



Forecasting Exports in Competition Interactions of Oligopoly Markets by Gravity Theory

Fatemeh Rezaee*, Sayed Gholamreza Jalali Naini, Ahmad Makui, Saeed Mirzamohammadi

Department of Industrial Engineering, Iran University of Science and Technology, Tehran, Iran

Abstract This paper presents the exports role as an opportunity in the economic development of a country. Then using the gravity model was analyzed the export competition and Interactions of competitors. The gravity model was estimated using the annual International data from 2001-2013 by Panel Data. Thus, was considered factors such as cost of transportation and economic items in the expression of export. Finally, to determine the case study after many searches pistachio was chosen. Taking advantage of the model is focused interactions between Iran and America on export of pistachio. And finally export was forecasted in 2018. The results obtained show that the export of both countries is increasing, but the export rate of Iran is decline while it is rising for America. Distance parameter as transport costs represent was recognized the important factor affecting the export. Iran should use marketing strategies such as promotion and quality improve to maintain their own place.

Keywords Exports, Gravity Model, Panel Data

1. Introduction

The real world is a multi-agent environment and interaction among agents is needed to realize those goals. Sometimes in the multi-agent environment, contrast to other agents purposes and thus leads competition among them. In this competition, agents that are able to observe the behavior of other agents and create a model of how they will be are more successful. And planning for the future can be cause more favorable. The paper is going to deal a model of export products in market oligopoly and analyze it using gravity theory in export. The significance of export in international trading has attracted researchers to determine the best solution from different scientific perspective. The question is which of the scientific options can act better in determining desired strategy in such relations and complex competitive interactions within trading area. One of the most important hypotheses in economic transactions and competitions is gravity model. This study uses the gravity model to review interactions of competitors in applying suitable strategy of exporting the products in oligopoly market.

At the following, in second section the literature review is considered where viewpoint of researchers in theoretical area of export and gravity model as well as research literature on this area are provided. Third section dedicates to research pattern including modeling of export products in oligopoly market. Forth part represents case study and research findings. In fifth section, the experimental results are analyzed.

2. Review of Literature

To understand the casual relationships of export, while many strategic variables are linked to performance, most of them were as predicted or can be similar to alternative hypotheses; that is, effective factors on export performance can be universal and their factors can't be determined [1]. However, one of the successful methods



used widely by economists in interpretation and explanation of export among the countries is gravity model. Hence, the paper will have a brief review on export issues and gravity hypothesis, and the studies on this area.

2.1. Export

The time for trying to prove the significance of export growth by individuals [2-8] who considered it as one of the key factors of economic growth, is ended. The economy of world, especially economic parade of countries such as Hong Kong (China), Taiwan, Singapore, and South Korea, has proved it. Export is a main part of international trade and one of the economic indices that show the relation of the country with world economy [9]. Open economy of last decade lead to development of models in achieving sustainable rate of economic growth, that focus on different factors such as openness of economic, exchange rate, tariffs, trade performance, etc. Nowadays, not only productivity of resources such as earth and workforce drive export development, but factors such as expansion of market, innovation and increase of productivity, educational impact on suggestion of new ideas and technology transfer, skill and entrepreneurship increase this motivation. What is currently needed is a profound attitude toward export. In fact, formerly the companies were in the wake of export and world market boom to achieve profitability and economic position, but today the idea is obsolete [10]; Gilaninia et al. (2013) [11] believe the governments themselves should try to expand export markets and economic development. Economic success of countries with open economic policy shows that open and extroversion market is the desired policy [12]. On the other hand, global competition has enforced great pressure on economic-oriented companies to set up new and effective strategies to compete in the global market. Ram (1987) believe the attitude of states should be based on the reliable growth hypothesis, while regarding that because of differences between countries, it should be interpreted according to situation of each country and based on science [13]. In fact, today's competitive world require scientific and accurate strategies in competitive and complex domain, in a way that one of the best hypothesis to assist decision-makers in selection and application of desired strategy is gravity theory.

2.2. Gravity theory

In international business, gravity model is a systematic framework to measure business pattern among countries. Tinbergen and Poyhonen [14] were the first who applied gravity model in reviewing business flows. Deardorff (1997) proved the gravity equation has features of most of the models and can be justified by common trading theories to estimate an applicable gravity model based on utility function traction system [15]. The equations used in gravity model looks like generally to each other that its main components is amount of trade between two countries, the country's GDP, population and common properties. Equations used in the gravity model is generally similar to each other that its main components are the amount of trade between the two countries, the country's GDP, the distance between the two countries, the population of the two countries and common characteristics. The product of exporting country is shown production capacity in the exporting country, distance between two countries, and represent the cost of transportation goods between the two countries.

Number population is indicating extend of market and similarly diversity of production and less need to trade with other countries. Gravity model of trade is a systematic framework for designation trade model between countries as of today, have focused by researchers. Anderson et al. in 1979 started the firs of formal action to derive the model based on assuming dissimilar goods [16]. Bergstrand in 1989 discovered the figure theoretical properties of bilateral trade. Feenstra et al. (2001) used of the framework of dissimilar goods with increasing returns to justify the gravity model [17]. And finally Anderson et al. (2003) proved a practical model of gravity bewitch lead to problem solving. Many practical applications have emerged in international trade literature which can help to improve the performance of the gravity model [18]. Also Deardorff (1995) improved econometric features of the gravity equation and Edwards (1991) helped to the explanatory variables [15, 19]]. One of the important factors in the exports for the exporting country is estimate of importing country demand and fulfilling of it. In order to we consider to study of factors and variables affecting to the demand function export products.

According to Goldstein and Khan's study (1999) is export demand for a good which is under the influence of different factors such as product export prices to world prices (average prices of goods in world markets) and real income of importing countries [20]. Also, Warner and Kreinin applied a similar model like Goldstein and



Khan for exports of agricultural products .in addition variables In Goldstein and Khan's model added effective exchange rate, expected rate of exchange rate changes as influencing factor to export. Tyler (1981), Cheng and Wall (2004), Surrey (2013) respectively, applied weighted Index of Industrial Production, long-income countries and relative price of exports in estimating the demand function [21-23]. Applying a generalized gravity model, as well as main variables of it such as production, distance, the real exchange rate, Sologa and Winter (1999) have used virtual variables such as vicinity, cultural similarity and convergence to show the rate of internal and external trade flows [24]. Results of the study show there is no meaningful evidence on increase of internal trading based on new wave of regionalism. There are many practical applications in international trading literature that help to improve gravity model.

To understand how each of the variables is obtained, they are explained more at the following. The distance of this relation is assessed by geographical distance (Km) between capitals of two countries. The distance between two countries represents the cost of product transportation between two countries, while it is inverse the trading rate between two countries. There are various alternatives to show the economic variables in gravity model, one of the best of which with theoretical bases to show economic size of countries is Gross Domestic Product (GDP). Increasing GDP enhance ability of the country to attract and produce goods. Hence, supply and demand of export between two countries will increase; in another word, GDP have positive effect on bilateral trade flows. Population is also the other variable of gravity model to determine economic variable and indicate the market size.

3. Study Method

According to the literature, generalized gravity model is one of the suitable models in trade flow among countries. This model is used to analyze the export flow. Based on this method, different factors explain the export flow from countries of origin to destination countries. According to gravity model, the formula 1 is suggested by Bergstrand [25]:

$$EX_{ij} = \beta_0 GDP_i^{\beta_1} GDP_j^{\beta_2} POP_i^{\beta_3} POP_j^{\beta_4} D_{ij}^{\beta_5} A_{ij}^{\beta_6} \varepsilon_{ij} \quad \text{Eq.1}$$

Where, EX indicate the export of country I to j, GDP the gross domestic product of two countries, POP the population of both countries, D the distance, A the virtual variable and ε disruption factor. To facilitate the estimation of relation, using logarithm it is changed to linear model and relation 2 is obtained.

$$\ln EX_{ij} = \beta_0 + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta_3 \ln POP_i + \beta_4 \ln POP_j + \beta_5 \ln D_{ij} + \beta_6 A_{ij} + \ln \varepsilon_{ij} \quad \text{Eq.2}$$

According to relation 2, attraction and repulsion variables are regarded relative. It is useful in simple interpretation of model and less require estimation of parameters that lead to higher degree of freedom [26]. Therefore, relation 3 is acquired:

$$\ln EX_{ij} = \alpha_0 + \alpha_1 \ln\left(\frac{GDP_i}{GDP_j}\right) + \alpha_2 \ln\left(\frac{POP_i}{POP_j}\right) + \alpha_3 \ln D_{ij} + \alpha_4 A_{ij} + \ln \varepsilon_{ij} \quad \text{Eq.3}$$

Here, the data are used separately for export to calculate the effect of various variables on export model of the countries. In relation 3, the distance variable between two countries is always constant over the time, and is considered as the constant effect of regression that can't be directly applied to the model. It ignores not only the constant effect on distance, buton other constant factors such as similarity of language, culture, race, etc. in origin and destination countries; because pistachio is consumption goods that can't be produced in all countries, the distance can be regarded as the main factor of constant effects. In this study the constant effect factor is representative of distance. Therefore, in regressions with constant effect, the intercepts estimated by eq. 3 is considered as distance. According to explanation of generalized gravity model, in this study the GDP, population and real exchange rate as representative of economic power of the countries and distance as transportation cost implicated in intercept of constant effect regression, eq.4 is estimated as:

$$\ln EX_i = \alpha_0 + \alpha_1 \ln\left(\frac{GDP_i}{GDP_j}\right) + \alpha_2 \ln\left(\frac{POP_i}{POP_j}\right) + \alpha_3 \ln\left(\frac{REER_i}{REER_j}\right) + \ln \varepsilon_{ij} \quad \text{Eq.4}$$

To review the export, here the unilateral generalized gravity model with combined data is used. After reviewing the literature of gravity model and considering the model variables, it is found that the most important factor in exporting any product irrelevant to the type of product is related to factors such as economic power, population and distance of importing country. Therefore, the case study was selected after many investigations to analyze a



product that Iran is excelled in its export and has competitor with strong economic power, to compare them in oligopoly market. According to Statistical Yearbook of Commerce in 2011, one of the export products that was on the ten top products of Iran's non-oil exports and raised about 799 million dollars of income is pistachio [27]. Hence, the export of pistachio was extracted from World Food Organization (2001-2013), and estimated with economic, population and distance data obtained from major scientific sites such as World Bank, Statistics Bank, etc. for Iran and U.S. as exporter and Hong Kong, Germany, China, Italy, French, Luxembourg, Belgium, Spain, Canada, Japan and Netherland, as importers [28-29].

4. Experimental Results

This section considers study method, explains the model, and talks about modeling the exportable pistachio of Iran and U.S and their competition. In order to remove the heterogeneity of bias and solo work practices, combined data method with fixed effects were used. To confirm fixed effect method and its superiority to accidental effects, the accidental effect method was also tested and rejected because of less R^2 than fixed effect method; however, the Hausman test also approved the superiority of fixed effect on accidental effect. F test was used to investigate the possibility of combining cross-sectional and time-series data. The Hausman test was used to choose the fixed effect or accidental effect method. The test was trying to find out whether unobservable individual effects include factors that are correlated to explanatory variables; in this way, accidental effect method is superior to fixed effect and is selected as more suitable and applicable method [30].

One of the main validation tests in study of data such as combined data with time dimension is stationarity test. Stationarity test is applied to prevent spurious regression (unrelated data with high determinant coefficient) and find equilibrium relationship between variables before model estimation. Therefore, to confirm the accurate results of regression in any method of estimation regarding time and number of data, the stationarity of them must be ensured. First, stationarity is placed in level zero (the variables), if it is fixed, the model estimation process is continued, otherwise, stationarity of variables would be analyzed by first order difference (with one order differentiation) or logarithmic differentiation with a time lag (conversion of $(x_t - x_{t-1})$ to $\ln(x_t) - \ln(x_{t-1})$) or second order differentiation. Stationarity test is done on all variables, whether dependent or independent [31].

To estimate export gravity model of two countries, stationarity test applying Levin, Lin and Chu method is used for each of the variables of export volume of the country, GDP, population and exchange rate. Coefficient of all variables is meaningful based on Levin, Lin and Chu test, unit root of variables are rejected, and stationarity of data are concluded. F test makes combination of data possible. After approving stationarity and data combination, fixed and accidental effects are studied and their superiority was discussed. The Hausman test is used to recognize superiority of one effect to another. Hausman test is one of the main tests and combined data studies. The main hypothesis of fixed effect pattern is each of the factors have certain fixed rate; since for applying each of the fixed rates a virtual variable is considered; fixed effect estimator is also called least squares estimators of virtual variables. Fixed effect model is a classic regression model that requires no new condition for analysis, and the model can be evaluated using the usual average squares. The advantage of fixed effect model is it can show the effects that are different in each of the factors but doesn't change during time. On the other hand, disadvantage of the model is that for each of the virtual variables a coefficient should be estimated. This is problematic when the number of factors is high. Another method of model estimation is accidental effect. This model differs from fixed model in that the intercept values for each variable is not fixed, but selected accidentally. The advantage of this model to fixed effect model is that fewer parameters number should be estimated. Hausman test apply Chi-square test; if probability of test statistic is more than 0.05, in meaningful level of 95% the fixed effects are preferable to accidental effects; otherwise, accidental effects are selected. Results of this test for each of the models related to Iran and U.S are indicated in table 1 and 2, and the full output is provided in Appendix 1 extracted by software Eviews.

According to the results, it can be concluded the fixed effect is preferable than accidental effect. After investigating the fixed and accidental effects and preference of fixed effect on accidental effect, the export gravity model of Iran and U.S is estimated. It is considered that fixed effect is not only approved by statistic relations, but theoretically it corresponds with the Goldstein view, because he believed when the future is



predicted, fixed effect model is more applicable. The estimation results of both models are shown in table 1 and 2.

Table 1: Gravity model data of Iran export

Variable	Coefficient	Std. Error	t-Student	Prob
C	2.403680	0.226408	10.672	0.000
GDP _{Ir}	-0.33180	0.045189	-7.315	0.000
REER _{Ir}	-0.681495	0.097048	-9.103	0.000
Pop _{Ir}	0.681495	0.097048	0.5460	0.000
Hausman Test	27.983			
F-statistic	536.42			

Table 2: Gravity model data of USA export

Variable	Coefficient	Std. Error	t-Student	Prob
C	13174.27	4679.953	2.81504	0.005
GDP _{Us}	420.6976	86.16495	4.882468	0.000
REER _{Us}	-11386.10	2341.826	-6.862060	0.000
Pop _{Us}	-570.6360	92.12231	-6.194330	0.000
Hausman Test	45.063			
F-statistic	14.649			

In follow, each of the factors is analyzed.

GDP: increasing income of each country enhances the demand for importing goods and services from other countries; hence the coefficient of this variable is positive in the model. As seen in table 1 and 2, GDP coefficient of countries importing from Iran is negative, that shows according to the aforementioned world statistics, in the years of study due to increasing the power of U.S in taking over the world pistachio market, or because of some political issues such as sanction, etc., the export rate of this product is decreased with the increase of importing GDP; therefore, because of decreasing demand of importers, the export is reduced in Iran even though the GDP is increased. The relationship between GDP of importing countries and export rate of the U.S. is positive, that seems inevitable regarding the increasing power of this country in market.

Population: the population variable is also indicated in this model for countries importing from both Iran and U.S. It is predicted that importing country with higher population (to meet the needs of population) imports more. According to table 1 and 2, the population of country importing from U.S is negative. Pistachio is considered a luxury product; hence with increase of population the countries spend their exchange in more necessary goods. The population and export of these countries with Iran has negative relationship; considering other factors such as cost, and transportation, increasing population increases tendency to import from Iran.

Exchange rate: because the exchange rate has converse relation with the power of money, increasing exchange rate of importing countries reduced financial ability and demand rate. In this regard, reducing the exchange rate increases export rate.

In this study the main determinant factor of pistachio trade is examined applying gravity model. According to the above equations, functions of Iran export EX_1 and the U.S. export EX_2 , is calculated as:

$$EX_1 = 2.4036 - 0.6732reer_i - 0.3318gdp_i + 0.6814pop_i + \varepsilon$$

$$EX_2 = 13174.27 - 11386.10reer_i + 420.6976gdp_i - 570.6360pop_i + \varepsilon$$

5. Discussion and Conclusion

Moreover, to find better approach to the situation of export in future, the export has been forecasted in the form of scenarios.

In building scenario of situation for future years, GDP is examined, however, in future it would have normal, high and low economic growth with 5% changes; the export rate was predicted assuming the other factors are fixed. The export rate based on different conditions is predicted in tables 3, 4, and 5.



Table 3: Forecasting the export in fix economic growth

Exporter	Iran	USA
Importer		
Hong Kong	109531	36739
Germany	34182	5184
China	29982	2893
Italy	15375	4437
France	13419	4792
Luxembourg	16849	2853
Belgium	10448	10293
Spain	8563	2589
Canada	2798	3589
Japan	5293	3529
Netherlands	15124	16136

Table 4: Forecasting the export in high economic growth with 5% changes

Exporter	Iran	USA
Importer		
Hong Kong	93126	39703
Germany	28025	5648
China	29159	3183
Italy	14982	7923
France	13041	5983
Luxembourg	14983	2984
Belgium	1394	14204
Spain	9804	2629
Canada	6237	3986
Japan	4639	5442
Netherlands	14814	17428

Table 5: Forecasting the export in low economic growth with 5% changes

Exporter	Iran	USA
Importer		
Hong Kong	103742	34895
Germany	34927	34927
China	32738	32738
Italy	15174	15174
France	16536	16536
Luxembourg	17944	17944
Belgium	11957	11957
Spain	8974	8974
Canada	3186	3186
Japan	5269	5269
Netherlands	14708	14708

According to these tables, the different responses of countries importing pistachio from Iran and U.S. to change of GDP is observed, that will be discussed in estimation of gravity model. Ultimately, optimal rate of Iran and U.S export in 2018 indicate decreasing trend of Iran export and increasing export of pistachio in U.S., that is a threat for Iran that may lose its position as premier exporter of pistachio in the world, and reduce its global share after the passage of time, while the U.S with increasing trend will dominate the world pistachio markets.



Reviewing absolute amount of exports in Iran and U.S., based on prediction of increasing the export rate of Iran in 2018, with a comprehensive look and reviewing change rate, the export growth of U.S will be more than Iran.

References

- [1]. Marandu, E. E. (2008). Strategy factors associated with the export performance of manufacturing firms. *Proceedings of the Academy of Marketing Science*, 7-11. doi: 10.1007/978-3-319-11797-3_7.
- [2]. Emery, R. F. (1968). The relation of exports and economic growth: A Reply. *Kyklos*, 21: 757-760.
- [3]. Syron, R. F. & Walsh, B. M. (1968). The relation of exports and growth: A note, *Kyklos*, 21(3): 541-545.
- [4]. Serven, A. K. (1968). The relation of exports and economic growth: Comment. *Kyklos*, 21(3): 546-48.
- [5]. Kravis, I. B. (1970). Trade as a handmaiden of growth: Similarities between the ninetieth and twentieth centuries. *Economic Journal*, 80 (320): 850-872.
- [6]. Heller, P. S. & Porter, R. C. (1978). Exports and economic growth: An empirical re-investigation. *Journal of Development Economics*, 5:191-93.
- [7]. Bhagwati, J. (1978). Anatomy and consequences of exchange controls regime: Liberalization Attempts and Consequences. Cambridge, MA: Ballinger.
- [8]. Krueger, A. O. (1978). Foreign Trade Regimes and Economic Development: Liberalization Attempt and Consequences. Cambridge, M A.: Ballinger.
- [9]. Soltani, M. & Saghaian, S. (2012). Export Demand Function Estimation for U.S. Raisins. *Work paper for presentation at the Southern Agricultural Economics Association Annual Meeting, Birmingham*.
- [10]. Farhangi, A. A., & Lotfi, A. (2009). Investigating Adaptation of Marketing Services in Trade Promotion Organization of Iran with exporters' expectations. *Journal of Business Management*, 1: 119-34.
- [11]. Gilaninia, Sh., Monsef, S. M. Sh. & Mosaddegh, L. (2013). Investigating effective factors on export performance of ceramic tiles companies. *Interdisciplinary journal of contemporary research in business*. 5: 935-939.
- [12]. Udah, E. B. (2012). Export-Growth Hypothesis: An Econometric Analysis of the Nigerian Case. *Interdisciplinary Journal of Research in Business*, 2(4): 39-49.
- [13]. Ram, R. (1987). Exports and economic growth in developing countries: Evidence from Time-Series and cross sectional data. *Economic Development and Cultural Change*, 36(1):51-63.
- [14]. Ekanayake, E. M. Mukherjee, A., & Veeramacheneni, B. (2010). Trade Blocks and the Gravity Model: A Study of Economic Integration among Asian Developing Countries. *Journal of Economic Integration*, 25(4): 627-643.
- [15]. Deardorff, A. V. (1995). Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World? *The Regionalization of the World Economy*, Chicago: University of Chicago Press, doi:10.3386/w5377
- [16]. Anderson, J. E. (1979). A Theoretical Foundation for the Gravity Equation. *American Economic Review*, 69(1): 106-116.
- [17]. Feenstra, R., Markusen, J., & Rose, A. (2001). Using the Gravity Equation to Differentiate Among Alternative Theories of Trade. *Canadian Journal of Economics*, 34(1): 430-447.
- [18]. Anderson, J. F. & Van Wincoop, E. (2003). Gravity with Gravitas. A Solution to the Border Puzzle. *American Economic Review*, 93(1): 170-192.
- [19]. Edwards, S. (1991). Trade orientation, distortions and growth in developing countries. *Journal of Development Economics*, 3716, 31-37.
- [20]. Goldstein, M., & Khan, M.S. (1999). The Supply and Demand for Exports: A Simultaneous Approach. *Journal Review of Economics & Statistics*. 60: 275-286.
- [21]. Tyler, W. G. (1981). Growth and exports expansion in developing countries: Some empirical evidence. *Journal of Development Economics*, 9: 121-130.
- [22]. Surrey, A. (2013). *Advanced Econometrics*. Tehran: Publication of Ethnography.
- [23]. Cheng, I., & Wall, H. J. (2005). Controlling for Heterogeneity in Gravity Models of Work and Integration. *Federal Reserve Bank of St. Louis Review*, 87(1): 49-63.



- [24]. Sologa, I., & Winters, A. (1999). Regionalism in the Nineties: What Effects on Trade? CEPR Discussion Paper Series Number 2183.
- [25]. Bergstrand, J. H. (1989). The Generalized Gravity Equation, Monopolistic Competition and the Factor Proportion Theory in International Trade. *The Review of Economics & Statistics*, 71(1): 143-53.
- [26]. Karimi, H. (2006). Globalization, economic integration and trade potential: gravity model of trade analysis. *New Journal of Economics and Business*, 5: 143-118.
- [27]. <http://www.tccim.ir/ImpExpStats.aspx?slcImpExp=Import&slcCountry=&sYear=1391&mode=doit>
- [28]. <http://www.worldbank.org/>
- [29]. <http://www.fao.org/>
- [30]. Asgari, H., Taghavi, M., Asgari, M., & Shaker, A. (2008). Investigate the causes of the brain drain from developing countries to developed countries in the form of gravity model. *Journal of Quantitative Economics*, 5(2): 22-31.
- [31]. Ashrafzadeh, S. H. & Nader, M. (2013). Econometric panel data. Tehran: Tehran University Cooperative Research Institute.

