown.

Another effective factor is the distance factor which is considered as a substitute for trade barriers – like transportation costs, time, cultural differences, and market access barriers. We expect negative effect of this variable on trade flows because increasing distance means increasing costs, especially transportation costs. Buch et al. (2003) showed that due to potential uncertainty of those gravity equations that integrate all bilateral partners – with no control for relative distances – the changes of distance coefficient give no valuable information about temporal changes of distance costs. We have used the "Centrality Index" (Anderson and Van Wincoop, 2000), or the "Remoteness Index" (Wei, 1966) to remove this ambiguity.

There is also another explanatory variable in our model which is known as TCI (Trade Conformity Index). This variable is named as "trade structure variable" too. We have used this variable to get more familiar with Iran's trade structure and answer this question: "Which of these is Iran's trade model based on: Hechscher-Ohlin; differentiated products; or increasing return to scale?" so this model is specified as follows:

$$\ln T_{ij} = \beta_0 + \beta_1 \ln [Y_i \cdot Y_j] + \beta_2 \ln [(Y/P)_i (Y/P)_j] + \beta_3 \ln D_{ij} + \beta_4 \text{TCI}_{ij} + \varepsilon_{ij} \quad (4)$$

TCI between two countries (i and j) is defined as below:

$$\text{TCI}_{ij} = \frac{\sum [X_{ki} \times M_{kj}]}{\sqrt{[\sum X_{ki}^2 + \sum M_{kj}^2]}} \quad (5)$$

$$i, j = 1, 2, \dots, N$$

$$K = 1, 2, \dots, N$$

Where K is the commodity group, X_{ki} is the share of k commodity group in i 'th country exports, and M_{kj} is the share of k commodity group in j 'th country exports.

So TCI varies between 0 and 1. When this index is zero, the trade structure between two countries is perfectly competitive, then if it equals to 1, that structure is a complementary trade structure. If the share of exports in the countries is equal, then TCI will be zero and while the share of exports in one country equals to share of imports for her trade partner, TCI will be 1. Thus in fact TCI also represents the difference between supplies of productive factors in the two countries. Since TCI varies from 0 to 1, its natural logarithm is very low, so we insert its non-logarithmic form in the equation.

The TCI coefficient β_4 , becomes positive when trade volume increases with the rising trade complementarities. This fact precisely represents the Hechscher-Ohlin trade model of inter-industry trade. On the contrary, β_4 becomes negative when the trade volume increases with the rising competitive trade structure; this situation is differentiated product model with inter-industry trade. As a result, the estimation of β_4 allows us to distinguish three mutually exclusive hypotheses:

- 1: $0 > \beta_4$ or the Hechscher-Ohlin inter-industry trade model.
- 2: $0 < \beta_4$ or product differentiation model with dominant intra-industry model.
- 3: $\beta_4 = 0$ which means indeterminacy of the model.

Since trade liberalization and reducing custom tariffs and barriers – at least for tariff unions – are among the first commitments of all members, in this paper we will refer to trade liberalization.

There are three general indicators for trade liberalization: weighted average of import tariffs; non-tariff barriers; and bureaucracy corruption in custom administrative system. The main source of all these indicators is the "Economic Freedom Index" from Heritage Foundation. Using field studies throughout 161 countries, this institution reports annual statistics about economic freedom in different countries. The countries from all around the world are sorted according to their trade liberalization index. The more tariff and non-tariff barriers (such as import quota, special permits for imports and so on) are, the less will be the rank of that country. This indicator is represented in our model by the symbol TP (William W. Beach, 2005).

In this model, dummy variable Z is considered as an explanatory variable to define the effects of common borders or cultural similarities on the bilateral trade flows. The theme of trade agreements and gravity model has been developed by extensive works of Frankel (1997). We used his works to formulate the final framework of our model. So:

$$\ln T_{ij} = \beta_0 + \beta_1 \ln [Y_i \cdot Y_j] + \beta_2 \ln [(Y/P)_i \cdot (Y/P)_j] + \beta_3 \ln D_{ij} + \beta_4 TCI_{ij} + \beta_5 \ln (TPIt \times TP) + \beta_6 Z_{kij} + \varepsilon_{ij} \quad (6)$$

As mentioned before, Z_k is a dummy variable. This variable equals to 1 if there is any adjacency or common language between Iran and her trade partner; otherwise it will be zero. In this study, Z_k equals to 1 for countries like Iran, Tajikistan, Pakistan, Kazakhstan, Russia, Kirgizstan, and Uzbekistan. The changes of trade flows due to this variable depend on the sign of its coefficient. Theoretically we expect β_6 to be greater than zero.

4.2. Estimation Method

The general analysis has done according to data of bilateral trade flows between Iran and 8 members of SCO which is done with respect to GDPs, per capita GDPs, and the distance between the two countries. The data of bilateral trade flows are gathered from international statistics of WDI and Trademap (2001-2009). The real amounts of exports and imports are in million dollars and according to constant prices of 2000. So the sample includes all trade partners of Iran which are the main or observer members of SCO (Iran, Pakistan, China, Russia, Kazakhstan, India, Tajikistan and Uzbekistan).

The use of panel data is one of general methods for removing the heterogeneities between trade partners in the gravity model. This method at least has two advantages: considering the temporal relationship between variables, and making possible to control the individual effects of each partner; though these effects may be unobservable and impossible to measure.

Though some variables - like distance and other dummy variable which are temporally constant – does not directly introduced in the model of fixed effects, we may regress the intercepts obtained at the first stage of the estimation to reach these variables:

$$FX_{ij} = \beta_0 + \beta_1 D_{ij} + \beta_2 Z_{kij} + e_{ij} \quad (7)$$

Where FX_{ij} is the vector of individual effects.

5. Empirical Results and Data Analysis

Based on the estimations of gravity model, F test and Hausman Test, conformity of this model with panel data framework was verified. On the other side, based on the test of no correlation between individual effects, and explanatory variables of fixed effects method, this characteristic was confirmed.

It is worth to mention that due to the co linearity – which comes from constant distance between the countries – and the existence of some dummy variables which have the same values in different years or even for different countries, at the first stage, we estimated the model as a panel data without these variables and with disaggregation of distance, dummy adjacency variable and similar culture variables. Then at the second stage, the intercept – as a dependent variable -

was regressed for each country with regard to the distance and dummy variables. The results for both variables were insignificant. The reason of this insignificance may be the limitations of this study (small size of the sample, elimination of Mongolia due to trivial trade of that country with Iran, and severe economic and trade sanctions imposed by the Western countries that has lead a great volume of trade with China, Russia and India when there are many cultural dissimilarities and great distance between Iran and aforementioned countries). Thus when we removed the distance and dummy variables, the results of our model showed high competences of the gravity model for specification of Iran's trade volume with members of SCO.

So this model is confirmed at 95 percent confidence interval. The table which comes below includes the results of the estimation of model coefficients. The coefficient of GDP – which according to theoretical foundations of gravity model is the most impressing factor – is significant. Iran's volume of trade with those countries grows 3.6 percent as GDP increases 1 percent.

In the majority of empirical results, this coefficient is less than unit which may be due to factors as: a huge national market, the little production scale, and the size of trade barriers (Trefler, and McCallum, 1995). Regarding the conditions of Iran – including the sanctions, trade barriers, and special dependent to trade with China and Russia) the GDP coefficient is greater than expectations or is larger than the norms in empirical results of other countries.

The coefficient of the second variable of this model – per capita national product – is significant but its sign does not consistent with the expectations. Of course as we mentioned before, it is impossible to say any definite view about the size and sign of this coefficient because the population factor – nested in the per capita product – make both factors of market size and economies of scale to be effective. Though some studies about Iran and other similar countries show that this coefficient may be insignificant. For example, Frankel (1997) found that this factor effects on the volume of trade less than 0.1 percent. The introduction of Chin and India – with their large population and little per capita income – makes the effectiveness of this variable even less than before. Thus it seems that the main factor in Iran's trade model with members of SCO, largely follows the GDP and not per capita GDP.

Regarding to positive sign of TCI, we may argue that the trade complementarities lead to greater volume trade with these countries. This is consistent with intra-industry Hechscher- Ohlin trade model. Therefore we may say that trade structure is more complementary and not competitive.

The coefficient of "trade policies index" (TP_{ij}) – which is the weighted average of custom tariffs, non-tariff barriers, and bureaucratic corruption in the custom administration – is represented by β_5 . Positive and significant coefficient of this coefficient confirms the assumption that: "the volume of foreign trade with member states will grow if the integration with those countries, improvement of trade liberalizations (removal of tariff and non-tariff barriers) and eradication of corruption in tariff administration and in related organizations take place. We expect the coefficient of this indicator to be positive. The estimation results showed that the trade liberalization variable is positive and significant at 95 percent interval, so the assumption that "the trade volume of Iran and her 8 trade partners has grown due to trade liberalization" is verified.

Therefore, there is urgent need to contract regional treaties with qualified members of that organization which have high trade potentials. Contracting such treaties - with the aim of trade liberalization, weaken or removing the trade and tariff barriers -may help the foreign trade sector to grow greatly.

The most important theme for completing the results is omitting the distance variable from estimated model. In the original version of the gravity model, there is a clear place for that variable, but after more contemplation with respect to economic and trade conditions of Iran, we may find that some factors – such as increasing sanctions of the Western countries and former trade partners of Iran, and sever trend of Iran to expand the trade relations with China, Russia and India – neutralize the effects of distance, and makes this variable to be ineffective. Hence, we studied the political evolutions and their effects on results of this model. From a different approach, the findings of introducing the political risk indicator in the previous model are presented in the table of the annex. We can see there that this variable is insignificant. This indicator was studied only for 6 members who include 97 percent of total trade volume in the group (Iran, China, Russia, India, Kazakhstan, and Pakistan). That indicator was not mentioned in international statistics for Uzbekistan, Tajikistan, and Kirgizstan. Being insignificant means that probably there are some other economic or non-economic considerations trade relations of Iran and those countries.

6. Conclusion

SCO is an economic and security block which turns to an effective pole in the world's political and economic affairs. In recent years, he economic activities and trade co-operations of the members of this organization has grown rapidly. Observers have positive views about future expansion of these economic co-operations. So, since the main member

states of this treaty – China, Russia) are among the main trade partners of Iran, and due to aggravation of sanctions which the Western countries have imposed on this country, the trade structure of Iran inclines to other countries. To address this new inclination, we studied the trade structure of Iran with member states of SCO, based on the gravity model and panel data method.

Our results indicate that the gravity model is capable to greatly explain the trade trend of Iran with the member states of this treaty. It seems that trade model of this country with the countries of t SCO, follows from GDP and not from per capita GDP. This may be

due to great share of the countries like China and India – with their large population and low per capita income – in that treaty.

Furthermore, with respect to the positive value of the coefficient of "equality of trade", we may argue that the general trade model of Iran follows from intra-industry trade and the Hechscher-Ohlin trade model. In fact the volume of trade increases due to trade complementarities. This situation features the intra-industry Hechscher-Ohlin trade model and confirms that the structure of trade with member states of SCO is rather complementary and not competitive (Table 1).

Table 1 – Estimation Results of Model

<i>Explanatory Variables</i>	<i>Fixed Effects</i>		
	<i>t - Statistic</i>	<i>Standard Error</i>	<i>Coefficient</i>
<i>Constant</i>	-5.46	24	-131.99
<i>In [Y_i.Y_j]</i>	4.98	0.72	3.61
<i>In [(Y/P)_i.(Y/P)_j]</i>	-3.31	0.88	-2.92
<i>TCI_{ij}</i>	9.19	0.66	6.1
<i>Ln (TPI_t × TPJ_t)</i>	2.48	0.08	0.2
<i>R²</i>		0.98	
<i>F - Statistic</i>		327.5	
<i>Numbers of Observation</i>		72	

We found that trade integration with member states of SCO, improvement of trade policies, to remove the restrictions of trade liberalization (like to impose transparency and remove corruption in custom administration) will lead to increased volume of trade between these countries.

From all these evidence and economic measures of the gravity model, and apart from other relations of international trade system, it seems that Iran membership in SCO – relying complementary intra-industry policy – may expand the capacity of trade with the member states of this treaty.

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