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RESEARCH ARTICLE

Determinants of Iran's exports: A Gravity Model Analysis under Panel Data

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ABSTRACT

This paper aims at investigating the important factors affecting Iran's export trade to major 5 trading countries from 2000 to 2012. The analysis employs a gravity model with some modifications using the panel data estimation technique. The results show that the export trade of Iran has positive relationship with the country's GDP and importing countries' GDP. Furthermore, it has a negative relationship with distance from Iran to trading partners. Border effects and exchange rate play a significant role in promoting exports of Iran. So these factors have contributed to explaining the success in exports of Iran over the years of past decade.

Key words: Iran's exports, Gravity Model, Panel Data, International Trade,

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INTRODUCTION

International or foreign trade is recognized as the most significant determinants of economic development of a country, all over the world. Foreign trade is exchange of capital, goods, and services across international borders or territories. In most countries, it represents a significant share of gross domestic product (GDP). While international trade has been present throughout much of history, its economic, social, and political importance has been on the rise in recent centuries.

Generally no country is self-sufficient. It has to depend upon other countries for importing the goods which are either non-available with it or are available in insufficient quantities. Similarly, it can export goods, which are in excess quantity with it and are in high demand outside (Smriti, 2014).

Iran, like many other countries, imports from and exports to other countries various types of goods and services. It is essential that Iran's exports be measured to determine its status in international trade among the countries. So this study will survey determination of Iranian exports in the period of 2000-2012, using the Gravity Model.

The gravity model which has been extensively used to study the effects in trade flows between countries, based on Newton's Universal Law of Gravitation, explains that the amount of bilateral trade between a pair of economies is directly proportional to the product of their economy size (GDP) and inversely proportional to the distance between them.

The remainder of the paper is structured as follows: section 2 provides a review of the literature on the gravity model. Section 3 describes the methodology and data used in the research. Section 4 presents the estimation of the research model and analysis. Section 5 concludes.

2. Literature Review:

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There has been much research on the gravity model, which is widely applied in examining determinants of exports.

When in 1962 Jan Tinbergen, the future winner of the first 1969 Alfred Nobel Memorial Prize for economics, was sketching the empirical analysis for a report financed by a New York-based philanthropic foundation, his mind was back at his college years. In 1929 he had received his PhD in physics from Leiden University, the Netherlands, with a thesis entitled *Minimum Problems in Physics and Economics* under the supervision of Paul Ehrenfest, a close friend of Albert Einstein's (Szenberg, 1992; Leen 2004). Before getting into the world of economics, Theoretical physics was his favorite, so when he had to propose to the team of fellow colleagues of the Netherlands Economic Institute an econometric exercise "to determine the normal or standard pattern of international trade that would prevail in the absence of trade impediments", he came out with the idea of an econometric model formulated along the lines of Newton's law of gravity (Benedictis and Taglioni, 2011). Tinbergen (1962) stated that GDP of trading countries has a positive effect on exports, while distance can impose a negative on exports. Based on Newton's Law of Universal Gravitation, Tinbergen shows that the trade from country i to country k is defined as:

$$EX_{ik} = G\frac{Y_i \times Y_k}{\text{Distance}_{ik}} \quad (1)$$

Where EX_{ik} represents the trade between country i and k. Y_i and Y_k are GDP of country i and country k. $\text{Distance}_{\text{ik}}$ captures the distance from country i to country k.

Before Tinbergen, Ravenstein (1885) and Zipf (1946) used gravity concepts to model migration flows.

Independently from Tinbergen, Pöyhönen (1963), inspired by Leo Tornqvist, published a paper using a similar approach. Describing the exchange of goods between countries in matrix form, Pöyhönen makes it evident how international trade flows also depend on *internal trade*, a point also briefly covered by Tinbergen in the main text of his book (Tinbergen 1962, pp. 60-61).

Tinbergen's student and team-member of the Netherlands Economic Institute, Hans Linnemann, published a follow-up study (Linnemann 1966) which extended the analysis and discussed the theoretical basis of the gravity equation using the Walrasian model as a benchmark.

Linnemann (1966) together with Aiken (1973) apply the gravity model but exclude prices. They provide a general specification of the gravity model which the flow of trade between countries is subject to GDP of country i, k (Yi, Yk), distance from i to k (Dik) and factors that affect trade between country i and k. The equation is defined as:

$$EX_{ik} = \beta_0 (Y_i)^{\beta_1} (Y_k)^{\beta_2} (\text{D}_{ik})^{\beta_3} (A_{ik})^{\beta_4} u_{ik} \quad (2)$$

By the 1970s the gravity equation was already a must. The famous international trade book by Edward Leamer and Robert Stern included almost an entire chapter on it (Leamer and Stern 1970, pp. 157-170), based on the contribution of Savage and Deutsch (1960). Leamer and Stern's book introduced trade economists to the term resistance that entered their glossary as a synonym for distance and other trade impediments.

In 1979, James Anderson proposed a theoretical explanation of the gravity equation based on a demand function with Constant Elasticity of Substitution (CES), where each country produces and sells goods on the international market that are differentiated from those produced in every other country. The model, however, is limited by the assumptions of identical preferences for goods and the identical structure for tax and transport.

Helpman and Krugman (1985) used a differentiated product framework with increasing returns to scale to justify the gravity model. They asserted that the theory behind comparative advantage does not predict the relationships in the gravity model. Using the gravity model, countries with similar levels of income have been shown to trade more. Helpman and Krugman see this as evidence that these countries are trading in differentiated goods because of their similarities. This casts some doubt about the impact Heckscher-Ohlin has on the real world.

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. In this framework price effects might be an important additional variable that should be included in the gravity model. In this case, GDP deflators or real exchange rates have been utilized frequently.

Baldwin (1994) emphases that gravity models are most suitable for industrial goods, since they generally exhibit increasing returns to scale which can result in significant two-way trade of similar products between similar countries. It therefore appears to be useful to apply gravity models to trade between the industrialized countries to obtain reliable results. However, the model coefficients will be subject to issues like income elasticity of the products, the capital-labor ratio, and how integrated the trading countries are.

Deardorff (1998) has made serious advances while proving that the gravity model can be validated from standing point of standard trade theories. He opines that the Heckscher-Ohlin model is consistent with the gravity equations, so he applies the theory to derive the gravity equation. He states that the Heckscher-Ohlin model can provide the foundation of the gravity model.

Helpman (1999) concludes that the primary advantage of using gravity models is to identify determinants influencing volume of trade, as well as some underlying causes for trade. He believes that volume of trade is not considered by many trade theories, and that the gravity equation works best for similar countries with considerable intra-industry trade between them, rather than for countries with different factor endowments and a predominance of inter industry trade. Helpman suggests that product differentiation can be considered above and beyond factor endowments.

Feenstra (2004) shows that the bilateral trade between two countries depends on their GDPs. His method consists in including importer and exporter fixed effects in order to control for the specific country multilateral resistance term, instead of estimating it.

After that, many experimental works was done on the subject, but were not so significant in terms of theorization.

Each of these studies has examined the situation of foreign trade in the country or countries using the gravity model. For example, we can mention the following:

Kristjánsdóttir (2005) for Iceland; Stait (2005) and Hatab*et al* (2010) for Egypt;

Simwaka (2007) for Malawy; Rahman (2009) for Bangladesh and (2010) for Australia; Ozdeser and Ertac (2010) for Turkey; Gul and Yasin (2011) for Pakistan; Soori (2012) fot Iran; Crescimanno *et al* (2013) for Italia; Koh (2013) for ASEAN countries; Abidin *et al* (2013) for Malaysia and Nguyen (2014) for Vietnam.

3. Model Specification and Methodology of Research:

Bergstrand (1985) presents the gravity model, which calculates the effects of variables on exports between two trading countries. The model specification is shown in equation (2). The paper will use equation (2) with further extension of some variables to identify the gravity model specification for Iran.

$$EX_{it} = \beta_0 (Y_{i,t})^{\beta_1} (Y_{k,t})^{\beta_2} (D_{ik,t})^{\beta_3} (ER_{ik,t})^{\beta_4} (B_{ik,t})^{\beta_5} u_{ik,t} \quad (3)$$

Taking natural log of equation (3), the gravity model specification is defined as:

$$\ln EX_{ik,t} = \beta_0 + \beta_1 \ln Y_{i,t} + \beta_2 \ln Y_{k,t} + \beta_3 \ln D_{ik,t} + \beta_4 \ln ER_{ik,t} + \beta_5 B_{ik} + u_{ik,t} \quad (4)$$

Where EX_{it} is the export volume from Iran to trading partner at time t. Y_i denotes GDP of Iran, Y_k denotes GDP of country k. D_{ik} is the distance from Iran to country k (from Tehran to capitals of country k). ER_{ik} is the foreign exchange rate between IRR and foreign currency (foreign currency per IRR) at time t, B_{ik} denotes the dummy variable that captures border effects (1 if country k shares the same border and 0 if different border).

Table 1: Description of specific variables

Variables	Description	Sources
EX_{ik}	Export volume from Iran to country j	CBI
Y_i	Gross Domestic Products of Iran (base year 2000)	WDI
Y_k	Gross Domestic Products of country j	WDI
D_{ik}	Distance between Iran and country j	(DFT)
ER_{ik}	Exchange rate	WDI
B_{ik}	Dummy variable (1 if sharing same border and 0 is others)	DFT

Hypotheses:

1) It is expected that the increase in GDP of Iran will encourage an improvement in exports ($\beta_1 > 0$).

2) It is expected that if Yj rises, country j will import more goods from Iran, So Iran's export will increase ($\beta_2 > 0$).

3) The gravity model can show the negative sign of distance variable due to the transaction, transport costs or risks of transportation and cultural differences ($\beta_3 > 0$).

4) It is expected that The Marshall-Learner condition holds. This means that exchange rate depreciation will encourage exports ($\beta_4 > 0$).

5) It is expected that if country j shares the same border with Iran, trade will be higher ($\beta_5 > 0$).

Data and Countries:

Data are collected from different sources including Central Bank of Iran (CBI), World Development Indicators (WDI), Distance From To (DFT). Countries are selected on the base of the report has been published on the Official Website of Iran and Emirates Chamber of Commerce (I.E.C.C.). This report shows the top five Iran's export destinations include countries: China, Iraq, United Arab Emirates, India and Afghanistan. We select these countries and try to investigate the important factors affecting Iran's export trade to these countries using the Gravity model. In addition to date which we found and extracted in sources (CBI, WDI, DFT) for research variables, we select the years of 2000-2012 as time period of the research. The number of observations is 65. Summary of statistics are provided in Table 2.

Table 2: Summary of statistics

Variables	Mean	Std.dev	Min	Max
EX_{ik}	1619.662	1637.364	41.2	6337.14
Y_i	1.38e+11	2.24e+10	1.01e+11	1.66e+11
Y_k	1.04e+13	2.26e+13	1.31e+10	9.68e+13
D_{ik}	1338.898	783.1027	612.09	2827.62
ER_{ik}	231.2544	500.5171	0.310857	2133.778

Source: calculations done by researcher using Eviews

4. Results and analysis:

There are three ways to estimate the model specification including pooled ordinary least square (OLS), fixed effects and random effects when using balanced panel data. In This paper we will use Eviews 6 to estimate and test a method of estimation, which is likely to provide the best estimation of the gravity equation for Iran's trade.

Tests of the model selection:

Some tests are applied to select the estimation method include F-test and Hausman test. First, the F- test is used to identify the appropriate method between OLS and fixed effects and random effects. Second, the Hausman test is designed to verify fixed effects and random effects. Table 3 shows the results of these tests.

Table 3: Tests of the model selection (F and Hausman tests)

Test	Prob.	Decision
F	0	H_0 rejected, so panel data method should be used.
Hausman	1	H_0 not rejected, so random effect model should be used.

Source: calculations done by researcher using Eviews

As shown in Table 3, the first row is devoted to F-test. Probe of F- test is equal to 0 that is less than %5. So the null hypothesis of F-test has been rejected. Since this test is used to choose between paned data and pooled data method, rejection of the null hypothesis means that panel data method should be used in this paper.

The second row of the Table 3 is devoted to Hausman test. This test compares the fixed and random effect models. Probe of Hausman test is equal to 1 that is more than %5. So the null hypothesis of Hausman test cannot be rejected. The null hypothesis implies that Use of random effect model is better than fixed effect model. Based on the results of the F and Hausman tests, we use panel data and random effects to estimate the research model.

The estimation result and discussion:

The paper uses the panel data random effect estimation to identify parameters of the gravity model for Iran's exports. The results of estimation of the model using data from 2000 to 2012 are shown in Table 4.

Table 4: Results of estimation

Independent Variable: EX_{ik}			
Variable	coefficient	t-statistic	Prob.
β_0	-121.38	-8.52	0.00
$\ln Y_i$	4.65	7.42	0.00
$\ln Y_k$	0.84	2.85	0.00
$\ln D_{ik}$	-2.35	-2.04	0.04
$\ln ER_{ik}$	0.15	3.93	0.00
B_{ik}	3.56	2.27	0.02
R-squared	0.92		
Adjusted R-squared	0.91		
F- Statistic	141.33		
Prob(F- Statistic)	0		

Source: calculations done by researcher using Eviews

In the Table 4, the results of estimation of research model for investigating the factors affecting Iran's exports to 5 countries have been shown. Model was estimated using panel data and random effect method.

R-squared and Adjusted R-squared is 0.92 and 0.91 respectively. It means that explanatory variables used in the model of this study show the 92 percent of changes in Iran's exports. This shows the power of the regression in explaining the effects of variables on exports.

F- Statistic and its prob is 141.33 and 0 respectively. Prob(F- Statistic) is less than %5. It means that the model is significantat the %95 level. Since the Prob(F- Statistic) is less than %1, we can say that the model is also significant at %99 level.

As can be seen in Table 4, all of coefficients are significant at the %95 level. In the following, we will explain the results of coefficients of the model.

First, estimated coefficient for $\ln Y_i$ is 4.65, which is significant at the %95 level (and also %99 level). As expected theoretically, GDP of Iran, which shows production capacity, has a positive impact on Iran's exports. We can say that for every one percent increase in GDP, lead to increase 4.65 percent in Iran's exports.

Thus the first hypothesis cannot be rejected and is confirmed at 95% level (and also %99level) and we can say that the increase in GDP of Iran will encourage an improvement in exports.

Second, estimated coefficient for $\ln Y_k$ is 0.84, which is significant at the %95 level (and also %99 level), shows that GDP of trading partners also has a positive effect on exports of Iran. It is defined as consumption capacity of importing countries. In addition to this coefficient, we can say that if trading partners' GDP increase one percent, the level of Iran's exports will increase 0.84 percent. This result is also consistent with theoretical expectations. Thus the second hypothesis is confirmed at 95% level (and also %99level) and we can say that if Yj rises, country j will import more goods from Iran, So Iran's exports will increase.

Third, estimated coefficient for $\ln D_{ik}$ is -2.35, which is significant at the %95 level. As expected theoretically, distance between Iran and other countries have a negative impact on Iran's exports. One percent increase in distance between Iran and country j, lead to decrease 2.35 percent in Iran's exports. So the third hypothesis is confirmed at 95% level and we can say that the estimated gravity model in this paper can show the negative sign of distance variable due to the transaction, transport costs or risks of transportation and cultural differences.

Fourth, estimated coefficient for $\ln ER_{ik}$ is 0.15, which is significant at the %95 level (and also %99 level). In addition to this coefficient, we can say that if exchange rate increase one percent, the level of Iran's exports will increase 0.15 percent. This result is also consistent with theoretical expectations. Thus the fourth hypothesis is confirmed at 95% level (and also %99level) and we can say that the sum of exchange rate elasticity of export and import are greater than unity. In the other word The Marshall-Learner condition holds.

Fifth, estimated coefficient for B_{ik} is 3.56, which is significant at the %95 level. As expected theoretically, a common border between Iran and other countries have a positive impact on Iran's exports. Because of the proximity between the two countries, reducing the cost of transportation, cultural, social and political similarities, a common border increase the exports between two countries. So the fifth hypothesis cannot be rejected and is confirmed at 95% level, and we can say that border effects contribute to explaining the increase in export growth of Iran.

Overall, it can be said, the research model has had high power in explaining the effect of factors on Iran's exports, for three reasons: first, R-squared and Adjusted R-squared was 0.92 and 0.91 respectively that is very high. Second, all of coefficients of explanatory variables were significant at the %95 level, and according to F-statistics, general validity of regression was approved. Third (and most important), sign of all the explanatory variables corresponded with theoretical expectations.

Conclusion:

The purpose of this paper was investigating the important factors affecting Iran's export trade to major 5 trading countries: China, Iraq, United Arab Emirates, India and Afghanistan from 2000 to 2012. We employed a gravity model with some modifications using the panel data estimation technique to analyze. The hypothesis were five that each of them was about to discover the effect of a particular factor on exports level of Iran. These factors were Gross Domestic Products (GDP) of Iran, GDP of trading partners, distance between Iran and trading partners, exchange rate, and common border between Iran and trading partners. Data were collected from different sources including: CBI, WDI and DFT, and were analyzed using Eviews software.

Based on the results of the F and Hausman tests, we used panel data and random effects method to estimate the research model.

The power of the regression in explaining the effects of variables on exports was high, and the model was also significant at %99 level.

All of coefficients are significant at the %95 level (and some of them at %99 level to) and the entire hypothesis was verified at the %95 level (and some of them at %99 level to).

The result of hypothesis testing showed that: (a) GDP of Iran has a positive impact on Iran's exports. It means the increase in GDP of Iran will encourage an improvement in exports; (b) GDP of trading partners also has a positive effect on exports of Iran. In the other word if GDP of trading partners rises, the country will import more goods from Iran, So Iran's exports will increase; (c) distance between Iran and other countries have a negative impact on Iran's exports; (d) the sum of exchange rate elasticity of export and import are greater than unity. In the other word The Marshall-Learner condition holds; and (e) a common border between Iran and other countries have a positive impact on Iran's exports. The singe of all coefficients were consistent with theoretical expectations.

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