JAME
E-ISSN:2791-7401
Volume : 2, Issue 2, 2022
URL: https://journals.gen.tr/jame

Received: 2022-09-09
Acccepted: 2022-12-22

RESEARCH ARTICLE

The evaluation of Turkey's foreign trade with different country groups within the framework of the gravity model

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Abstract

The gravity model is based on the law known as the gravitational law discovered by Newton and was first used by Tinbergen to explain the foreign trade flow. It assumes that the size of the countries affects the foreign trade flow positively and the distance variable affects the foreign trade flow negatively. After the collapse of the Soviet Union, the Black Sea Economic Cooperation Organization was established under the leadership of Turkey to develop foreign trade with the countries that declared their autonomy. Similar to the story of the disintegrating Soviets, the Balkan Countries also declared their independence by leaving Yugoslavia. This study aims to investigate whether the gravity model is appropriate to explain Turkey's exports and imports to the Black Sea Economic Cooperation (BSEC), Balkan and selected countries during the 1996-2019 period. Export and import were used as dependent variables. Gravity model variables such as GDP, distance, population, language and common border variables were used to explain the exports and imports of the respective countries. For all these models, panel data analysis techniques were employed; pooled, random and fixed effects models were estimated and then tests for the model selection were carried out to choose the most appropriate model. After the appropriate models were determined, the assumption tests were executed. As a result of the study, it was concluded that the gravity model was suitable to explain Turkey's imports to the Balkan countries and exports to the selected country groups. The results of the study suggested that while the gravity model was suitable for explaining the factors affecting Turkey's trade flow for some country groups, it further suggested that it was not suitable for some countries.

Keywords: Panel Data Analysis, Gravity Model, Foreign Trade, BSEC, Balkan Countries

JEL codes: C2, C23, F1

* This study was produced from Beyda Demirci's master thesis named Evaluation of Turkey's Export with Different Country Groups within The Framework of Gravity Model: A Panel Data Analysis.

Citation: DEMİRCİ, B. & SEVÜKTEKİN, M. (2022). The evaluation of Turkey's foreign trade with different country groups within the framework of the gravity model. *Journal of Applied Microeconometrics (JAME)*. 2(2), 51-65, DOI: 10.53753/jame.2.2.02

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1. INTRODUCTION

The Black Sea region is the connection point with the Europe and Central Asia due to the institutional and geopolitical ties. This geopolitical context shows that the Black Sea states compose an compelling paradigm of cooperation along with the conflict in the international system. In the early 1990s, emerging states in the Black Sea region came to the basic understanding that institutionalizing their relations at the regional level would do much to enhance their security (Manoli 2003: 208). In other words, the fall of the Soviet Union was a turning point for countries located at the Black Sea Region. After the collapse, not only new states were established in the region, but also new problems and threats emerged in the region, therefore the idea of acting together in peace appealed to those countries. In this direction, the Black Sea Economic Cooperation was established in order to form a free trade zone in the region. Before the Economic Cooperation, there was no regional formation in this region. When the region is considered from this perspective, the first concrete breakthrough is the Black Sea Economic Cooperation (Cagıran 2000: 4).

The main purpose of the Black Sea Economic Cooperation is to increase the economic, commercial, scientific and technological cooperation by making use of the geographical proximity of the member countries and the complementary qualities of their economies. First of all, it aims to remove the obstacles in this regard by increasing trade. Afterwards, it is to ensure the free movement of goods, services, and goods for the development of economic relations between these countries. As stated in the articles in the Summit Declaration of the Black Sea Economic Cooperation, the cooperation is the main way to establish peace and security in the region (Oktay 2003: 246).

During the Cold War, Yugoslavia became a shield against the direct threat of the Soviet Union to Europe (Ucar et al. 2019: 347; Kenar 2005: 126). At that time, Yugoslavia was supported by the Western countries. However, immediately after the Cold War, Yugoslavia was dragged into a civil war. In addition to the European Union's inability to intervene in this civil war, the increase in the number of refugees and its inability to prevent arms and human smuggling caused a loss of reputation. The European Union developed different types of strategies after the Dayton Peace Agreement in 1995 to resolve this great civil war in the Western Balkans (Kodaman and Bas 2017: 48-49). After the treaty, Yugoslavia was officially dissolved. The state, which continued as the Federal Republic of Yugoslavia until 2003, renamed to Serbia-Montenegro. Then, in 2006, Serbia and Montenegro became two independent states. Vojvodina and Kosovo are located within the borders of Serbia. In 2008, Kosovo was separated from Serbia, leaving Vojvodina as the only autonomous region.

Trade means exchange. This exchange can be defined as goods or services. The exchange of goods between individuals and/or groups creates trade. The person who offers the good or service for sale would charge a fee for this, and the person benefiting from this good or service would pay the price and demand that his request is fulfilled completely. This exchange forms the basis of trade (Yarbasi and Gurtan 2012: 1). Exports are the purchase of goods and services produced by one economy for other economies (Dinler 2012: 399) whereas imports are defined as the purchase of goods or services produced in a foreign country. Imports are also defined as foreign purchase which is the entry from customs, nationalization and realization of the value of goods or services purchased from abroad, free zones for a fee through banks (Yarbasi and Gurtan 2012: 52).

While 12.3% of Turkey's total exports are to the BSEC, 6.5% to the Balkan, 35.87% to selected countries whereas 16% of its imports are to the BSEC, 4% to the Balkan and 55.42% to the selected countries. The crisis that occurred in 2008 was reflected in the percentages of exports and imports in 2009.

This study's aim is to find an answer to the question of whether the gravity model is suitable to explain Turkey's exports and imports to the BSEC, Balkan and Selected Countries between 1996 to 2019. The gravity model is a model that is frequently used to explain the flow of foreign trade since the 1960s. The panel data analysis techniques were used in this study. The study is outlined as follows; Section 2 provides the literature. Section 3 consists of the methodology concerning the gravity model for the panel data. Section 4 presents the data set and the analysis results and finally Section 5 reports the conclusion.

2. REVIEW OF PREVIOUS LITERATURE

The gravity model, which was first applied by J. Tinbergen in 1962, was criticized for its lack of theoretical background. Subsequently, Poyhonen (1963) and Linneman (1966) developed the specifications and provided estimates for the determinants of trade flows, and in 1973 Aitken applied this model to the regional trade agreements. There is a bulk of literature employing the gravity model.

Aitken (1973) aimed to investigate the determinants of European's trade flow in his study. Using data from 1951-1967, the effects of the European Economic Community (EEC) and the European Free Trade Association (EFTA) on trade flow within the gravity model framework were investigated. The independent variables used in the model were the country's gross national product (GNP), population, distance of the trade centre and for the dummy variables for common border and being a member of the EEC or EFTA. The study reported that GNP had a positive effect on the trade flow whereas population and distance variables were associated with a negative effect on the trade flow. Being a member of the EEC had positively affected the trade flow between these countries, and the trade between EFTA countries also had a positive effect, albeit small.

Endoh (1999) determined the impact of regional formations of the Mutual Economic Assistance Council (CMEA) and the Latin American Free Trade Area (LAFTA) on Japan's trade flow (EEC), as well as analyzed the trade-enhancing and reducing effects of these regional formations during the 1960-1994 period. He predicted the gravity model using the cross-sectional data. The explanatory variables were Gross domestic product (GDP), common language, population, the distance between the capitals of the countries for the dummy variables common border, and being a member of CMEA, LAFTA, and EEC. According to the estimation results, common border, common language and GDP positively affected, population and distance negatively affected the trade flow. The effects of CMEA, LAFTA, and EEC memberships varied according to the models established over the years.

Soloaga and Winters (1999) aimed to determine the effects of the member of selected organization on the imports and exports of the member countries; these organizations were North American Free Trade Agreement (NAFTA), Latin American Integration Association (LAIA), Central American Common Market (CACM), Gulf Cooperation Council (GCC), Association of Southeast Asian Nations (ASEAN), Andean Commonwealth (AP), EEC, EFTA. For this purpose, a gravity model was established by using the panel data for the period from 1980 to 1996. GDP of countries, distance between economic centers, population, the surface area of countries, common border, not having a common language, and the effects of these regional formations were used as independent variables. The analysis results reported that the trade flow was associated with positive effects of countries' populations, GDPs, and the use of a common language while distance and common borders were associated with negative effects. It was concluded that regionalization did not have a major impact on the trade flow.

Egger (2002) examined the trade flow of the Organization for Economic Cooperation and Development (OECD) and Central and Eastern Europe (CEEC) countries during the 1986-1987 period. The gravity model in the context of the random effects model was estimated. The independent variables used by Egger in his gravity model were GDP, the distance of their capitals from each other, real exchange rate, sizes, factor endowment differences and the dummy variables for common language and common border. Although there were problems with the model results, he concluded that the gravity model was a useful model for the trade flow.

Kien and Hashimoto (2005) examined the trade flow of the ASEAN Free Trade Area (AFTA) for the period 1988-2002. The model was estimated within the framework of the panel gravity model. In the model, countries' GDP, distance between capitals of two countries, population, exchange rates, common language and regional trade agreements were used as explanatory variables. Results of the analysis reported that the trade flow was affected by GDP, exchange rate, and common language positively, while it was affected negatively by population and distance.

Rojid (2006) aimed to calculate the effect of the regional formation among the Eastern and Southern Africa Common Market (COMESA) of 147 countries on the trade flow. Besides, the COMESA members aim to explore the trade potential. Rojid estimated the gravity model using panel data from 1980-2001. GDP, population, distance between the capital cities of the country, exchange rate, common border, and language were used in the model as the explanatory variables. As a result of the analysis, the trade flow was affected by common language and common border positively while negatively by GDP, population, real exchange rate, and distance.

Nitsch (2007) examined the effects of the G7 and G8 countries on the trade flow of 175 countries. In the analysis, the gravity model was estimated by using panel data for the period from 1948-1999. The independent variables used in the model were countries GDP, GDP per capita, distance between the capital cities of countries, the land area of countries, coast to the sea, having a common language, and border. While GDP, GDP per capita, common language, and border had positive effects on the trade flow, the area of the countries, being landlocked, and distance affected the trade flow negatively.

Ozkaya (2011) investigated the effect of Turkey's commercial agreements on its exports to 113 countries. Three different models were estimated using a panel data set for the period 1996-2006. Variables used to explain the trade volume were gross national income, population, distance between countries, per capita income, cross-exchange rate, foreign exchange reserve and the dummy variable for the trade agreement between countries. As a result, while the signed bilateral agreements did not have a statistically significant effect on Turkey's exports, it was concluded that the multilateral agreements (apart from the Customs Union Agreement), to which Turkey was a party had a statistically significant positive effect on Turkey's exports.

Aysun, Oksuzler and Yılgor (2012) examined Turkey's trade potential with the EU-15 of the Customs Union, which was established between Turkey and the EU. The import and export gravity models were estimated using panel data for the period 1980-2009. Independent variables in the gravity models were GDP, population, distance between the capital of the countries and a dummy variable for Customs Union. While the Customs Union had a strong effect on Turkey's imports, its effect was weaker on the exports.

Dinç (2012) examined Turkey's export potential with different country groups. Panel data for the period 1990-2006 were used for the gravity model. The variables used in the model were GDP per capita, population, distance between countries and whether there was a customs union agreement or not. As a result of the analysis, while GDP and common border variables were reported to affect the export potential positively, the distance variable affected the export negatively. Other variables' effects on the export varied according to the country groups.

Golovo (2014) aimed to examine the changes in the foreign trade of the Eurasian countries in the period 1994-2012 and analyze the trade potential through the gravity model. Between 1994 and 2012, 86 countries were included in the analysis. The study stated that the economic size of the countries, the distance between them, the common border and common language, the WTO membership and the existence of free trade agreements were determined as the main factors affecting the world trade. It was reported that the quality of the infrastructure and institutions of the countries and the level of protectionism had a lower effect.

Šimâkovâ and Stavârek (2015) investigated the effect of the exchange rate volatility on Hungarian foreign trade on different product groups with the gravity model. The variables included in the model as independent variables were GDP, population, distance, exchange rate volatility and whether there was a common boundary. The result of the analysis varied according to the product groups, but one important point to note was that the exchange rate volatility affected Hungarian foreign trade negatively.

Ramaswamy, Choutagunta and Sahu (2020) examined the determinants of trade flows of 31 Asian countries for the period 2007-2014 within the framework of the gravity model. In the study, they examined the performance of free trade agreements. As a result of the analysis, the trade flow was affected by distance and some trade agreements negatively whereas GDP and population could significantly explain trade flows.

3. METHODOLOGY

3.1. Gravity Model

The gravity model is formulated on the Law of Gravity which was developed by Newton in the 17th century. Tinbergen explained the foreign trade flow by using the economic size and distance variables of the countries in his model. Tinbergen states that there are variables other than economic size and distance affecting trade, but he further states that the main factors among them are economic size and distance as listed below:

• The amount of exports a country can supply depends on its economic size.

• The amount that can be sold to a particular country would vary according to the market size of that country.

• Trade volume would depend on shipping costs (Tinbergen 1962: 263).

$$T_{ij} = G\frac{M_i^{\alpha} * M_j^{\beta}}{D_{ij}^{\theta}} \quad (1)$$

where T_{ij} is trade flow between countries i and j, M_i and M_j are economic size of countries i and j, here, if Tij, is a monetary flow, measured as (e.g. export values). M refers to the gross domestic product (GDP) or gross national product (GNI) of each country if the Tij is the flow of people. It would be more accurate to measure M with population. D_{ij} is defined as distance between countries i and j, G indicates the constant. α, β, and θ show the model parameters. We would like to note that when α=β=0, θ=2, Newton's equation is reached (Tinbergen 1962: 263).

Economic size (GDP, GNP) has positive effect whereas distance has negative effect on the foreign trade flow. The mathematical format of the model is shown in Equation 2:

$$logT_{ij} = a + \beta logY_i + \gamma logY_j + \theta logD_{ij} + \varepsilon_{ij} \quad (2)$$

In the basic gravity model, economic size and distance are used. To expand the model, population variable is included. In addition to, dummy variables for border, language, and colonial ties are added to the model.

As the economic size of the countries that trade together increases, their mutual trade would increase. However, as the distance between countries increase, the counterpart trade would decrease (Dincer 2013, 7). Dummy variables for common language, common border, landlocked or economic integration could be included in the model to represent geographical and cultural factors.

3.2. Panel Data

Panel data consists of data that includes observations of several individuals or companies over time. Panel data observations, therefore, contain at least two dimensions: a) the sub-index i indicates the cross-section size, and b) the t-index indicates the time dimension (Hsiao 2005).

In general, the panel data model is expressed as below:

$$Y_{it} = \alpha_{it} + \beta_{kit}X_{kit} + u_{it} \quad i = 1,..,N \; t = 1,..,T \quad (3)$$

where Y refers to the dependent variable, X_k represents the explanatory variable, α is the constant parameter, β and u are the slope parameter and the error term respectively. i indexes units and t represents time.

Panel data are divided into two groups: a) balanced panel data and b) unbalanced panel data. Unbalanced panel data consists of missing observations for some variables during a certain time in the data collection process (Xu, Lee and Ho 2007: 572). Balanced panel data in which each unit is observed in every time dimension and as therefore, there exist no missing observations in the data.

In panel data, more than one unit comes together; each unit has its characteristics. Variables that reflect the properties of units are called unit effects. While this effect varies by unit, it is constant over time. Panel data that deal with the time dimension together with the unit, each period may have its own characteristics. The variable that reflects time-specific features is called the time effect. While this effect is constant among units, it varies according by time (Yerdelen Tatoglu 2013: 5).

3.3. Panel Data Models

In general, there are two types of commonly used panel data models in the literature (fixed and random effect models). We further include pooled model in this section. These models are explained as follows:

a) Pooled Model (POLS Model): A model in which all parameters are constant is called a classical model. In the absence of the effects of units and time, all data can be estimated with an ordinary least squares regression model. Although most of the time unit and/or time effects are present, sometimes none of these effects are statistically significant. This model is also called the pooled regression model (Yaffee 2003: 3). The model is as follows:

$$Y_{it} = \beta X_{it} + u_{it} \qquad i: 1, \dots., N \quad t: 1, \dots, T \tag{4}$$

b) Fixed Effects Model: Panel data, changes occur due to the differences between units or times, or differences between units and over time. One way to include this change in the model is to assume that this change causes another change in some or all the regression model coefficients. The regression coefficients are obscure, but fixed parameters. If these are allowed to vary in one or two dimensions, this is a fixed effect model. In this sense, to distinguish between two kinds of regression coefficients: the intercept and the slope parameters. When just variations in the intercept are considered, the resulting regression name the covariance model (or dummy variable model (Mátyás, L. & Sevestre 2008: 30).

The one-way fixed effects models in other words dummy variable/covariance model are shown in Equation 5:

$$Y_{it} = \alpha_i + \beta_2 X_{2it} + \cdots . \beta_k X_{kit} + u_{it} \tag{5}$$

The change of the constant coefficient from unit to unit is provided by dummy variables. One-way fixed effects model with dummy variables are expressed as follows (Guris 2015: 14):

$$Y_{it} = \alpha_1 D_{1\mathrm{i}} + \cdots \alpha_N D_{\mathrm{Ni}} + \beta_2 X_{2it} + \cdots + \beta_k X_{2kt} + u_{it} \tag{6}$$

where $D_{it} = \begin{Bmatrix} 1 & for\ i.unit\ (i = 1, \dots N) \\ 0 & Other\ Situation \end{Bmatrix}$

where

c) Random Effects Model: In panel data models, if the effects are treated as random variables, such as the error term, the existence of random effects is mentioned. Unlike the fixed-effects model, the effects of the units are random, depending on the random draw process of the sample (Baltagi: 2005: 14).

One-way random-effect models: In the error component model, the change in unit or time dimension is added to the model as a component of the error term, affecting only the constant parameter. In the random coefficient model, the change in unit or time dimension is added to the error term to affect all parameters (Mátyás, L. & Sevestre 2008: 47).

The one-way random effects models are shown as below:

Error components model:

$$Y_{it} = \delta_i + \beta_2 X_{2t} + \cdots + \beta_k X_{kt} + \nu_{it} \qquad \delta_i = \bar{\delta} + a_i \tag{7}$$

$$Y_{it} = \bar{\delta} + \beta_2 X_{2t} + \cdots + \beta_k X_{kt} + u_{it} \qquad u_{it} = a_i + \nu_{it} \tag{8}$$

where $\bar{\delta}$, is population mean is the constant parameter while a_i is the unit effect error term component.

Torres-Reyna (2007) states that it is important to check three assumptions when using panel data analysis techniques. These assumptions are the cross-sectional dependence, autocorrelation and heteroscedasticity. Tests should be carried out to examine the existence of the autocorrelation, cross-sectional dependence, and heteroscedasticity. The Ordinary Least Squares (OLS) in classical and fixed effects models, the Generalized Least Squares (GLS) estimator for random effects model lose BLUE (Best Linear Unbiased Estimator) features. The alternative estimators should be used to determine the standard errors that are robust to these problems (Cınar 2021: 469). In determining the robust standard errors, the number of T and N is also important in addition to the model properties. Suitable robust estimators are determined and the model is estimated.

4. DATA AND ANALYSIS

The analysis covers the period 1996-2019. The reason for choosing this period is because Turkey joined to the World Trade Organization in 1995 and the first case of the Covid-19 pandemic in Turkey which disrupted trade sector, occured in March 2020.

This study aims to analyze whether the gravity model is appropriate to explain Turkey's exports and imports to the member of the Black Sea Economic Cooperation Organization, Balkan countries and other selected countries the period 1996-2019, using panel data analysis techniques. To explain the exports and imports of the member states of the Black Sea Economic Cooperation Organization, two different models were estimated. Due to the embargo imposed by Turkey on Armenia, there does not trade data from Turkey to Armenia for the years 1996-2008 and 2014-2015. For this reason, two different models were created by completing the missing Armenia data with the interpolation method in the analysis and by excluding Armenia from the analysis.

Table 1. Variables and Abbreviations

Name of Variable	Description	Source
X	Turkey's exports to the relevant country (1000 USD$)	Turkish Statistical Institute
M	Turkey's imports to the relevant country (1000 USD$)	Turkish Statistical Institute
GDP	GDP of the exporting /importing country (USD$)	World development indicators, world bank
TRGDP	Turkey's GDP (USD$)	World development indicators, world bank
POP	Population of the exporting/importing country	World development indicators, world bank
TRPOP	Turkey's population	World development indicators, world bank
DISTANCE	Distance of capitals of exporting /importing countries from Ankara, capital of Turkey (km)	Tr.distance.to
BORDER	1 if it shares a common border with Turkey, 0 otherwise	Centre d'études prospectives et d'informations internationales
LANG	1 if it shares a common language with Turkey, 0 otherwise	Centre d'études prospectives et d'informations intçernationales

The country groups used in the analysis are as follows: Albania, Azerbaijan, Bulgaria, Georgia, Macedonia, Moldova, Romania, Russia, Serbia, Ukraine, Greece, and Armenia as the BSEC member states. In the model established for the Balkan countries, Bulgaria, Albania, Romania, Bosnia and Herzegovina, Croatia, North Macedonia, Serbia, Slovenia, and Greece. The countries used for the selected countries were Canada, France, Germany, Iran, Norway, Qatar, Russian Federation, Sweden, the United Kingdom, and United States.

After estimating the pooled, fixed and random effects models, the tests were conducted to determine the appropriate model among these models. The results for the model selection are presented in Table 2.

Table 2. Results for the Model Selection

		EXPORT		IMPORT		EXPORT	IMPORT	EXPORT
		ALL BSEC	NONARM BSEC	ALL BSEC	NONARM BSEC	BALKAN	BALKAN	SELECTED COUNTRIES
F Test	Prob > F	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Breusch Pagan LM Test	Prob>chibar2	0.00	0.00	0.21	0.00	0.00	0.00	0.00

The hypotheses of the F test, which allows us to choose between fixed effects and pooled models, are as follows:

H_0: $\beta_i = \beta$ [There is no unit effect in the model.]

H_1: $\beta_i \neq \beta$ [There is unit effect in the model.] (9)

Since the p probability value for all models is less than 0.001, the H_0 hypothesis is rejected. For all models, estimation is not appropriate with the POLS.

Breusch Pagan LM test hypotheses comparing the pooled model and the random effects model are presented in Equation 10.

H_0: $\sigma^2\mu = 0$ [There is not unit effect in the model.]

H_1: $\sigma^2\mu \neq 0$ [There is unit effect in the model.] (10)

Except for the model in which all the BSEC countries established for import were included, the H_0 hypothesis was rejected because the p probability value was below the critical value of 0.001 in all other models, the POLS was not suitable for all models. H_0 hypothesis was not rejected since the p probability value was 0.208>0.001 in the model that includes all the BSEC countries established for import. As a result, the pooled effects model was suitable.

All models included the DIST variable, which was one of the main variables of the gravity model and did not change according to years. If the fixed effects model was chosen, the DIST variable is dropped from the model. For this reason random effects model would be continued for all models.

Table 3. Assumption Tests Results

			EXPORT ALL BSEC	EXPORT NONARM BSEC	IMPORT ALL BSEC	IMPORT NONARM BSEC	EXPORT BALKANS	IMPORT BALKANS	EXPORT SELECTED COUNTRIES
homoscedasticity			Pr>F	Pr>F	Pr>F	Pr>F	Pr>F	Pr>F	Pr>F
	W0		0.000	0.000	0.000	0.000	0.000	0.000	0.000
	W50		0.000	0.000	0.000	0.000	0.000	0.000	0.000
	W10		0.000	0.000	0.000	0.000	0.000	0.000	0.000
cross-section dependence			P-value	P-value	P-value	P-value	P-value	P-value	P-value
	Pesaran		0.00	0.00	0.00	0.00	0.00	0.814	0.57
autocorelation			pr>chi2	pr>chi2	pr>chi2	pr>chi2	pr>chi2	pr>chi2	pr>chi2
	Random Effects Two Sided	LM(Var(u)=0)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		ALM(Var(u)=0)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Random Effects One Sided	LM(Var(u)=0)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		ALM(Var(u)=0)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Serial Correlation	LM(Var(u)=0)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		ALM(Var(u)=0)	0.040	0.000	0.000	0.000	0.000	0.000	0.000
	Joint Test	LM(Var(u)=0) Lambda=0)	0.000	0.000	0.000	0.000	0.000	0.000	0.000

H_0: $\sigma_i^2 = \sigma^2$ [The variances of the units are equal in the model. / The homoscedasticity assumption is valid.]

H_1: $\sigma_i^2 \neq \sigma^2$ [The variances of the units are unequal in the model. / The homoscedasticity assumption violated.] (11)

According to the Levene, Brown and Forsythe (1974) test results, since the p probability value was 0.000<0.001, the H_0 hypothesis was rejected, and all models were reported to have the heteroscedasticity problem.

H_0: $\rho_{ij} = 0$ [There is no correlation between units. / There is no cross-section dependence.]

H_1: $\rho_{ij} \neq 0$ [There is a correlation between units. / There is a cross-section dependence.] (12)

Since the probability value was greater than 0.001 according to Pesaran (2004) test results of the export model established with the selected countries and the import model established with the Balkan countries, the H_0 hypothesis could not be rejected, there was no cross-section dependence. Other alternative models had the cross-section dependence.

H_0: $\rho = 0$ [There is no autocorrelation.]

H_1: $\rho \neq 0$ [There is autocorrelation.] (13)

According to the results of The Augmented Lagrange Multiplier (ALM) and Lagrange Multiplier (LM) test statis-

tics, the H_0 hypothesis was rejected because the p probability value for all models was below the critical value of 0.05. All installed models had the autocorrelation problem.

As a result of the diagnostic tests, the models were re-estimated using the appropriate resistant estimators. Since there were autocorrelation, heteroscedasticity, and cross-sectional dependency problems in the models established for the analysis of exports and imports to the BSEC countries and Balkan's export, the Driscoll Kraay Estimator was used for these models. There were autocorrelation and heteroscedasticity problems in the export model established with the selected countries and the import models established with the Balkan countries. These models were re-estimated using the Arellano, Froot, and Rogers estimators.

4.1. Results of the Model Including Armenia for the BSEC Member States

In this chapter, the estimation results of export and import models to the BSEC countries are included.

The Export Model is expressed as below:

$$log\, X_{ijt} = \beta_0 + \beta_1\, log\, GDP_{jt} + \beta_2\, log\, TRGDP_{it} + \beta_3\, log\, POP_{jt} + \beta_4\, log\, TRPOP_{it} + \beta_5\, log\, DIST_{ij} + \beta_6 BORDER_{ij} + \beta_7 LANG_{ij} + u_{ijt} \quad (14)$$

The Import Model is defined as in Equation 15:

$$log\, M_{ijt} = \beta_0 + \beta_1\, log\, GDP_{jt} + \beta_2\, log\, TRGDP_{it} + \beta_3\, log\, POP_{jt} + \beta_4\, log\, TRPOP_{it} + \beta_5\, log\, DIST_{ij} + \beta_6 BORDER_{ij} + u_{ijt} \quad (15)$$

Table 4. Including Armenia for the BSEC Member States Models Results

Including Armenia For the BSEC Member States								
	EXPORT				IMPORT			
Independent Variables	**Coef.**	**P> |t|**	**Std. Err.**	**t**	**Coef.**	**P> |t|**	**Std. Err.**	**t**
GDP	0.248	(0.15)	0.165	1.51	-0.306	(0.410)	0.364	-0.8
TRGDP	0.839	(0.000)***	0.182	4.61	0.736	(0.110)	0.443	-1.66
POP	0.293	(0.72)	0.796	0.37	2.121	(0.000)***	0.277	7.66
TRPOP	0.604	(0.48)	0.839	0.72	1,133	(0.391)	1.296	0.87
DIST	-1.452	(0.82)	6.22	-0.23	-2.158	(0.009)**	0.752	0.75
BORDER	-0.796	(0.64)	1.681	-0.47	0.517	(0.403)	0.517	0.51
LANG	0.537	(0.40)	0.62	0.87				
constant term	-9.192	(0.65)	20.003	-0.46	7.594	(0.033)*	7.594	7.59
sigma_u		1.237				0.213		
sigma_e		0.284				0.903		
Wald chi2		421.68				3052.74		
Prob > chi2		0.00				0.00		
Rho		0.95				0.052		
Number of Observations (N)		288				288		
overall R^2		0.371				0.451		

Note: Coef. refers to coefficient and Std. Err. represents standard error.

In the export model in which Armenia was included, there was a significant positive relationship 1% significance level between Turkey's exports to the BSEC countries but Turkey's GDP, while the GDP and population of the exporting countries, Turkey's population, DIST, BORDER and there was no significant relationship with LANG.

A 1% increase in Turkey's GDP increases Turkey's exports to the BSEC countries by 0.83%. The Wald test, which evaluates the general significance of the model, indicates that the probability value is significant for the model as a whole. R^2 value is 0.37, one could suggest that the changes in the independent variables explain 37% of changes in the dependent variable. In the import model, the effect of the population of the importing countries was found to be significant the level of 1% and the impact of the DIST variable as statistically significant at the level of 5% for the Turkey's import to BSEC countries. Other variables in the model were found to be insignificant. A 1% increase in the population of importing countries increased imports by 2.12%, while a 1% increase in DIST decreased imports by 2.15%. The variables in the import model explained imports by 45%, the model was generally significant.

4.2. Results of the Model Excluding Armenia for the BSEC Member States:

In this section, the estimation results of export and import models to the Balkan countries without Armenia are included.

The Export Model is represented as in Equation 16:

$$log\, X_{ijt} = \beta_0 + \beta_1\, log\, GDP_{jt} + \beta_2\, log\, TRGDP_{it} + \beta_3\, log\, POP_{jt} + \beta_4\, log\, TRPOP_{it} + \beta_5\, log\, DIST_{ij} + \beta_6 BORDER_{ij} + \beta_7 LANG_{ij} + u_{ijt} \quad (16)$$

The Import Model is demonstrated as below:

$$log\, M_{ijt} = \beta_0 + \beta_1\, log\, GDP_{jt} + \beta_2\, log\, TRGDP_{it} + \beta_3\, log\, POP_{jt} + \beta_4\, log\, TRPOP_{it} + \beta_5\, log\, DIST_{ij} + \beta_6 BORDER_{ij} + \beta_7 LANG_{ij} + u_{ijt} \quad (17)$$

Table 5. Excluding Armenia for the BSEC Member States Models Results

	Excluding Armenia for the BSEC Member States							
	EXPORT				**IMPORT**			
Independent Variables	**Coef.**	**P> |t|**	**Std. Err.**	**t**	**Coef.**	**P> |t|**	**Std. Err.**	**t**
GDP	0.542	(0.001)***	0.135	2.22	0.153	(0.358)	0.163	0.94
TRGDP	0.648	(0.001)***	0.172	3.77	1.261	(0.000)***	0.248	5.07
POP	-0.056	(0.84)	0.281	-0.2	1.358	(0.001)***	0.364	3.73
TRPOP	1.241	(0.12)	0.776	41.6	0.293	(0.640)	0.620	0.47
DIST	0.068	(0.94)	0.937	0.07	-1.309	(0.011)**	0.475	-2.75
BORDER	0.218	(0.018)**	0.085	2.55	0.514	(0.146)	0.341	1.50
LANG	0.382	(0.09)**	0.215	1.77	0.125	(0.763)	0.410	0.31
CONSTANT TERM	-17.216	(0.036)**	7.738	-2.22	-18.857	(0.005)**	6.096	-3.09
sigma_u		0.173				0.246		
sigma_e		0.121				0.208		
Wald chi2		1198.86				502.59		
Prob > chi2		0.00				0.00		
Rho		0.671				0.583		
Number of Observations		264				264		
overall R^2		0.8822				0.913		

Note: Coef. refers to coefficient and Std. Err. represents standard error.

In the export model in which Armenia was included, there was a significant positive relationship at 1% significance level between Turkey's exports to the BSEC countries and Turkey's GDP and GDP of the exported countries, 5% significance level BORDER and LANG. However, Turkey's population and population of the exporting countries, DIST there was no significant relationship with Turkey's export. While a 1% increase in Turkey's GDP increased the exports to these countries by 0.64%, 1% increase in the GDP of the exporting countries affects exports by 0.54%, positively.

The effects of common language and common border variables on exports were found to be significant and positive. When the Wald test probability value was considered, it was found be highly significant. The R^2 value of 0.88 means that the independent variables explain 88% of exports. In the import model excluding Armenia, Turkey's GDP was significant at the level of 1% and the DIST variable was significant at the level of 5%. Other variables in the model are not statistically significant. 1% increase in Turkey's GDP affected imports positively by 1.26%, while a 1% increase in DIST affects 1.35% negatively. 91% of the variables used in the model, which were in general significant, explained imports.

4.3. Balkan Countries Model

In this section, the estimation results of export and import models to the Balkan countries are reported.

The Export Model is reported as in Equation 18:

$$log\, X_{ijt} = \beta_0 + \beta_1\, log\, GDP_{jt} + \beta_2\, log\, TRGDP_{it} + \beta_3\, log\, POP_{jt} + \beta_4\, log\, TRPOP_{it} + \beta_5\, log\, DIST_{ij} + \beta_6 BORDER_{ij} + u_{ijt} \quad (18)$$

The Import Model is shown below:

$$\log M_{ijt} = \beta_0 + \beta_1 \log GDP_{jt} + \beta_2 \log TRGDP_{it} + \beta_3 \log POP_{jt} + \beta_4 \log TRPOP_{it} + \beta_5 \log DIST_{ij} + \beta_6 BORDER_{ij} + u_{ijt} \quad (19)$$

Table 6. Balkan countries Models Results

BALKAN COUNTRIES								
	EXPORT				IMPORT			
Independent Variables	**Coef.**	**P> |t|**	**Std. Err.**	**t**	**Coef.**	**P> |t|**	**Std. Err.**	**z**
GDP	0.307	(0.282)	0.278	1.10	0.572	(0.017)**	0.238	2.39
TRGDP	0.842	(0.009)**	0.295	2.85	0.843	(0.003)**	0.283	2.98
POP	-0.211	(0.629)	0.431	-0.49	0.105	(0.895)	0.794	-0.13
TRPOP	2.374	(0.120)	1.471	1.61	1.720	(0.258)	1.522	1.13
DIST	-2.087	(0.027)**	0.885	-2.36	-2.572	(0.059)*	1.360	-1.89
BORDER	0.557	(0.004)***	0.174	3.20	0.462	(0.166)	0.333	1.38
CONSTANT TERM	18.468	(0.083)*	10.191	-1.81	15.784	(0.002)	5.208	-3.03
sigma_u		0.184				0.446		
sigma_e		0.149				0.256		
Wald chi2		1106.07				9804.24		
Prob > chi2		0.000				0.000		
rho		0.604				0.751		
Number of Observations		216				216		
overall R^2		0.842				0.76		
					R^2 within	0.718	R^2 between	0.782

Note: Coef. refers to coefficient and Std. Err. represents standard error.

Turkey's exports to the selected Balkan countries had a significant effect on Turkey's GDP and DIST variables at the level of 5% and the common border variable at the level of 1%. 1% increase in the Turkey's GDP affected exports by 0.84%, positively but DIST variable affected negatively. Export countries and Turkey's population did not have a significant effect on exports to Balkan countries. According to the Wald test result, the model was statistically significant. R^2 of the model was 0.84, and the independent variables used in the model explained exports by 84%. In the model explain Turkey's imports to selected Balkan countries, the GDP of the importing countries and Turkey was significant at the level of 5%, and at the level of 10% the variable of DIST was significant. Other variables were statistically insignificant for this model. %1 increase in Turkey's GDP affected imports by 0.84%, 1% increase in GDP of importing countries was 0.57% positive, DIST affected imports negatively. The independent variables used in the model explained 76% of model, the model was generally significant.

4.4. Selected Countries Model

In this section, the estimation results of the export model to the selected countries are included.

The Export Model indicated as below:

$$log\, X_{ijt} = \beta_0 + \beta_1\, log\, GDP_{jt} + \beta_2\, log\, TRGDP_{it} + \beta_3\, log\, POP_{jt} + \beta_4\, log\, TRPOP_{it} + \beta_5\, log\, DIST_{ij} + \beta_6 BORDER_{ij} + \beta_7 LANG_{ij} + u_{ijt} \quad (20)$$

Table 6. Selected Countries Models Results

SELECTED COUNTRIES EXPORT				
Independent Variables	**Coef.**	**P> |t|**	**Std. Err.**	**t**
GDP	0.642	(0.001)***	0.179	3.59
TRGDP	0.478	(0.004)**	0.168	2.84
POP	0.505	(0.001)***	0.147	3.44
TRPOP	1.506	(0.019)**	0.642	2.35
DIST	-1.315	(0.000)***	0.292	-4.51
BORDER	0.729	(0.000)***	0.175	4.16
CONSTANT TERM	-18.196	(0.000)***	4.012	-4.54
Number of Observations		264		
Mean dependent var		6.102		
SD dependent var		0.711		
Chi-square		5.128.466		
R^2 within		0.863		
R^2 between		0.938		
overall R^2		0.913		
Prob > chi2		0.000		

Note: Coef. refers to coefficient and Std. Err. represents standard error.

While there was a positive and significant relationship between Turkey's exports to the selected countries and Turkey's GDP and population, the GDP and population of exporting countries, and the LANG dummy variable, there was a negative significant relationship between the DIST variable. While the 1% increase in Turkey's GDP increased its exports to the selected countries by 0.47%, a 1% increase in the population increased exports by 1.50%. While 1% increase in the GDP of the selected exporting countries increased exports by 0.64% and 1% increase in population increased export by 0.50%. A %1 increase in distance reduced exports by 0.72%. The effect of the common language variable was positively significant. The R^2 value of 0.91 means that the variables in the model explained 91% of exports. Due to the data structures, the expected estimates for import to selective country models could not be obtained.

5. CONCLUSION

This study aims to find an answer to the question of whether the gravity model explains Turkey's exports and imports to Black Sea Economic Cooperation Organization members, Balkan, and the selected countries. Due to the deficiencies in the data of Armenia, two different models were created for the Black Sea Economic Cooperation Organization, in which Armenia was included and then excluded. The missing data were produced by the interpolation method. In the study, export and import data according to the countries included in the foreign trade data group of TURKSTAT were used as the dependent variable. The analysis covers the period from 1996, when the Customs Union Agreement entered into force, to 2019, when there were no Covid-19 cases in Turkey.

The pooled, fixed and random effects models were estimated for all models. In order to select among these models, F, Breush Pagan (1980), Hausman tests were performed. According to the F test results, the fixed effects model was more suitable among all models compared to the pooled model. According to the result of the Breush Pagan test, the random effects model was more suitable compared to the pooled model. Hausman test was used to compare the fixed effects and random effects models and to select the appropriate model. Regardless of the test result, since the distance variable, which was one of the gravity model variables, was a constant variable according to years, the random effects model was chosen as the appropriate model for all country groups. The assumptions of the models created for all country groups were tested. As a result of the tests, there was heteroscedasticity, cross-section dependence and autocorrelation problems in export model for the Balkan countries and models for BSEC countries. here was heteroscedasticity and autocorrelation problems in export model for the selected countries and import model for Balkan countries. The result was reached by estimating the models with resistant estimators developed against these problems. Arellano, Froot and Rogers Estimators were used for the selected countries export and Balkan countries import, while Driscoll Kraay Estimator was used for other models. In terms of the gravity model, our study concluded that Turkey's exports to the selected countries and BSEC (Except Armenia) countries were suitable in explaining Turkey's import model of Balkan countries.

Funding

The authors states that this study has received no financial support.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Submission Declaration Statement

We confirm that this work is original and has not been published elsewhere, nor is it currently under consideration for publication elsewhere.

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