ESTIMATION OF INTERNATIONAL TRADE

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ÖZET

Çalışmada Türkiye ile 37 OECD ülkesi arasında dış ticaret hacmi incelenmiş olup, özellikle lojistik performans indeksinin Türkiye'nin dış ticaret hacminde değişim yaratıp yaratmadığı analiz edilmiştir. Takip edilen bu amaçla, 2007-2020 aralığında Türkiye ile OECD üyelerine ait datalarla panel çekim modeli yöntemiyle Türkiye'nin dış ticaret hacminin saptanmasında lojistik performans indeksi etkileri araştırılmıştır. Tezde, toplam dış ticaret hacminin, Türkiye'nin OECD ülkelerine ihracatının ve Türkiye'nin OECD ülkeleri ile ithalatının bağımlı değişken olduğu üç farklı model kurulmuştur. Modellerde kullanılan değişkenler, Türkiye ve OECD ülkelerinin gayri safi yurt içi hasılası, arge yatırımları, popülasyonu, lojistik performans indeksi ve ülkeler arasındaki mesafedir. Modellerde otokorelasyon, heteroskedasite ve yatay kesit bağımlılığı sorunu olduğundan bu sorunlara dirençli olan Huber-Eicker-White tahmincisi kullanılmıştır. Elde edilen sonuçlar incelendiğinde, dış ticaret hacminin bağımlı değişken olduğu modelde ülkelere ait GSYH ve dış ticaret hacmi ilişkisinin işaretinin pozitif yönde olduğu sonucuna ulaşılmıştır. Çekim modelinin çalışmalarda kullanılan ana değişkenleri mevcuttur. Bunlardan ülkeler arası coğrafi uzaklığı ifade eden değişken en çok kullanılanlar arasındadır. Ticaret akımları ile ilişki yönü negatiftir. Türkiye'nin lojistik performans indeksi ilk iki modelde, dış ticaret hacmi üzerinde pozitif ve anlamlı etkiye sahiptir. OECD ülkelerinin nüfusları ve Türkiye'nin dış ticaret hacmi arasında beklentiler doğrultusunda pozitif bir ilişki olduğu görülmüştür. Çalışmanın ana amacı değerlendirildiğinde, Türkiye'nin lojistik performans indeksi dış ticaret hacmi üzerinde pozitif ve anlamlı bir etkiye sahiptir.

ABSTRACT

The study analyzed foreign trade volume among Turkey and 37 OECD countries, especially the sway of the logistics performance index on Turkey's foreign trade volume. In light of this, the effects of the logistic performance index in determining Turkey's foreign trade volume were analyzed by using the data of Turkey and OECD countries in the 2007-2020 period. In the study, three different models were established in which the total foreign trade volume, Turkey's exports to OECD countries, and Turkey's imports with OECD countries are dependent variables. The variables used in the models are the GDP of Turkey and OECD countries, R&D investments, population, logistics performance index, and distance between countries. Since the models have problems with autocorrelation, heteroskedasticity, and cross-section dependence, the Huber-Eicker-White estimator, which is robust to these problems, was used. When the results obtained were examined, it was concluded that the sign of the relationship between GDP and foreign trade volume of the countries in the model in which the foreign trade volume was the dependent variable was positive. The gravity model has main variables used in the studies. Among these, the variable that expresses the geographical distance between countries is among the most used. In the study, the direction of relationship with trade flows is negative. Turkey's logistics performance index positively and significantly affects foreign trade volume in the first two models. It has been observed that there is a positive relationship between the populations of OECD countries and Turkey's foreign trade volume, in line with expectations. When the study's primary purpose is evaluated, Turkey's logistics performance index has a positive and significant effect on foreign trade volume.

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1. Introduction

The main task of all economies in the world is to increase the welfare level of people. Economies try to balance between limited resources and endless human needs. The main inputs used for these needs are goods and services. In order to meet these needs, that is, to grow their economies and increase their welfare, countries either produce goods and services themselves and improve their welfare by consuming what they produce, or they try to increase their welfare level by purchasing them from other countries. The exchange of countries with each other to meet their needs is called "international trade". Another reason for international trade other than supply and demand imbalances is geographical conditions. A different important reason for international trade for countries is to make a profit. A country with lower technological infrastructure and less workforce may prefer to import that product instead of producing it. This is because importing this good is less costly than producing it.

International trade is one of the most important branches of economics. Dynamics in the field of international trade simultaneously affect economic activities. International trade has undergone significant developments and changes over time. Specific breaking points in history have affected all areas of life as well as the field of commerce. The liberalization in foreign trade, which came into effect in the 1980s, in other words, the ongoing economic and technological developments with globalization have created a competitive environment between countries on a global scale. Each country has made some efforts to increase its welfare and economic growth in a competitive environment.

The purpose of international trade is to meet the needs of all consumers by purchasing goods and services that are not available in the country or that have high cost or low quality and selling the goods and services that are surplus in the country to foreign countries. Today, all countries make foreign trade. Countries sometimes produce more than they need and export the over-produced goods by selling them to other countries. Countries import the missing goods from other countries if their production does not meet their needs. Because of each country's location and technological development, the products they can produce may differ. All consumers living in a country may have different tastes and preferences. In addition, there are differences in the prices of manufactured goods from country to country. Therefore, it tries to meet consumers' demands by importing and exporting to other countries. For example, countries with fertile agricultural land or skilled labor can become exporters of the goods they produce by producing them cheaper. Countries that do not have these characteristics, on the

other hand, import from other countries instead of bearing more costs and producing these products.

In the Turkish economy, the 1980s take place in the literature as the years of liberalization and foreign trade. In these years, Turkey abandoned import substitution policies and adopted an export-based economic policy model. This transition has also increased the importance of foreign trade policies economically. The economy's main target has been economic growth by increasing net exports. This period also created the understanding of growing relations in the economy and foreign policy. Improving relations has accelerated the foreign trade process of the Turkish economy. This situation has led Turkey to seek new markets or diversify the market.

The effect of the logistic performance on the foreign trade balance of the countries constitutes the one purpose of this research. Logistics performance in a competitive environment depends on which countries the companies will be located in. It significantly impacts decisions about which suppliers it will buy from and which markets it will enter. High logistics costs and a low level of logistics service constitute an obstacle to trade, foreign direct investments, and thus economic growth. For these reasons, improving logistics performance has become an important development policy goal. The World Bank developed the logistics performance index (LPI) to help countries develop logistics reform programs to increase their trade capability and competitiveness. Thanks to this index, countries find the opportunity to compare themselves with other countries in terms of international logistics activities, and they see the opportunities and obstacles in front of them.

The study analyzes trade flows between Turkey and OECD countries using the 'gravity model'. The gravity model is divided into three as 'basic gravity model', 'augmented gravity model', and 'dynamic gravity model'. According to the basic gravity model, which states that the main factors explaining international trade are national income and geographical distance between countries, income is a factor that positively affects foreign trade flows since the volume of imports and exports is related to the economic size of a country. On the other hand, the distance between countries is seen as a factor that negatively affects foreign trade flows since it indicates the cost of transportation. On the other hand, the augmented gravity model has been developed over time by incorporating different parameters such as population size, common language, common border, and economic integrations onto the basic gravity model. It is frequently used in the literature because the gravity model is concise and straightforward, and the model's data can be easily accessed.

In this study, data for the period 2007-2020 and trade flows between Turkey and 37 OECD countries will be tested using panel data analysis with the help of the gravity model. In the study, the foreign trade volume between Turkey and OECD countries has been examined, and it has been analyzed whether the logistics performance index has created a change in Turkey's foreign trade volume. In the study, three different models were established in which the total foreign trade volume, Turkey's exports to OECD countries, and Turkey's imports to OECD countries are dependent variables. The variables used in the models are the gross domestic product of Turkey and OECD countries, R&D investments, population, logistics performance index, and distance between countries. Since the models have autocorrelation, heteroscedasticity, and cross-section dependency problems, the Huber-Eicker-White estimator, which is resistant to these problems, was used. When the literature studies related to the subject are examined in detail, it is seen that the gravity model is used extensively to analyze trade movements between countries. In this respect, it is expected to contribute to the existing literature by using the most up-to-date and wide-ranging data to determine the nature and determinants of trade flows between Turkey and OECD countries and their effects.

The study consists of four parts. In the first chapter, there is an introduction to the scopes that form the basis of the thesis. The introduction includes the concept of foreign trade, the reasons for foreign trade, the logistics performance index, the general distinction of the gravity model, and Turkey's globalization process.

In the second part, the theoretical and empirical background of the gravity model is detailed. This section mentions the emergence, development and separation of the gravity model, the basic gravity model, augmented gravity model and dynamic gravity model structures. The model structure of the variables added to the gravity model, which has developed with various economic approaches, has been emphasized, and the primary studies based on these approaches have been mentioned. In addition, the methodology, indicators and rankings of OECD countries and Turkey, especially of the selected logistics performance index, are mentioned in the study. Finally, trade potential calculation and various literature studies based on Turkey and logistics performance are included.

In the third chapter, pooled least squares model, fixed-effects model and random-effects model, which are the basis of panel data analysis, are mentioned, and the Hausman test, F test and LM test are cited about which one to use. In addition, Huber, Eicker and White Estimator, which is resistant to autocorrelation, cross-section and heteroscedasticity problems and used as

the estimator of the study, is included. Finally, data presentation, established models, descriptive statistics and analyzes are included in this section.

In the last section, the results and evaluations will be included. Besides the main variables evaluated within the scope of the gravity model, the trade flow between Turkey and OECD countries has been shaped based on the logistics performance index.

2. Theoretical And Empirical Background of Gravity Model

2.1.Introduction

Foreign trade theories are good at explaining the origins of foreign trade; however, they are not similarly successful in explaining the determinants of the geographical distribution and size of foreign trade. The goal of the gravity model is to fill this gab. The gravity model is comprehensively utilized to explore components that identify mutual trade flows. The gravity model properly clarifies these flows in empiric environment; therefore, its usage increases continuously. The model is depended on The Law of Gravity, established in physics by Sir Isaac Newton in the late 17th century (Dinçer, 2014:5). In the law on which the gravity model is based, the variables are mass and distance. With the adaptation of this model to the economy, these variables gave way to trade flows and GDP. The distance between two countries (km) is used instead of the distance between matters (Ram and Prasad, 2007). This model states that the flow of trade between countries, cities, partners, etc., is directly proportional to output and inversely proportional to distance.

Earlier, the gravity model has not been extensively taken into account in the economic literature. However, the model is successful enough in explaining the relationship between many different variables, particularly trade. Additionally, the results produced by the model have amplified its worth in the economics literature. Thus, the model has been accepted wide spritely. The economic adaptation of this approach is powerful for relationship of variables.

2.2.History

According to the most common definition of the gravity model, it explains economic flows between different geographical locations reciprocally. In extended version of this approach, besides the economic situation, distance variables, and according to the purpose of the study, variables can be selected. Even if the gravity model posits that the flows between two geographical locations are related to economic size and geographic distance, the same relation was repeatedly emphasized by many researchers from different fields before. One of the pioneering studies in which the gravity model is seen was the work of Ernest Ravenstein in 1885. In his study, Ravenstein (1885) investigated migration flows. He gave importance to the

relations and surface area sizes of the regions he dealt with in his study. In another study, Isard (1954) had similar approach with the gravity model. While developing his approach, he utilized the rules from another branch of physics, Potential Electricity, instead of The Law of Gravity by Newton.

It is possible to count more than one name that greatly improves gravity model. However, Jan Tinbergen was first to formulate the model mathematically and conduct experimental application. He published his book including the formulation in 1962, which is "Shaping The Word Economy: Suggestions For an International Economic Policy". The formula contains more than one primary variable. The first of these is the GNP of the exporting country. In addition, the economist added the GNP of the importing country and the distance between them as variables. Also, economist Tinbergen mentioned the negative impact of transportation costs. According to him, these costs depend on the distance variable and have a negative effect on the trade flow. This was the first step for the gravity model in applying to foreign trade flows. It can be said that Jan Tinbergen's contributions for the model has a significant effect on its recognition.

Some other contributions were done for the gravity model by experimental developments and studies until the 1970s. For a while, although the gravity model's good compatibility with the economic variables was successful, after a while, opposite ideas emerged. For instance, Anderson, took a part in the discussion studying the gravity model's theoretical framework. Similarly, some other researchers maintained the discussion. Anderson re-established the model's success by making several measurements in his study. It also compared the imperfect competition and the gravity model.Anderson stated that these two different models ended in the same theoretical results.

After 1950s the amount of international trade has amplified profoundly throughout the world. Therefore, a bunch of different theories have tried to find out the causes of trade. the gravity model is among these theories. As a technique of studying and analyzing foreign trade flows, the gravity model has been applied in foreign trade for almost last 50 years (Tatlıcı and Kızıltan, 2011: 287-288). Many researchers have opened the way for the gravity model, and it took the place as the most frequently used model for explanation of international trade. The findings from a great amount of studies in different fields have revealed that the area size of partners and the distance between them are the determinants of trade flows between countries (Ata, 2012: 277).

Helpman was another researcher studying the gravity model. He investigated two-way trade flows with this model. He emphasized that model is an influential tool to explain foreign trade models concerning product differentiation and increasing returns to scale. Helpman emphasized that the decision about whether to use the gravity model depends on the data. The gravity model has been adequately documented in terms of this concept. In addition, Helpman touched upon the factor combinations with the intra-industry trade ratio. It assumes that this connectivity is gradually decreasing with multidirectional trade flows. According to Helpman, this happens because of the increase in the activities of multinational firms. He mentioned that the reason for this is that the activities of the companies create this effect.

Lazslo Matyas (1998) was another supporter of the gravity model. According to him, the success of bilateral trade flows and regional integrations can be successfully explained by the gravity model. He made recommended some implementations concerning how to make econometric definition; thus, the model can produce proper results. He also emphasized that an appropriate gravity model should contain individual constants, and this is true for both the exporting and importing countries. According to him, a comprehensive gravity model including the effects of time should be developped (Matyas, 1997: 397).

2.3.Types of Gravity Model

The gravity model has three different types which are the Basic -Dynamic-Augmented Gravity Model. In this section these three types will be explained.

2.3.1. Basic Gravity Model

Thanks to some pioneers, the law of gravity, which was previously used in physics, was adapted to economics to explain trade flows. The formulation of Newton's law in physics is as follows;

"Newton's Law of Universal Gravitation"

$$F_{ij} = G\frac{M_i M_j}{D_{ij}2.}$$

(2.1)

F_{ij}: Gravity force between objects i and j

G: Gravitational constant

M_i: Mass of object i

M_j: Mass of object j

D_{ij}: Distance between objects i and j"

The adapted version of gravity model in of international trade and the definition of each item are also shown below.

"Gravity Model in International Trade

$$X_{ij} = G' \frac{Y_i Y_j}{T_{ij}\Theta}, \qquad T_{ij}\Theta = \left(\frac{t_{ij}}{P_i P_j}\right)^{\sigma-1}$$

(2.2)

X_{ij}: Export from country i to country j

G': Inverse of global output (G'≡1/Y)

Y_i: domestic production of country i

Y_j: total expenditure of country j

T_{ij}^{θ}: Total trade costs between countries i and j

σ : elasticity of substitution between goods

P_i : Price index of country i

P_j : Price index of country j

t_{ij} : "Bilateral trade cost between partners i and j. t_{ij} is typically approximated in the literature by various geographic and trade policy variables, such as bilateral distance, tariffs and the presence of regional trade agreements (RTAs) between partners i and j "

The model can be modeled differently in terms of variables, depending on the distance, area of the cities, partners, countries, and the purpose of the subject studied. The gravity model, adapted to the economic structure based on Newton, is similar to the law in physics. As in physics, it is mentioned that large economic structures interact more than small ones, and the attraction of close partners is greater than those farther away.

As the model developed, the suggested approaches multiplied. One of them is the trade flow approach from country i to j. In addition to the main variables mentioned, the method also said the existence of common variables such as language and border that affect this dual

relationship. Over time, the model has also been used in migration, tourism and other fields besides commerce (Baier and Bergstrand,2006)

In order to analyze international trade, gravity models are first used in the studies of Tinbergen (1962) and Pöyhönen (1963) at the beginning of 1960s. Findings from these contemporary and independent studies were similar. On the other hand, the study of Tinbergen (1962) was prominent and more successful in the adaptation of Law of Gravitation to international economics. Tinbergen (1962), inspired from the opinion that using data on difference between the potential trade amount of countries trade flows can be determined. Additionally, in the absence of factors hindering trade between countries the actual trade volume can be calculated. Inspiring from the Law of Gravitation Tinbergen (1962) focused on two main variables affecting the model. The first is the variable, which is the economic situation indicator, and the second is the distance. He argues that the amount of trade is inversely proportional to the distance and directly proportional to the financial variable.

Tinbergen analyzed model applying data from 18 countries in 1958. Depending on his results he announced that three determinants of the gravity model had high explanatory power. Tinbergen (1962) extended his study using various political or quasi-economic variables. His findings revealed that the volume of trade was significantly affected by a common border between countries. In another study with more comprehensive data from 42 countries in 1959, Tinbergen (1962) reached similar findings. Additionally, he found out that when the diversity of exported goods increased the volume of trade was increased as well. The model used by Tinbergen (1962) depends on a static analysis and the change in exports over time was neglected.

Tinbergen (1962) applied Gini concentration coefficient in his calculations. Findings from these calculations revealed that in the case of producing differentiated goods and consumers' acception of product variety, the explanatory power of the gravity model increases. However, the gravity model is not compatible with existing foreign trade theories. Tinbergen's model (1962) addresses factors associated with international trade. Bilateral trade volume ;

$$"T_{ijt} = ln\left(X_{ijt} + X_{jit}\right)"$$

(2.3)

X_{ijt}: represent the export of goods from country i to country j

X_{jit} : represent the export of goods from country j to country i in period t

Tinbergen's (1962) adaptation into international economic analysis is shown below:

$$X_{ij} = C\frac{Y_i^a Y_j^b}{D_{ij}^{\ d}} \tag{2.4}$$

X_{ij} : the trade flow from country i to country j

Y_i : the economic size of country i

Y_j : the economic size of country j

D_{ij}: physical distance between the countries

C: is the gravitational constant

a, b, and d: coefficients that measure the response of X_{ij} to changes in Y_i, Y_j, and D_{ij}, respectively.

Depending on the approach, in the literature, a and b values are + and d -. While the economic size of the country determines the export capacity of a country, the economic size of the importing country determines the export volume. Transportation costs are represented by the distance factor in the model. Increasing of transportation costs is positively associated with increasing of geographical distance between countries. Conversely, there is a negative correlation among volume and distance.

Pöyhönen (1963) is another pioneer of the gravity model besides Tinbergen (1962). He studied data of trades belonging 1958 from 10 different European countries. Depending on his findings Pöyhönen (1963) concluded that the main determinants of trade between countries were the exporting and importing volume of countries. Additionally, he stated that transportation costs are determined by the physical distance between the two countries.

Similarly, the amount of trade between countries is strongly associated with economic size of the countries and the geographical distance between them, notwithstanding the exporting and importing countries' trade policies. Findings from the Pöyhönen's (1963) study revealed that Regional Trade Agreements and cultural proximity between countries are significant determinants of trade volume, and their effects are positive.

Works of Tinbergen (1962) and Pöyhönen (1963) regarding the gravity model were maintained by Linnemann (1966). Mutual trade flows are determined, according to him, by the supply of the exporting country, the demand of the importing country, and the variables that may generate trade resistance. Linnemann (1966) is known for depicting the interaction of potential supply and demand for tradable goods as a model. In his model, he used population factor and the complementarity factor. In order to reveal whether or not two trading partners complement each other's product composition, the complementarity factor has a vital role. It is possible to apply complementarity as a representative variable of relative factor endowments. It is also possible to apply it as an indicator of future trade potential. Thus, when the integration of the Factor Endowment Theory with the Gravity model is taken into account Linneman's (1966) study is the prominent (Armstrong, 2007). In his equation, Linneman's (1966) formulated the complementarity index as shown below:

$$C_{ij} = \cos\ \alpha_{ij} = \frac{\mathrm{x_i m_j}}{|\mathrm{x_i}| \cdot |\ \mathrm{m_j}\ |}$$

(2.5)

x_i : stands for the total export of country i.

m_j :stands for the total import of country j.

α: measures the compatibility of the trade patterns of countries i and j with each other.

Different agents may stand out against to trade. Natural barriers like geographical distance between countries might be another. Linneman's (1966) formulated his own model, the Basic Gravity Model, in his study as shown below:

$$X_{ij} = \alpha_0 Y_i^{\beta} Y_j^{£} N_i^{\Omega} N_j^{¥} {D_{ij}}^{\mu} P^{\varepsilon}\mathrm{ij}$$

(2.6)

X_{ij}: the trade flow between country i and j.

Y_i and Y_j: the economic sizes of countries i and j respectively.

Ni and Nj: represent the population of countries i and j, respectively.

Dij: depicts the physical distance between two parties.

P_{ij} :depicts the preferential trade factor. Preferential trade factor means a set of policy practices that promote or resist trade.

β, £, Ω, ¥, μ, ε: parameters of the model.

Equation 2.6 posits that the potential demand of country j for the goods of country i is positively correlated with the national income level and population of country j; moreover, it is negatively correlated with the physical distance from country i. In another study with data belonging 1959 from 80 countries, Linnemann (1966) investigated the determinants of bilateral trade flows. Depending on the findings from this study he stated that trade flows can be extensively determined by economic size, population, physical distance and preferential trade factor. As a result, the Basic gravity Model approach posits that trade can be determined by three main factors (Paas, 2000, p. 635). First of this, Country's exports to world. The second one is Country's import from world. The last one is the factors that affect the trade for good or bad.

2.3.2. Dynamic Gravity Model

According to the gravity model, mutual trade flows are in equilibrium at each point in cycle. Moreover, this assumption is not true. Foreign trade between countries is not always in balance, and countries frequently have either a foreign trade deficit or a foreign trade surplus. Therefore, the gravity model should be developed dynamically to cover up this lagging feature of trade. Thus, zero trade balance assumption is discarded from the model. As a result, the equation of bilateral export flows is shaped as shown below (Kim et al., 2003):

$$\left(\ln X_{\mathrm{ijt}} - \ln X_{\mathrm{ijt-1}}\right) = \lambda\left(\ln X^{*}{}_{ijt} - \ln X_{\mathrm{ijt-1}}\right) + \eta_{\mathrm{ijt}} \qquad (2.7)$$

η_{ijt}: refers to the error term with zero mean and constant variance.

X^*_{ijt} : refers to the desirable equilibrium export level, which shows a zero-trade balance at any time t

X_{ijt}: refers to the actual export level

Bilateral exports of goods are formulated with the assumption that exports are in balance (X^*_{ijt}) as shown below:

$$\ln X_{ij} = \alpha + \beta \ln Y_i + \lambda \ln Y_j + \emptyset Z_{ij} \quad (2.8)$$

α : $-\ln Y_w$ (World real GDP)

Z_{ij} : a vector of time-invariant variables such as distance and border effects.

Y_j : denotes real GDP in importing country j.

Y_i : denotes real GDP in exporting country i.

After association of Eqn. 2.8 into Eqn. 2.7, Eqn. 2.7 can be reformulated as shown below:

$$\ln X_{ijt} = \alpha\lambda + (1-\lambda)\ln X_{ijt-1} + \beta\lambda \ln Y_{it} + \Upsilon\lambda \ln Y_{jt} + \Phi\lambda Z_{ij} + \eta_{ijt}$$

or

$$\ln X_{ijt} = \alpha^* + \lambda * \ln X_{ijt-1} + \beta * \ln Y_{it} + \Upsilon * \ln Y_{jt+}\Phi * Z_{ij} + \eta_{ijt} \quad (2.9)$$

This Eqn. presents **typical partial adjustment model;**

β^* and Υ^* refers to the short-term effects of income changes on bilateral exports

β and Y: refers to long-run income effects

λ: shows the adaptation rate parameter, and it takes a value between 0 and 1. The value of 1 for this coefficient (or λ^*=0) indicates a full adaptation.

Because world income is constant at any time t , shown as Y_w takes a part in the model as a constant term. The index w in Y_w stands for world. On the other hand, world income varies

over time, which impacts the share of a country in total income and bilateral trade flows, in time series or panel analysis.

Considering the gravity model, the rate of change of the variables considered may be slower or faster than that of the importing country. In accordance with these dynamics, the Dynamic gravity model has been developed. Therefore, integration of the changes in world income into the Dynamic Gravity Model depicted in Equation 2.9 is required. The modified version of the equation is shown in Equation 2.10 below (Kim et al., 2003;Akça, 2021):

$$\ln X_{ijt} = \alpha^{*}_{ij} + \lambda \ln X_{ijt-1} + \beta^{*} \ln Y_{it} + \mathrm{Y}^{*} \ln Y_{jt+} \Phi^{*} \ln Y_{wt} + \eta_{ijt}$$

(2.10)

As seen in Equation, the modified version of the Dynamic Gravity Model contains changes in world income. Similarly, this modified model formulated mutual trade flows. The Zij vector refers to the time-invariant variables in Equation 2.9. However, it is represented in the modified model shown in Equation 2.10 with country-specific individual effects.

2.3.3.Augmented-Gravity Model

Gravity model is successful to signalize dispersion of economic operations among targeted countries. That is why; the gravity model has been extensively utilized in modeling economic interactions. Gravity model presents opportunities to model international mutual effects between countries in resolvable way.

2.3.3.1.Tinbergen's Model

While generating the Basic Gravity Model, Tinbergen used two main variables, which were "economic size (GDP)" and "geographic distance". Afterwards, Tinbergen modified the model using dummy parameters besides these two main variables. In this regard, Tinbergen added dummy parameters into the model. After extending the model the equation is seen as shown below:

$$X_{ij} = \beta_0 (Y_i)^{\beta 1} (Y_j)^{\beta 2} (D_{ij})^{\beta 3} (CB_{ij})^{\beta 4} (CN_{ij})^{\beta 5} (BC_{ij})^{\beta 6}$$

(2.11)

X_{ij} refers to export flow from country i to country j.

Y refers to GDP, which represents the economic size of both countries.

D refers to the distance between the two countries.

CB is one of the dummy variables added into the model lately, and it refers to countries sharing the same border. In the case that targeted countries share the same border, the dummy variable takes a positive value. If it is not the case the dummy variable takes the value 0.

CN is another dummy variable added into the model lately, and it refers to the Commonwealth of Nations countries. In the case that targeted countries are parts of the Union, the dummy variable takes a positive value. If it is not the case the dummy variable takes the value 0.

BC is another and the last dummy variables added into the model lately, and it refers to the Benelux countries. In the case that targeted countries are Benelux countries, the dummy variable takes a positive value. If it is not the case the dummy variable takes the value 0.

As a result, Equation 2.11 posits being a member of the Commonwealth of Nations positively affects the trade between two member countries. On the other hand, sharing the same border with a member country or being a Benelux country does not raise the correlation coefficients significantly (Dinçer, 2014: 11).

As mentioned above, there are three main determinants of trade between countries in the original gravity model by Tinbergen which are export flow, GDP and distance. In this regard, Tinbergen (1962) run the model using data from 2 countries. Findings from the study reveal similar results to his earlier ones. It is stated that these parameters are not salient determinants of exports. That is, the effect of the economic size of the importing country on exports is lower than the effect of the economic size of the exporting country on exports. As a result, Tinbergen seeks a solution by expanding the model, and he applied the Gini coefficient as a new factor. While adding this new factor, Tinbergen presumes that the export capacities of countries that do not specialize in export goods and those that sell a large variety of goods abroad might be different. The expanded version of the Tinbergen's model is shown below.

$$X_{ij} = \beta_0 (Y_i)^{\beta 1} (Y_j)^{\beta 2} (D_{ij})^{\beta 3} (G_{ij})^{\beta 4}$$

(2.12)

Equation 2.12 posits that G refers to the Gini coefficient. In the case that the country exports a single good, the Gini coefficient earns the value 100. There is a negative correlation between heterogeneity of the exported goods and Gini coefficient. In other words, while one of them increases, the other decreases. Depending on his study, Tinbergen concluded that valuable results were obtained from the study concerning international trade flows; however, further and more detailed studies are required to get more decisive and clearer results, which can bring extensive and satisfactory explanations on the roles of "geographical location".

Pöyhönen was one of the pioneers investigating trade flows among countries applying the gravity model. Following Tinbergen, Pentti Pöyhönen (1963) extended the gravity model adding dummy variables. Because the gravity model has a weak theoretical infrastructure it has been massively criticized. Nevertheless, the gravity model has been frequently used by numerous economists. The reason behind this is the empirical success of the gravity model.

2.3.3.2.Linnemann's Model

Similar to Tinbergen and Pöyhönen, H. Linnemann was another economist contributing the development of the gravity model. Moreover, H. Linnemann was closely related to Tinbergen because he was the thesis advisor of him. H. Linnemann (1966) developed the original gravity model generated by Tinbergen applying some theoretical propositions. New variables have been added to the model. The first of these is the GNP share of the demand and the second is the population. Linnemann focused on the tendency towards trade and its indicators. Along with these measurements, he proposed a method such as the previously known Walrasian Equilibrium. On the other hand, even if this equation is used in the gravity model it is not simplified because of the great amount of determinants of the gravity model (Deardorff, 1995: 5).

The extended version of the Linnemann's gravity model is shown below as Equation 2.13 (Genç, 2011:82):

$$X_{ij} = \beta_0 (Y_i)^{\beta 1} (Y_j)^{\beta 2} (P_i)^{\beta 3} (P_j)^{\beta 4} (D_{ij})^{\beta 5}$$

(2.13)

Equation 2.13 posits that;

$(Y_i)^{\beta 1}$: refers to exporting country i's GNP.

$(Y_j)^{\beta 2}$: refers to importing country j's GNP.

$(P_i)^{\beta 3}$: refers to population of country i.

$(P_j)^{\beta 4}$: refers to population of country j.

$(D_{ij})^{\beta 5}$: refers to that i and j represent the distance between countries.

$\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$ and β_5 are the variables of the equation.

Some other researchers tried to contribute development of the theoretical basis of the gravity model. However, their works have not been successful enough to gain a proper theoretical framework. Thus, seeking a robust theoretical basis for the model still continue. Nevertheless, the gravity model is frequently preferred while studying foreign trade. Despite the model deficiency concerning theoretical basis, explanatory power makes it worthy.

2.3.3.3. Anderson - Van Wincoop's Model

Even if the model was used frequently until the 1980s, it was academically accepted following its theoretical explanation. Thanks to some academicians, particularly Anderson and Van Wincoop (2003), the gravity model has been widely accepted as a trade model in the foreign trade literature recently. They have changed the face of the model and opened a new way for it. They developed the model applying appropriate econometric definitions and adding new variables. In this regard, they extended the gravity model adding various dummy explanatory variables. This version is formulated as shown below in Equation (2.14):

$$X_{ij} = \beta_0 (Y_i)^{\beta 1} (Y_j)^{\beta 2} (D_{ij})^{\beta 3} (N_{ij})^{\beta 4} (LE_{ij})^{\beta 5} (CL_{ij})^{\beta 6} (CE_{ij})^{\beta 7} (CB_{ij})^{\beta 8} (TA_{ij})^{\beta 9} (CC_{ij})^{\beta 10}$$

(2.14)

Eqn 2.14 posits that;

N_{ij} : refers to GNP variable per capita representing purchasing power,

LE_{ij} : refers to Linder effect, which shows the difference in factor distribution between countries,

CL_{ij} : refers to common language,

CE_{ij} : refers to the impact of colonialism,

CB_{ij} : refers to common boundary,

TA_{ij} : refers to free trade agreements,

CC_{ij} : refers to the common currency.

$\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9$ and β_{10} are the variables of the equation.

As shown in Equation 2.14, the extended version of Anderson and Van Wincoop's (2003) gravity model has the same variables, the first two variables, with the basic model depicted in Equation 2.13.

Apart from the abovementioned types, there some other types of Gravity Model equations. In accordance with the requirements of the countries or the design of the studies, the Gravity Model has been modified. While modifying the model some variables have been included and some other excluded; however, the GDP, which refers to the economic size, and the distance between the targeted countries have been kept as constant. In the study, for instance, called "The Gravity Model and Global Trade Flows" by Hassan Kalbasi in 2007, the distance variable was applied into the gravity model in three different ways as car distance, sea distance, and the distance to the center. In another study with modified gravity model Limao and Venables (2006) took into account some other variables(Turhan, 2012: Tombak, 2010: Zarzoso and Ramos, 2005).

The Gravity Model led to change variables in the equation in accordance with various study design and the needs of the country or the area. This can be seen clearly in recent studies, which have added some variables in to the gravity model. In these studies, new variables, such

as membership of FDA or any economic integration have been used to investigate their impact on foreign trade. It is also possible to the extension of the gravity model adding some other variables regarding cultural and ethnic values. For instance, some studies added common language into the model as a symbol of cultural proximity to measure its effect on foreign trade.

2.3.3.4. A Brief of Augmented-Gravity Model

There is appropriate evidence to believe that the Basic Gravity Model is successful to explaining bilateral trade flows of foreign trade. On the other hand, today's trade structure is comprehensive and the Basic Gravity Model is not sufficient to explain it as a whole. Therefore, a clear need has been emerged for extension of the Basic Gravity Model adding some cultural, geographical and political variables. These extended versions of gravity model are named the Augmented Gravity Model (Değirmen, 2012, p. 54). Thus, the Gravity Model has been become easier to apply and more compatible with the general structure of the global economy. Moreover, the empirical and theoretical validity of the gravity model in analyzes of international trade has been strengthened (Westerlund & Wilhelmsson, 2011). The Augmented Gravity Model is shown below (Bergstrand, 1985):

$$X_{ij} = \beta_0 (Y_i)^{\beta 1} (Y_j)^{\beta 2} (D_{ij})^{\beta 3} (A_{ij})^{\beta 4} u_{ij}$$

(2.15)

"According to Equation 2.15, Xij refers to the flow of goods from country i to country j; Yi and Yj refers to the economic sizes of countries i and j (GDP), respectively; Dij refers to the physical distance between countries i and j; and Aij refers to all other factors that promote or impede the flow of trade between countries i and j." Augmented Gravity Model has four main variables to clarify mutual trade flows. The first of these is economic size. Second, there is the distance. Another variable is the border effect. Last variable is cultural and colonial ties. Beside these four main variables some other variables are used in the model. These variables are, for instance, common currency, FDA, and religion. Additionally, the gravity model led to add historical and non-economic variables.

2.4. Gravity Model and Logistics Performance Index

The beneficial aspect of companies' competitiveness is performance measurement techniques. Organizations need to know themselves, shape their organizational behaviour according to customers' demands, and make a healthy performance evaluation through

feedback. In this context, the "Logistics Performance Index" (LPI), which analyzes the current situation of countries on a global scale with the effect of globalization and creates a roadmap, was first published by the World Bank in 2007. The study report was updated by the World Bank in 2010, 2012, 2014, 2016, and 2018. Today, "The Aggregated LPI", which mainly combines 2012, 2014, 2016 and 2018, is published in the World Bank. This version provides a comparison of 167 countries. Each year's scores in each component were weighted.

The Logistics Performance Index is an interactive comparison tool created to help countries identify the challenges, opportunities and what they can do to improve their performance in trade logistics. LPI 2018 allowed a comparison between 160 countries. The LPI is based on a World Bank survey conducted by worldwide operators that provides feedback on the “logistics-friendly” principle of countries operating in commercial logistics. The institution aims to combine the in-depth information of the countries operating in logistics, the countries they trade with, the experiences of the global logistics environment and the characteristics of other countries with a qualitative assessment. Feedback from logistics service providers is also supported by quantitative data on the performance of critical components of the logistics chain in the country of operation. For this reason, it can be said that LPI consists of qualitative and quantitative methods and helps create logistics-friendly profiles for the countries in question.LPI also offers researchers, companies and countries two different perspectives, international and national, by measuring performance throughout the logistics chain within a country (The World Bank, 2019).

2.4.1. Logistics Performance Index Methodology

Published by the World Bank every two years, LPI evaluates the logistics performance of 167 countries. While LPI was measured with seven indicators in the first year it was published, it started with six indicators in the following years. The Logistics Performance Index for 2018 consists of a standard questionnaire consisting of two main sections, national and international. In 2018, 160 countries were evaluated in the international field and 100 countries in the national field of the report by logistics professionals. The 2018 report, unlike the previous ones, also provides new information about cyber security threats in logistics and the use of electronic commerce platforms by transporters (Logistics Performance Index And Its Indicators [LPI] 2018). The international dimension of the Logistics Performance Index examines the countries in question under six essential components (Ministry of Customs and Trade). These;

- Customs
- Infrastructures

• International Shipments

• Quality of Services

• Tracking and Monitoring

• On-Time Delivery

The six core components have been selected based on theoretical research and the experience of logistics professionals operating internationally. The Logistics Performance Index scores of the countries are determined by scoring these six basic components. The index calculated by taking the weighted average of these six indicators is scored as the lowest one and the highest five. The people to be surveyed for the index measured as a result of the survey made to 1000 senior executives are determined by the International Federation of Freight Forwarders Associations (FIATA), Global Express Association (GEA), and Global Transportation and Global Facilitation Partnership for Transportation and Trade (GFP).

The first part of the Logistics Performance Index survey includes international raw data. This section asks participants to evaluate their overseas trading partners according to six essential components. These trading partners are randomly selected based on the most important import and export markets of the countries where the survey participants are located (Ministry of Customs and Trade,2017). The International Logistics Performance Index provides an overall summary of the performance of logistics services by combining the six main components scored by the participants and collecting them in a single criterion. Survey questions are scored between (1) very low and (5) very high.

2.4.2. Indicators of The Logistics Performance Index

LPI includes more than 6000 evaluations made by logistics professionals (with 1000 international logistics agencies) to compare the logistics profiles of 160 countries and consists of six dimensions in total (Complete, 2014).

2.4.2.1.Infrastructure

Respondents were asked to evaluate the quality of trade and transport infrastructure (ports, roads, airports, railways, storage/loading facilities, telecommunications, and IT) in their country (Complete, 2014).

2.4.2.2.Efficiency of Customs

Within the scope of the component in which the effectiveness and efficiency of customs processes are evaluated; Many sub-dimensions such as the delivery and control of the import transaction, the delivery and control of the export transaction, the transparent provision of the

controls at the customs gates are discussed (Arvis et al., 2016). However, since customs are not the only institution involved in border management, supply chain performance is restricted by institutions located at the border other than customs. At this point, cooperation between all border management administrations (including standards, health, phytosanitary, transport, and veterinary institutions) and modern approaches that ensure legal compliance are critical.

2.4.2.3.International Shipping

Of the companies participating in the survey on international shipment; They were asked to evaluate the port fees in maritime transportation, the fees to be incurred in air transportation, railway transportation fees, storage and loading fees, and shipping agency fees with their sub-dimensions. With the integration of international competition and international trade, countries can improve their logistics performance. In addition, it is seen that the most crucial factor in reducing international trade costs in developing countries is trade research (Canbolat, 2016).

2.4.2.4.Quality of Logistics Services

Adequacy and quality of logistics services; road, railway, airway, maritime transport, storage and loading possibilities, customs administrations, trade and transportation institutions, customs brokers, transport agencies, standard and quality inspection institutions, senders and buyers are examined with sub-dimensions. The respondents were asked to evaluate the quality and adequacy of the services regarding the logistics service quality (Arvis et al., 2010).

The quality and adequacy of basic logistics services is valuable determinant of the country's logistics performance. Regarding the quality of logistics services, it received a low score in line with the railway infrastructure and rail transport (Köksal, Sezgin, & Mert, 2014). In addition, the operational load of supply chains generally applied to export transactions is lighter than that used to import transactions. For this reason, export transactions take a shorter time than import transactions, and the service provided is higher.

2.4.2.5.Tracking and Tracing

Thanks to the developments experienced today, there are significant developments in technology. These developments allow companies to monitor their shipments and easily control their movements within their supply chains. Smart systems, which are among the tracking and monitoring systems, are beneficial in tracking the product flow. While smart systems increase customer satisfaction, they also have cost-reducing effects for businesses; these smart systems provide an advantage in competition with other companies and effective fleet management (Canbolat, 2016). Within the scope of this component, the tracking and tracing of the shipments were evaluated by the users.

2.4.2.6.On-Time Delivery

The logistics performance index component is evaluated by the dimension of arriving at the destination on time for the shipments carried out. Within the scope of this component, pre-loading inspection, storage and loading, transshipment activities in maritime transport, exposure of the transported cargo to theft and informal wage demands are handled with sub-dimensions.

In order to achieve improvement in the on-time delivery component, the necessity of making innovations in customs clearance activities comes to the fore. In addition, it is emphasized that if unnecessary and bureaucratic procedures are eliminated, global trade is facilitated, and physical inspections are minimized, significant progress will be achieved in export and import times. According to the general data, export transactions are concluded in a shorter time than import transactions since minor track is applied in export transactions.

2.4.3.Logistics Performance Index Outlooks of Other Countries and Turkey

This section examines the 2018 LPI index, Aggregated LPI index, and Turkey's LPI index ranks by years.

Table 1: Top 10 countries of 2018 LPI Index Rankings

	overall LPI		Customs		Infrastructure		International shipments		Logistics quality and competence		Tracking and tracing		Timeliness	
Country	score	rank	score	rank	score	rank	score	rank	score	rank	score	rank	score	rank
Germany	4.20	1	4.09	1	4.37	1	3.86	4	4.31	1	4.24	2	4.39	3
Sweden	4.05	2	4.05	2	4.24	3	3.92	2	3.98	10	3.88	17	4.28	7
Belgium	4.04	3	3.66	14	3.98	14	3.99	1	4.13	2	4.05	9	4.41	1
Austria	4.03	4	3.71	12	4.18	5	3.88	3	4.08	6	4.09	7	4.25	12
Japan	4.03	5	3.99	3	4.25	2	3.59	14	4.09	4	4.05	10	4.25	10
Netherlands	4.02	6	3.92	5	4.21	4	3.68	11	4.09	5	4.02	11	4.25	11
Singapore	4.00	7	3.89	6	4.06	6	3.58	15	4.10	3	4.08	8	4.32	6
Denmark	3.99	8	3.92	4	3.96	17	3.53	19	4.01	9	4.18	3	4.41	2
United Kingdom	3.99	9	3.77	11	4.03	8	3.67	13	4.05	7	4.11	4	4.33	5
Finland	3.97	10	3.82	8	4.00	11	3.56	16	3.89	15	4.32	1	4.28	8

Source: World Bank, LPI 2018

According to the logistics performance index made in 2018, Germany ranked first among the logistics-friendly countries with a score of 4.20, while Afghanistan was the last country that is not logistics-friendly in 2018 data. When the LPI data of 2018 is evaluated, it is seen that the gap between the scores of the best-performing countries and the worst performing

countries has widened compared to 2016. From this point of view, it can be mentioned that the logistics infrastructure and investments of developed countries have increased due to globalization. In contrast, the deficiencies of the underdeveloped countries in their investment areas are still not realized. According to 2016 data, it is seen that there are fluctuations in the LPI scores of 10 developed countries, but there are still increases, and this is reflected in the LPI scores of 2018. The opposite is evident in the LPI scores of underdeveloped countries. When the 15 countries with the best performance in logistics are evaluated, it is observed that there are meager changes compared to both 2018, 2016 and 2014 reports. This situation can be explained by the fact that these countries have been dominant in the logistics sector on a global scale since the past and the economic stability in their countries is regular (Pınar,2020)

Regions in the last ten places in all logistics performance indices consist of low-income countries in Africa and the Middle East region. The mentioned countries are not able to bring themselves to the forefront in the commercial field as they consist of fragile economies affected by geographical disadvantages, natural disasters and political unrest within the country. While Turkey, which is among the upper and middle-income economies, is experiencing decreases in ranking and score, mainly due to its geography's economic and political imbalances, it is observed that China, Thailand, and South Africa lead this group. When we look at low and middle-income countries, essential economies such as India and Indonesia stand out as the best-performing countries in this group due to their proximity to major transportation hubs and sea transportation opportunities ([LPI] 2018).

In Aggregated LPI, weights are made according to years. The latest updated data weight is the highest. “Each year's scores in each component were given weights: 6.7 percent for 2012, 13.3 percent for 2014, 26.7 percent for 2016, and 53.3 percent for 2017”.

Table 2: Top 10 countries of LPI Aggregated Rankings

	overall LPI		Customs		Infrastructure		International shipments		Logistics quality and competence		Tracking and tracing		Timeliness	
Country	rank	score	rank	score	rank	score	rank	score	rank	score	rank	score	rank	score
Germany	1	4.19	1	4.09	1	4.38	4	3.83	1	4.26	1	4.22	1	4.4
Netherlands	2	4.07	3	3.97	2	4.23	6	3.76	2	4.12	7	4.08	6	4.3
Sweden	3	4.07	4	3.95	3	4.22	2	3.88	5	4.04	11	4.02	4	4.32
Belgium	4	4.05	13	3.74	10	4.03	1	3.97	3	4.1	4	4.11	2	4.4
Singapore	5	4.05	2	4	5	4.14	8	3.72	4	4.08	8	4.05	3	4.34
United Kingdom	6	4.01	8	3.85	7	4.09	10	3.69	7	4.04	5	4.1	5	4.32
Japan	7	3.99	5	3.91	4	4.19	14	3.61	8	4.03	9	4.03	9	4.24
Austria	8	3.99	14	3.71	8	4.07	5	3.78	6	4.04	2	4.13	11	4.22
Hong Kong, China	9	3.96	9	3.85	11	4.02	3	3.85	10	3.94	13	3.95	13	4.18
United States	10	3.92	11	3.76	6	4.1	23	3.54	11	3.93	3	4.13	16	4.14

Source: World Bank, Aggregated LPI 2021

In the Aggregated LPI, Germany ranks first, as in all other years, except 2012 and 2007 (Singapore first). In the last place is Somalia with a score of 2.

The scores and rankings of the six basic components that make up Turkey's logistics performance index covering all years are given in Table 3 below.

Table 3: Turkey's LPI Index by Years

		overall LPI		Customs		Infrastructure		International shipments		Logistics quality and competence		Tracking and tracing		Timeliness		Domestic Logistics Costs	
Year	Country	score	rank	score	rank	score	rank	score	rank	score	rank	score	rank	score	rank	Score	Rank
Aggregated (2012-2018)	Turkey	3.29	37	2.94	47	3.36	30	3.19	40	3.23	37	3.37	36	3.68	39	-	-
2018	Turkey	3.15	47	2.71	58	3.21	33	3.06	53	3.05	51	3.23	42	3.63	44	-	-
2016	Turkey	3.42	34	3.18	36	3.49	31	3.41	35	3.31	36	3.39	43	3.75	40	-	-
2014	Turkey	3.50	30	3.23	34	3.53	27	3.18	48	3.64	22	3.77	19	3.68	41	-	-
2012	Turkey	3.51	27	3.16	32	3.62	25	3.38	30	3.52	26	3.54	29	3.87	27		-
2010	Turkey	3.22	39	2.82	46	3.08	39	3.15	44	3.23	37	3.09	56	3.94	31	-	-
2007	Turkey	3.15	34	3.00	33	2.94	39	3.07	41	3.29	30	3.27	34	3.38	52	2.71	112

Source: World Bank, LPI

While Turkey ranked 34th with 3.42 in 2016, it dropped to 3.15 in 2018 and ranked 47th. It can be said that the reason for the regression in the last two years is primarily related to the customs processes, and then that the developed countries, which are higher in income than Turkey, can keep up with the innovations required by globalization more quickly and realize their logistics base investments on time. In addition, it can be easily mentioned that the political and economic negativities in the Middle East around Turkey negatively affect Turkey's logistics

performance (Pınar, Diken,2020). When the Aggregated LPI is analyzed, as a result of the weightings, Turkey ranks 37th among 167 countries with a score of 3.29.

2.5.Reckoning of Foreign Trade Potential

The trade potential between two countries should be considered while applying gravity model in international trade analysis. Therefore, numerous research studies have applied the gravity models to examine trade potential between targeted countries. 'Point Estimation Method' is one of the methods performed to examine trade potential. While using 'Point Estimation Method' first, coefficients captured from the estimation are enforced to independent variables. Later potential trade volume between targeted countries is estimated. In last step values are crosscheck with actual trade values.

It is possible to use two various approaches which produce the equal conclusion in the collation duration. While using the initial method, gap among potential-actual trade is estimated. A positive result from this calculation represents that potential trade > actual trade. A negative result from this calculation represents that the potential trade < actual trade. An equal result from this calculation represents that the actual trade = the potential trade. When it comes to another method, the ratio of between them is estimated. A result greater than 1 represents that actual trade is below potential trade. A result less than 1 represents that actual trade is above potential trade. A result equals 1 represents that actual trade = potential trade. Findings are helpful to draw short-term evidence. In order to obtain long-term conclusions, future trade values are required (Karagöz and Karagöz, 2009).

Some researchers generated a method similar to the Point Estimation Method. Their method is based on measuring the speed of convergence (Sandalcılar, 2012;Binh et al.,2011). Formulation of the method is shown below:

$$\text{Speed of convergence} = \frac{\text{Average growth rate of potential trade}}{\text{Average growth rate of actual trade}} \times 100 - 100 \tag{2.16}$$

According to the formula, if the ratio in the numerator is lower than the denominator, it converges to negative. This shows that there is potential for improvement. On the contrary, there is an amount above the normal trade potential. This model provides flexibility while using

the data in the analysis process, and it generates more consistent results. In his study, Sorhun (2013) investigated Turkey's foreign trade potential applying the Basic Gravity Model for the period 1995-2012. Depending on his findings he stated that Turkey's trade relations with other countries which Turkey trades most are lower than its potential. The region formed by the EU-15 countries has been the most lucrative region for Turkey's trade potential. On the other hand, although Turkey's import from these countries is greater than its potential, Turkey's exports to these countries are lower than its potential. The Middle East and Africa were the regions where Turkey's trade potential is realized least. Turkey's exports to Mediterranean countries and its imports from them were below its potential. It is similar for the Black Sea Economic Cooperation Organization member countries. Turkey's trade with the Central Asian countries was realized approximately 25% under its potential. According to Sorhun's (2013) findings the Turkey's export potential realized 62% and its import potential realized 70% in total. Egger (2002) has emphasized that a meticulous examination is necessary while comparing the results since the estimators' short- and long-term perspectives could be various. He has advised the usage of Hausman-Taylor's (1981) method. Because this model disposes of the systematical distinctions among actual-potential flows. Thus, minimizing the model determination errors more effective and consistent results might be obtained.

2.6. Review of empirical studies

2.6.1. Empirical Studies Examining Turkey's Case

Mehanna (2003) took part in the gravity model covering the years 1996-1999 in her study examining the trade volume between the Middle East countries and Turkey. In the study examining the commercial relationship between Turkey and partner countries, the effects of cultural and political variables are discussed. Corruption and political freedom were used as political variables in the model. On the other hand, the model includes the cultural variable as dummy variables that deal with language and religious affinities between countries. As a result of the study's estimation, while the political freedom variable did not significantly affect the trade flows, it was concluded that the trade between the Islamic countries was less than it should be.

In their research, Antonucci and Manzocchi (2005) examined the trade relationship between Turkey and the EU with the gravity model and conducted a study covering 1967-2001. The gravity model they created using the panel data model formed a series as the country's export of goods (import) / Turkey's GDP as the dependent variable. Country size, relative factor endowment, and distance as independent variables; EU membership, Customs Union, trade

agreement, and common border variables are included as dummy variables. Accordingly, firstly, the testability of Turkey's trade patterns with the gravity model was examined. Then the level of trade relations between Turkey and the EU was tested. According to the results, it has been examined that a gravity model can be created for Turkey in which the trade flows can be followed and whether there is a special relationship in the trade flows between Turkey and the EU, because it has been seen that the trade between the two parties is more than its potential. As a result, it was concluded that there is a notable commercial relationship between Turkey and the EU.

The work of Nowak-Lehmann et al. (2007), covering the years 1988-2002, has been a review on trade between Turkey and the EU. In this study, using the panel OLS with fixed effects method, the dependent variable is export, while the independent variables are GDP, GDP per capita, exchange rate, and transport costs. He examined Turkey's exports to the EU over industrial and agricultural products. By giving importance to monetary values in foreign trade between the two sides, they concluded that an increase in the actual value of the Turkish lira in terms of price competition would be an essential advantage for all sectors in Turkey's exports. They also concluded that Turkey, which has difficulties in the face of tariffs and tariff-like obstacles imposed by the EU, especially in the agricultural sector, will increase its exports in the agricultural sector by expanding the existing customs union agreement.

Genc et al. (2007), who examined the trade flows between the member countries of the Black Sea Economic Cooperation Organization (BSEC), analyzed the trade flows between the BSEC countries using the gravity model method using panel data based on fixed effects. The study concluded that the economic and population sizes of the countries having a common border and language affect the trade flows positively. In contrast, the distance between the member countries negatively affects trade flows.

Unlike other studies, Karagöz (2008), who did general research without considering a country or country group, examined Turkey's tourism potential in his research by using the gravity model. In the model, cross-section data of 2006 were used. While the model's dependent variable was the number of tourists coming to the country, the independent and dummy variables were expressed by the economic size of the countries (GDP), cultural and historical proximity, common border, and distance. As a result of the study's estimation, it was observed that GDP, cultural and historical proximity, distance, and common border variables positively affect the number of tourists coming to Turkey.

Kula and Aslan (2008) discussed Turkey's export volume with Middle Eastern countries (Egypt, Syria, Lebanon, Israel, Iran, Saudi Arabia, Jordan, Bahrain, Kuwait, UAE, Yemen, and Oman). The gravity model covering the years 1996-2005 was used in the study. While the study's dependent variable is Turkey's export values, the independent variables are the countries' GDP, the relative factor endowment between the importing country and Turkey, and the distance between the countries. The model has been estimated by the panel data method and the random effects method. As a result of the study's estimation, it was concluded that Turkey's exports to partner countries should be more.

Kayam and Hisarcıklılar (2009) estimated the factors that determine the direct investments from Turkey using the data between 1992 and 2005 with the gravity model and panel data method. Between 1992 and 2005, 11 countries, which constitute a significant part of the total investments, were examined. Investments from Turkey to foreign countries, GDPs, population and distance variables, as well as mutual trade, economic stability, productivity and similar factors were taken into account. As a result, it has been concluded that the direct investments from Turkey are market-oriented investments and the investors are turning to foreign investments as an alternative to the Turkish domestic market.

Bilici (2009) used the panel gravity model covering 1982-2008 to study Turkey's foreign trade. This study aimed to determine whether there is a break in the foreign trade flow after the Customs Union membership and determine the determinants of Turkey's foreign trade flow. Total trade, export, and import flows were examined one by one in the analysis. As a result of the estimation, it has been determined that the importance of EU countries in Turkey's foreign trade is very significant. However, it has been observed that after the Customs Union membership, its importance did not increase as expected and did not cause a significant break in trade flows.

Karagöz and Karagöz (2009) investigated Turkey's global trade potential. Distance as an explanatory variable, population, GNP and as dummy variable EU member, cultural and historical proximity, common border, economic cooperation, common religion were included in the model. As a result, it has been revealed that Turkey trades below its potential with 78 of the 169 countries in the sample. Chad, El Salvador, Nicaragua, Montenegro and Burma took the first five places among the countries with a trade volume below the potential and promising expansion in the trade flow. It has emerged that there is a trade flow above its potential with 91 other countries, and the Philippines, Spain, Poland, Ecuador and Costa Rica took first place among these countries.

Buzdagli and Kiziltan's (2011) study includes 62 countries with Turkish citizens and cross-section data for 2009. In practice, using the consumption goods export data, it was investigated whether the number of migration from Turkey to partner countries affects the export volume. In the estimation results of the study, it was concluded that the increase in the number of migration from Turkey to the partner countries increased the export of consumer goods.

In another study examining the relationship between foreign trade and migration, whether the amount of immigrants going from Turkey to other countries affects the trade volume between these countries and Turkey, and if there is an interaction, the subject was investigated by Karagöz (2011). In the research, the data of 2000-2005 for 24 countries where Turkish immigrants are settled were analyzed by panel data method and gravity model. In the study, the amount of bilateral trade (import and export) is used as a dependent variable, while the number of immigrants, the economic size of the partner country, the distance of the country and the population are used to explain the amount of bilateral trade. It has been revealed that there is positive and strong relationship between migration and trade in the case of Turkey.

Yaşar (2011) used a panel gravity model covering the years 1999-2009 in a study to measure Turkey's export volume to 20 EU member countries. The study analyzed whether the variables of distance and membership to the customs union affect Turkey's exports. In the estimation results, it was concluded that while the variable of being a member of the customs union had a significant effect on Turkey's exports to the partner countries, the impact of the distance variable had a lesser effect.

Tatlıcı and Kızıltan (2011) used the panel data method covering the years 1994-2007 in the study examining the export volume between Turkey and 46 partner countries to which Turkey exports the most, with the gravity model. While the countries' GDP is used as the dependent variable, the explanatory variables are; The population of the countries, the distances of the countries to the Turkish capital, the Customs Union, the common border, and Turkey's exports.Findings obtained from the estimation show that the national income variable positively affects Turkey's exports. However, the effects of population, common border and customs union agreement variables of Turkey and partner countries on Turkey's exports were not found significant.

Another study examining the effect of democracy on commercial relations tries to explain Turkey's export and import relations with democratic, partially democratic and non-democratic country groups in terms of mutual democracy levels to examine the gravity effect

of democracies between commercial ties. For this purpose, the panel gravity model was used based on data from 145 countries between 1996 and 2008. Democracy data, trade volume, GNP and distance variables between countries are used in the model. It has been concluded that the democratization process in Turkey will increase the export volume with democratic and developed countries much more than other countries (Altay,2011)

In a study examining the effects of bilateral and multilateral economic and commercial agreements, to which Turkey is a party, on Turkey's exports, it was investigated whether these agreements had an effect on Turkey's exports to 113 countries, and it was examined within the framework of the gravity model with the data between 1996-2006. In the model, in addition to the GNP and distance, the real exchange rate, the difference between the per capita income of two countries, the foreign exchange reserves, and the population variables are tried to be explained. As a result, the signed bilateral agreements did not have a statistically significant effect on Turkey's exports. Apart from the Customs Union Agreement, multilateral agreements to which Turkey is a party have a statistically significant positive effect on Turkey's exports (Özkaya, 2011).

Genç, Artan and Berber (2011) applied the Panel Data Method and gravity model by using 1997-2007 period data to reveal the determinants of trade flows in the Black Sea Economic Cooperation (BSEC) region. Population, GNP, common border, common language and distance variables were used in the study. According to the results, the GDPs and populations of the exporting and importing countries positively affect the trade flows in the region. However, the effect of the GDPs and populations of exporting countries on trade flows is greater. While the distance between the member countries affected the trade flows negatively, having a common border and speaking the same language positively affected the trade flows.

In a study that looks at foreign trade from the perspective of democracy, to measure the effect of democracy level on bilateral trade, the foreign trade and democracy relationship of 30 OECD and 16 MENA countries were tested with the 1997-2006 period data, gravity model and panel data analysis method. The model uses variables that do not change over time, such as the common border between countries, the common language, and the distance between countries. As a result, it was stated that democracy significantly affects bilateral trade between countries. (Kalaycı and Artan, 2012)

Ata (2012) examined the annual data for the 1980-2009 period by considering Turkey-All Countries-OECD-EU 27-Eurozone. Export, national income, population, distance, common border, common language, real exchange rate, colonial bond variables in the past have been

used. He used the Gravity model with the Panel Random Effects method. As a result of the study, it has been seen that distance and population have a negative effect on Turkey's exports. In contrast, national income and colonial ties in the past have a positive effect.

In a study examining the trade volume between Turkey and the BRIC countries, Turkey's trade with this group, which is among the growing markets likely to join the BRIC group, is analyzed. In this analysis, in which the panel gravity model was used, annual data of Turkey and four BRIC countries for 2001-2010 were used. While the GDP, population, and distance between the countries are insignificant, it has been determined that the import and export variables are significant and have an increasing effect on the trade volume. Unlike other studies, three different indices were used in the model, and how these indices affected the trade between Turkey and BRIC countries was also investigated. Among these indices, the Trade Dependency Index positively affects the trade volume; It was concluded that the Import Influence Index and the Export Tendency Index affected the trade volume negatively (Atabay Baytar, 2012).

Sandalcılar (2012b) used the panel data method and gravity model to estimate the determinants of agricultural product exports of the countries in the Black Sea Basin and analyze Turkey's agricultural product exports based on the goods group. In the study, annual data from 2004-2008 were used. Agricultural export data, GDP data, population data, geographical distance between countries, common language variables are included in the model. It has been determined that the GDP of the exporting and importing countries and the total population have a positive effect on exports, and the geographical distance between them has a negative impact. In addition, it was concluded that the use of a common language positively affected the export of agricultural products in the Black Sea Basin.

Another similar study in which the determinants of trade were estimated in Turkey's trade with BRIC countries was analyzed by Sandalcılar (2012a) using the panel gravity model. Turkey's foreign trade with BRIC countries, GDP, population and having a common border are positive; It has been determined that the geographical distance between countries affects negatively. As a result, Turkey's trade with Brazil, India and China is below its commercial potential; however, it is seen in the analyzes that a change in favor of Turkey started after 2006. In the trade with Russia, it has been revealed that Turkey has a foreign trade above its commercial potential. With this analysis, it has been determined that the commercial potentials of the countries are different from the real ones.

In a study examining the relationship between foreign trade and the customs union, the panel gravity model was used to reveal the effect of the 1996 Customs Union established between Turkey and the European Union on Turkey's foreign trade with the EU-15. GDP, population, distance, common religion, common language, common border and membership in a common economic union were used as dummy explanatory variables in the model estimated using annual data from 1980-2009. As a result, while the Customs Union had a significant effect on Turkey's imports, this effect was insignificant in Turkey's exports. (Aysun, Öksüzler and Yılgör, 2012).

In a study examining the relationship between foreign trade and migration from a different perspective, the effect of people immigrating from Turkey on intra-industry trade between Turkey and the country of immigration was examined. On the other hand, because labor migration may affect the foreign trade of different goods groups differently, the effects of migration flows on intra-industry trade are examined here, not the effects on total foreign trade. The study calculated the total, horizontal and vertical intra-industry trade indices between Turkey and 20 selected countries using the foreign trade figures for the 1980-2010 period. Then the extent to which these index values were affected by migration flows was tested econometrically. As a result, contrary to theoretical expectations, it has been revealed that migration flows in the case of Turkey lead to a decrease in intra-industry trade rates (Emirhan, 2014).

Most of the studies examining the effect of patent rights on foreign trade flows are made from the perspective of developed countries. However, Yaşgül (2015) stated that the most important pillar is the developing countries in his study. He analyzed the effect of strengthening patent rights in Turkey on the import of high-tech products by using the gravity model and panel data method. Twenty-five countries and nine main product groups were selected for analysis. Import data, GDP, population, distance, tariffs and patent rights variables are used in the model. As a result, the strengthening of patent rights increases imports both in terms of nine separate product groups and the sum of these product groups and causes market expansion.

Alper and Alper (2015) applied the gravity model on Turkey's exports of industrial goods to the EU in the study. 14 EU member countries to which Turkey exports the most were selected. Panel data analysis was used for the 2002-2012 period. In the created model, while the dependent variable is export, the independent variables are national income, distance, economic freedom index and population. As a result of the study, it has been found that the distance is positive, but the effect is minimal in Turkey's exports. It has been determined that

the countries' national income, the economic freedom in both Turkey and the importing countries, and the population of Turkey have a positive effect. However, the population of the country has no significant effect.

Doğan and Tunç (2016), in their study, examined Turkey's trade with Central Asian Countries with the help of the gravity model. Panel data analysis was used for the period 1995-2014. In the model created, trade volume was chosen as the dependent variable, and export, import, distance, GDP, population variables were selected as independent variables. The Commonwealth of Independent States (CIS) variable was also included as a dummy variable. It was determined that while the variables of GDP, import and export had a positive effect on the trade volume, the distance did not have a significant effect on the trade volume.

Çakır (2018) continued to work with Turkey-28 European Union (EU) countries annually in the 1996-2016 period. Export, national income, distance, population, customs union, seashore ownership variables were used. The Gravity model was integrated into the Panel Random Effects model and estimated. As a result, the increase in national income and the Customs Union have a positive effect on trade. It has been determined that it does not affect Turkey's exports because the population variable is meaningless. In the study, the effect of distance and coastal dummy variable, which is another explanatory variable, on trade was negative.

Şeker (2019) studied the annual period of 1996-2016 by including Turkey and D-8 countries in the analysis. Export, national income, distance, average customs tariff, exchange rate, colonial bond in the past, 2008 Global Crisis variables are used. Panel Data Analysis was chosen as the method. National income, colonial ties in the past, and tariffs on Turkey's exports to D-8 countries are positive; It has been determined that distance and exchange rates have negative effects.

Konak and Demir (2019) studied 1995-2017, using BRICS and Turkey. Export, national income, population, distance, trade freedom index variables were used. Estimation was made with stochastic boundary analysis, panel ordinary least squares and panel random effects (taking into account Driscoll and Kraay standard errors), and feasible generalized least squares methods.

Akçay and Saygılı (2019) included Turkey-EU, NAFTA, APEC, ASEAN, GCC and AEC in the analysis. The variables used in the study; exports, national income, distance, economic organizations, customs union and FTA (free trade agreements). The Panel Random

Effects model was used between 1996 and 2016. It has been observed that the distance has a negative effect on Turkey's exports. In contrast, the national income of Turkey and the national incomes of the union member countries to which Turkey exports and the economic organizations (except NAFTA and ASEAN) have a positive effect. It was also found that FTA and CU had positive effects on exports, but the impact of CU was greater.

Kotil (2019) worked with Turkey-European Union for 2002-2018 with annual data. Export, national income, distance, population, real exchange rate, citizenship bond variables are included in the analysis. As a result of the study, in which the panel random-effects model was used, it is seen that the countries' GDP, the real exchange rate index, and the citizenship bond variables have a positive effect on exports. Country populations and distance variables were found to be insignificant.

Akça and Bal (2020) analyzed Turkey and 30 countries between 2003 and 2018. The Panel Fixed Effects model was used in the study, in which the variables of export, national income, distance, membership of the world trade organization, and trade liberalization index were used. The increase in the economic size of Turkey and its trade partner countries affects exports positively. It has been found that the lengthening of the distance between the two parties, the fact that the trading partner country is a member of the World Trade Organization, and the increases in Turkey's degree of trade freedom decrease bilateral goods exports.

2.6.2.Empirical Studies Based on Logistics Performance

Wilson et al. (2003) found that facilitating trade in manufactured goods yielded $377 million in revenue to the regions under consideration. In addition, it is stated that exporters are more profitable than importers in large part of exports to OECD countries. Using the panel data method, the authors analyzed APEC countries from 1989-to 2000. While exports are the dependent variables in the study, GDP, GDP per capita, distance, NAFTA, ASEAN, LAIA membership, language (English, Spanish, Chinese), common border, tariff, port efficiency, customs environment, regulatory environment, e-business are independent variables.

Dennis (2006), on the other hand, considers the commercial costs (technical transactions in the trade process), which are invisible items in commercial transactions and increase in parallel with the duration of the commercial transaction, as commercial conveniences. According to this study, in parallel with the findings obtained with the LPI index, there is a positive relationship between trade facilitation and trade volume, and higher coefficients were obtained for exporters.

Hoekman and Nicita (2008) state that administrative and regulatory policies are as effective as trade policies. Using the gravity model in their study, the researchers measured the impact on trade of border restrictions, differences in trade costs and policies regulating the trade flow of goods. According to this; Domestic trade costs, economic environment and trade policies are important determinants of trade volume between countries. The effect of customs tariff preferences on trade volume is statistically significant. The study states that focusing on policies that contribute to the trade and logistics facilitation indices has a greater impact than activities to reduce business transaction costs.

Behar and Manners (2008) state that the logistics of neighboring countries are essential in bilateral trade and that good logistics reduces but does not eliminate the distance disadvantage between countries. They modeled the relationship between exports and logistics with the Gravity equation using the IMF's Trade Statistics Directive for the period 2001-2005, using the distance data provided by the French institute CEPII, which conducts research in the field of exports, GDP, international economics, and six subcomponents of LPI.Their studies state that apart from air transportation, landlocked countries need the logistics of neighboring countries to send their goods overseas. In support of this result, it is noted that border country logistics is not essential for countries other than landlocked countries. In addition, the researchers found that one standard deviation improvement in logistics quality would increase a country's exports by 59%.

Iwanow and Kirkpatrick (2009) have seen that the export performance of manufactured goods in Africa improves when policies at the border and behind the border are improved. In the study, which included 78 countries using the panel data method, the analysis period was 2000-2004. While the dependent variable is exports, independents are GDP, GDP per capita, population, distance, remoteness, tariff, common language, colony (past/present), common border, FTA membership, trade facilitation, quality of regulation, and infrastructure.They have obtained the result that it provides a higher return when compared to other countries. In addition, the researchers state that there is a need for reforms related to the quality of the regulatory environment, basic transportation and communication infrastructure, as well as commercial conveniences.

On the other hand, Hollweg and Wong (2009) found a negative relationship between the restrictions in logistics regulations and the logistics performance measured by the LPI index and its subcomponents. Based on the results, it is stated that a less restrictive commercial environment will provide better logistics sector performance.

Korinek and Sourdin (2011) examined the role of logistics in increasing international trade and the extent to which low-quality logistics is an obstacle to trade and found that high-quality commercial logistics increases bilateral trade by addressing maritime and air transport. The authors determined imports as the dependent variable. Independent variables are landlocked - importer, landlocked - exporter, border, common language, colony, border admin - importer, and border admin – exporter. On the other hand, they stated that improved commercial logistics is more critical for goods transported by air than goods transported by sea. They found that improvements in airport infrastructure particularly benefit middle-income countries more than low- and high-income countries. Other findings are that the quality of commercial logistics affects exports more than imports, that all of the LPI sub-indexes are effective on trade, and that the developments in infrastructure are important for exporters. According to the results obtained from the analyzes made according to the development levels of the countries, customs, tracking-tracing and logistics quality-competence have similar effects on all country groups. The group of countries that benefit most from the improvements in logistics infrastructure are middle-income countries.

On the other hand, Felipe and Kumar (2012) examined the sub-indices of commercial conveniences. They stated that infrastructure for exporters and customs for importers were the most important variables affecting the trade flow. In addition, they determined that significant gains will be achieved in trade with the improvement in commercial facilities. When all Central Asian countries are considered, an improvement in the LPI index provides a gain of 44%. When analyzed based on countries, it is seen that this rate varies between 28% as in Azerbaijan and 63% as in Tajikistan. The increase in exports is greater than in imports. When the sub-indices of the LPI index are examined, it has been determined that the most influential variable on total trade is infrastructure, followed by logistics quality and adequacy and customs.

According to Guner and Coşkun's (2012) results, the relationship between political risk variables and sub-components and LPI is positive and the level of significance is high. It is stated that the most exciting result is the positive and significant relationship between customs performance, government efficiency and corruption control. LPI and customs, infrastructure and logistics are positive and significant in the relationship between its sub-components of quality and competence and the human development index and its sub-components. Accordingly, logistics services are carried out smoothly and duly in the countries covered as institutional indicators improve.

Marti, Puertas and Garcia (2014) aimed to determine the effects of logistics performance index sub-components on the trade of developing countries in their study. The authors determined exports as the dependent variable. The independent variables are GDP, population, LPI, border, language and colonial relationship.They tried to determine the possible changes in the logistics sectors of the countries by comparing the data obtained in 2007 with the data obtained in 2012 by the developing countries in the five regions (Africa, South America, Far East, Middle East, and Eastern Europe) that they determined in the study. The gravity model was used in the analysis of the study. According to the findings obtained as a result of the analysis, it was determined that the development in any of the components of the logistics performance index led to significant growth in the trade flow of the countries.

In their study, Puertas et al. (2014) analyze the importance of the logistics performance of union member exporters to determine the possible advantages of EU membership. They state that commercial convenience is the second variable that affects the international trade volume of exporting countries. These results do not change both when the whole index is taken and evaluated based on sub-components. When the results of the LPI index are examined in detail, it is seen that the coefficients of exporters are higher than those of importers. Of the sub-components, customs, infrastructure and logistics quality and competence are the variables with the highest coefficients, respectively. For 2010, it is seen that logistics quality and competence, infrastructure, customs and tracking and monitoring came to the fore again for exporters. In the study conducted for 26 EU countries, it was concluded that logistics are more critical for exporters than importers. In recent years, it has been seen that logistics quality-competence and tracing-tracking have gained importance.

Marti et al. (2014a) and Marti et al. (2014b), in their study of developing countries with a coastline, concluded that commercial facilities increase the international trade volume of countries, more for exporters. Unlike other studies, Marti et al. (2014b) divided the tradable goods into five groups according to the degree of difficulty in logistics processes. They stated that the LPI index became more critical for goods whose logistics process is more complex, in other words, for goods that are more difficult to trade. In less developed countries such as the former Soviet Union countries, it is stated that the increase in commercial facilities for the majority of goods groups does not affect the trade volume or affects it at a low rate. This approach is interpreted as the institutional measures to improve logistics processes that do not exist in practice. Marti et al. (2014b), when logistics sub-components are evaluated separately, it is stated that infrastructure, timing, and customs variables are the most important variables

according to the results obtained from all countries. Considering the geographical region, it is stated that customs come to the fore in some regions, and infrastructure is an important sub-index only in Africa. In short, it is noted that each sub-components alone is not sufficient to explain the role of logistics in exports. Depending on the importance of the logistics performance of different sub-components, they gain importance in other regions.

In another study using the Augmented gravity model technically, LPI was used as a measurement. The authors of the study, Bensassi et al., aimed to investigate Spain's domestic and foreign trade. The study also examined the interaction between logistics and trade. They used data on bilateral exports from 19 Spanish regions. They found that logistics is significant for the analysis of international trade flows (Bensassi et al.,2015)

Wang and Choi (2018) aimed to determine the effect of logistics performance on foreign trade volume. The study used data from 43 countries published by the World Bank in 2010, 2012 and 2014. The gravity model was determined as the analysis method. As a result of the analysis, it was concluded that logistics performance affects exports more, and it is stated that this situation is more effective in developing countries.

According to Ofluoğlu et al. (2018), it analyzes the Effects of EU and MENA Countries Sample Sub-Components on Exports between 2007-2014 using the gravity model. As a result of the study, according to the logistics performance index scores of the countries, it has been concluded that the bilateral commercial activities between the countries positively affect.

Bugarcic, Skvarciany and Stanisic (2020) used the gravity model in their study to determine the effect of logistics performance on foreign trade volume. The countries in Central and Eastern Europe and the countries in the Western Balkans were chosen as the country groups subject to the study. As a result of the analysis, it has been determined that logistics positively affect bilateral trade. The logistics performance and services improvements have increased trade volume and reduced costs.

Reis, Amorim, Cabral and Toloi (2020) tried to determine the effect of logistics performance on soybean exports of Brazil, Argentina and the USA between 2012 and 2018. It is stated that the logistics performance index data published by the World Bank is used as a logistics performance indicator. The analysis method used in the study is the gravity model. As a result of the analysis, it was determined that there is a positive relationship between soybean export and logistics performance.

Zaninovic and Skender (2020) examined the effect of logistics performance in the bilateral trade of EU countries with the gravity model and Poisson-pseudo (PPML) method. They revealed that the differences in LPI values have a heterogeneous effect on bilateral trade.

3.Empirical Analysis

3.1.Introduction

In this part of the study, the trade flow, import, export, and logistics performance index relationship between Turkey and 37 OECD countries were analyzed from 2007 through 2020. The Huber, Eicker, and White estimator, which is robust against autocorrelation, cross-sectional dependence, and heteroskedasticity, was used in the analysis. All variables are converted to logarithmic form. Three different models have been established to investigate the effect of the logistics performance index on Turkey's foreign trade volume, imports, and exports with OECD countries.

Model 1:

$$\begin{aligned}\mathrm{LTRADE_{ijt}} = \beta_0 + \beta_1\mathrm{LGDP_{it}} + \beta_2\mathrm{LGDP_{jt}} + \beta_3\mathrm{LARGE_{it}} + \beta_4\mathrm{LARGE_{jt}} + \beta_5\mathrm{LPOP_{it}} \\ +\beta_6\mathrm{LPOP_{jt}} + \beta_7\mathrm{LLPI_{it}} + \beta_8\mathrm{LLPI_{jt}} + +\beta_9\mathrm{LDIST_{ijt}} + \mathcal{E}_{\mathrm{it}}\end{aligned}$$

Model 2:

$$\begin{aligned}\mathrm{LEXPORT_{ijt}} = \beta_0 + \beta_1\mathrm{LGDP_{it}} + \beta_2\mathrm{LGDP_{jt}} + \beta_3\mathrm{LARGE_{it}} + \beta_4\mathrm{LARGE_{jt}} + \beta_5\mathrm{LPOP_{it}} \\ +\beta_6\mathrm{LPOP_{jt}} + \beta_7\mathrm{LLPI_{it}} + \beta_8\mathrm{LLPI_{jt}} + +\beta_9\mathrm{LDIST_{ijt}} + \mathcal{E}_{\mathrm{it}}\end{aligned}$$

Model 3:

$$\begin{aligned}\mathrm{LIMPORT_{ijt}} = \beta_0 + \beta_1\mathrm{LGDP_{it}} + \beta_2\mathrm{LGDP_{jt}} + \beta_3\mathrm{LARGE_{it}} + \beta_4\mathrm{LARGE_{jt}} + \beta_5\mathrm{LPOP_{it}} \\ +\beta_6\mathrm{LPOP_{jt}} + \beta_7\mathrm{LLPI_{it}} + \beta_8\mathrm{LLPI_{jt}} + +\beta_9\mathrm{LDIST_{ijt}} + \mathcal{E}_{\mathrm{it}}\end{aligned}$$

3.2. Data Presentation

The definitions of the variables used in the models and the source of the data are given in Table 4.

Table 4: Definitions and Sources of Variables

Variable	Definition	Source
$LTRADE_{ijt}$	Foreign Trade Volume (export+import)	IMF eLibrary Data Direction of Trade Statistics
$LEXPORT_{iit}$	It shows the exports of Turkey (i) to the OECD trading partner (j) at time t.	IMF eLibrary Data Direction of Trade Statistics
$LIMPORT_{iit}$	It shows Turkey's imports from (i) OECD trading partner (j) at time t.	IMF eLibrary Data Direction of Trade Statistics
$LGDP_{it}$	GDP per capita of Country i (constant 2015 US$)	Word Bank (WDI)
$LGDP_{jt}$	GDP per capita of Country j (constant 2015 US$)	Word Bank (WDI)
$LARGE_{it}$	R&D Expenditures Made in i Country (% of GDP)	Word Bank (WDI)
$LARGE_{jt}$	R&D Expenditures Made in j Country (% of GDP)	Word Bank (WDI)
$LPOP_{it}$	Total Population of Country i	Word Bank (WDI)
$LPOP_{jt}$	Total Population of Country j	Word Bank (WDI)
$LLPI_{it}$	Overall Logistics Performance Index of Country i	Word Bank (WDI)
$LLPI_{jt}$	Overall Logistics Performance Index of Country j	Word Bank (WDI)
$LDIST_{ijt}$	Distance Between Capitals of Countries i and j (km)	https://www.distancefromto.net/

$LTRADE_{ijt}$ variable, which shows the foreign trade volume between Turkey and OECD countries used in the model, is included as a dependent variable in the model. In addition, $LEXPORT_{ijt}$ and $LIMPORT_{ijt}$, which show Turkey's exports to OECD countries and imports from OECD countries, respectively, are added as dependent variables in different models separately and examined. Independent variables; $LGDP_{it}$, $LGDP_{jt}$, $LARGE_{it}$, $LARGE_{jt}$, $LPOP_{it}$, LPOP_jt, $LLPI_{it}$, $LLPI_{jt}$, $LDIST_{ijt}$ respectively express; the real GDP per capita of exporting country i, real GDP per capita of importing country j, the percentage of R&D expenditures in-country in GDP, the percentage of R&D expenditures in country-j in GDP, the total population of country i, the total population of country j, the overall logistic performance index score of country i, the overall logistic performance index score of country j, the distance between the capitals of countries i and j in km.

3.3.Methodology

3.3.1.Panel Data Analysis

Three data analysis methods are used in econometric analysis. These are time series, cross-section, and panel data methods, which combine time and cross-section data (Gujarati, 2004: 25). Panel data analysis consists of bringing together the groups that are the subject of the analysis within a specific time period. The panel regression method is generally used in the panel gravity model, in which the determinants of trade flows are analyzed.

Mathematical representation of panel data analysis is;

$$Y_{it} = \alpha + X'_{it}\beta + u_{it} \tag{3.1}$$

i: represents cross-section.

t: represents time series.

α: represents the amount of data.

N: economic units.

T: observations belong to each economic unit in the model.

u_{it} : idiosyncratic error or time-varying error and represents unobserved factors that change over time and effect Y_{it}.

There are several advantages and disadvantages to using panel data analysis. Hsiao (2003) and Klevmarken (1989) list several benefits of using panel data (Baltagi, 2005: 1-9):

- Panel data acts as a check for individual heterogeneity. Panel data show that individuals, firms, states, or countries are heterogeneous. Contrary to panel data, time series and cross-section data can give risky results because they cannot control this heterogeneity.
- While the problem of multicollinearity usually arises in time-series data, panel data are more informative data, such as less simultaneity between variables and more degrees of freedom.
- Using panel data analysis in dynamically adjusted models provides more accurate results. If the time dimension of the panel data is desired, it may be easier to explain concepts such as unemployment and poverty. Therefore, panel data analysis is

also necessary to predict intertemporal relationships, life cycle, and intergenerational models.

- Panel data can identify and measure effects that are not easily detectable from cross-section or time-series data.
- Panel data models allow more complex models to be created and tested than other economic models.

Although the panel data method is more advantageous than the cross-section data and time-series data, there are some disadvantages of using the panel data method. The most crucial problem here is the data collection and panel creation process. The cross-section dependence in data with a short time dimension is the most important indicator of this problem.

3.3.2.Panel Data Regression Methods

The pooled OLS, fixed effects and random effects model will be discussed in this section.

3.3.2.1.Pooled Least Squares Model

The Pooled OLS Model is a method that can be used when the observations in the series are homogeneous. The mathematical representation and assumptions of classic panel data model are shown below.

$$Y_{it} = \beta_{0it} + \sum_{k=1}^{K} \beta_{kit} X_{kit} + u_{it} \qquad (3.2)$$

β_{0it}: constant term.

β_{kit} : Kx1 dimensional vector of parameters.

X_{kit} : returns the value of the kth explanatory variable for the ith unit at time t.

Y_{it} : shows the value of the dependent variable for the ith unit at time t.

β contains the constant and slope parameters. Here, the sub-indexes i; households, individuals, firms, cities, etc., and t indicates time such as day, month, year. In other words, i is the cross-section dimension; t represents the time dimension. The pooled least squares estimator for β can be calculated as follows.

$$\hat{\beta} = \left(\sum_{i=1}^{N} \sum_{t=1}^{T} X'_{it} X_{it} \right)^{-1} \left(\sum_{i=1}^{N} \sum_{t=1}^{T} X'_{it} Y_{it} \right)$$

(3.3)

When equation (3.2) is examined, it is striking that the slope coefficients are constant in terms of both time and cross-section. This regression analysis method begins with a series of data points to plot on the x- and y-axis graph. The regression analysis shows the dependent variables on the vertical y-axis and the independent variables on the horizontal x-axis. Due to the high margin of error in heterogeneous data, fixed-effects or random-effects models are generally used instead of the OLS method (Stock and Watson, 2006: 349-382).

3.3.2.2.Fixed Effects Model

The fixed ethics model contains the heterogeneity feature in the series and creates a different fixed-term for each section. In other words, the fixed effects model states that the slope coefficients (β) do not change, but the constant terms vary for each cross-sectional unit. If the differentiation occurs only in the time dimension, these models are called one-way fixed effects, and if the differentiation consists of both the time dimension and the cross-section dimension, these models are called the two-way fixed effects model. In the fixed-effects model, instead of adding a dummy variable to get rid of the problems or reduce the effect, the cross-section effect of the fixed term is eliminated by purging the model from the time environment (Özer and Çiftçi, 2009: 219-240). The coefficients of fixed effect models vary according to unit, time or unit and time. Models established to determine change by units or time are called 'One-Way Fixed Effects Models'. The models established to determine the change according to the common effects of units and time are called 'Two Way Fixed Effect Model' (Tatoğlu, 2013: 80).

Unit Dimension Fixed Effects Model: In this model, only unit effects are possible on the constant term.

$$\mathrm{Y_{it}} = \beta_{0\mathrm{i}} + \sum_{k=1}^{k} \beta_{\mathrm{k}} \mathrm{X_{kit}} + \mathrm{e_{it}}$$

(3.4)

Time Dimensional Fixed Effects Model: In this model, there are time effects on the constant term.

$$Y_{it} = \beta_{0t} + \sum_{k=1}^{k} \beta_k X_{kit} + e_{it} \quad (3.5)$$

Unit and Time Dimensional Fixed Effects Model: This model allows to see both time effects and unit effects on the constant term.

$$Y_{it} = \beta_{0it} + \sum_{k=1}^{K} \beta_k X_{kit} + e_{it} \quad (3.6)$$

The difference between the equation with the panel OLS is that it allows constant term coefficient changes. However, this change in the constant term is limited, that is, the constant term does not change with time. It is not enough to use a dummy variable to eliminate the inconsistency of the estimations in the fixed-effects model. Because the dummy variable used gives incomplete information in the estimation of the model. In this case, it is recommended to use the random-effects model.

3.3.2.3.Random Effects Model

It is possible to model if the individual effects are not entirely correlated with the explanatory variables if the constant terms are randomly distributed across the cross-sectional units (Greene, 2013: 371). If the effects are treated as a random variable, such as the error term, there are random effects (Tatoğlu, 2016: 79). The random effects (RE) model assumes that the explanatory variables and the error term are unrelated (Çeştepe and Tatar, 2018: 116).

Suppose there is no correlation between the independent variable and the cross-terms in the fixed effects and first differences estimation method. In that case, it seems reasonable to apply the pooled least squares method. However, the error term of pooled least squares contains both cross-term and residual error elements. Since the predictions of these two error items are not separated from each other, the efficiency is lost. The random-effects model distinguishes two elements from each other. In addition, time constant variables can be added to the model

in the random-effects model (Tatoğlu, 2016: 102). In panel data, it is more appropriate to use the fixed effects model if there is a relationship between the constant term (β_0) and the explanatory variables (X_{it}), and if there is no relationship, it is more appropriate to use the random effects model.The random-effects model and its basic assumptions are as follows (Greene, 2012: 371):

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \cdots \ldots + \beta_k X_{kit} + v_{it} \quad i= 1,2, \ldots., N \; t=1,2,\ldots.,T$$

$$v_{it} = \mu_i + u_{it} \tag{3.7}$$

v_{it} : error term in the random effects model.

u_{it}: residual errors.

μ_{it} : the unit effect which remains constant in terms of time path.

The error term expressed as v_{it} in the model consists of two components. u_{it} denotes the error term, μ_{it} denotes the differences between cross-terms and the variation between units over time. The basic assumptions of the random effects model are:

$E[u_{it}\mu_j|x]=0$ uncorrelated with each other (for all i, t, and j)

$E[u_{it}|x]=E[\mu_i|x]=0$. Their mean is zero

$E[u_{it}^2|x]= \sigma_u^2$ The variances of ε_{it} are fixed

$E[\mu_{it}^2|x]= \sigma_\mu^2$ The variances of μ_{it} are fixed

$E[u_{it}u_{js} \mid x] = 0$ $\quad t \neq s$ and $i \neq j$

$E[\mu_i\mu_j \mid x] = 0$ $\quad i \neq j$

$E[v_{it}^2 \mid x] = \sigma_u^2 + \sigma_\mu^2$

$E[v_{it}v_{is} \mid x] = \sigma_v^2 t \neq s$

$E[u_{it}u_{js}|x]=0$ For all t and s, if $i \neq j$

3.3.2.4.Comparison of Fixed Effects Model and Random Effects Model

- While estimating the model, if it is desired to make inferences for a specific unit, using the fixed effects model will be advantageous if the data set consists of observations of a large population. If inferences are made for the whole population, it will be advantageous to use the random-effects model.

- If there is a relationship between the independent variables and μ_i, the fixed-effects model is consistent, if there is no relationship between the independent variables and μ_i, the estimators of both models are consistent, but the random-effects model is more efficient.
- Time constant variables cannot be estimated using the fixed effects model. If these variables are used in the model, it is necessary to prefer the random-effects model (Tatoğlu, 2016: 167).
- If α_i correlates with the explanatory variables, the fixed effects model will be consistent and efficient, while the random effects model estimator will be inconsistent.
- The Hausman test tests whether α_i or ε_i is related to independent variables when choosing between the fixed effects model or the random-effects model. If α_i is related to independent variables, the fixed effects model is consistent while the random effects model is inconsistent.
- If the time dimension (T) is larger than the slice dimension (N) in the panel data studied, there will be a slight difference between the two estimators.
- With the addition of dummy variables to the fixed effects model, the increase in the number of estimators due to the increase in the number of sections estimates regression parameters complex by decreasing the degrees of freedom. However, in the random-effects model, the loss of degrees of freedom disappears and allows the inclusion of effects outside the sample in the model (Özer and Çiftçi, 2009: 42).
- In the panel data set, when the time dimension (N) is smaller than the cross-section size (N), the estimators obtained where the random-effects model is valid are more effective than the fixed effects model.
- While the random effects model also considers the factors that do not change with time, these factors cannot be observed directly in the fixed effects model (Tarı, 2014: 492-493).

3.3.3.Appropriate Model in Panel Data Models

In general, if it is thought that there are no cross-section or time effects in the observations, that is, the pooled model under the assumption that the observations are homogeneous, it can be said that it is more reasonable to use the fixed or random-effects models. Which of the three models to use can be made a priori as mentioned above, or this determination can be made due to several tests. The tests that are considered necessary among these tests and used in the econometric analysis will be examined here (Tatoğlu, 2018: 165-168).

3.3.3.1.Hausman Test

In this test developed by Hausman(1978), when choosing between fixed effects and random effects, it is checked whether there is a correlation between cross-section effect (μi) and Xit. While the null hypothesis represents no relationship between explanatory variables and cross-section effects, that is, the random-effects model, the alternative hypothesis represents a relationship between explanatory variables and cross-section effects, the fixed-effects model. The hypotheses of the Hausman test (Hausman and Taylor, 1981: 1383);

$$H_0: E\left(\frac{\epsilon_{it}}{X_{it}}\right) = 0 \ \ (Random\ Effect\ Panel\ Data\ Model)$$
$$H_1: E\left(\frac{\epsilon_{it}}{X_{it}}\right) \neq 0\ (Fixed\ Effect\ Panel\ Data\ Model)$$

(3.8)

While calculating the Hausman test statistic, the variance-covariance matrices of the OLS estimator and the within-group estimator are used. The Hausman test tests the equality of this difference to zero. If the difference between parameters is not systematic, using the random-effects model is more appropriate. If the difference between the variance-covariance matrices of the OLS estimator and the within-group estimator is large, if the difference between the parameters is systematic, the fixed effects model is valid (Tatoğlu, 2018: 184-192).

The test statistic is shown as (Hausman, 1978: 1263);

$$\hat{q} = \left(\widehat{\beta_{SE}} - \widehat{\beta_{RE}}\right) \qquad VAR(\hat{q}) = VAR\left(\widehat{\beta_{SE}}\right) - VAR\left(\widehat{\beta_{RE}}\right)$$

$$m = \widehat{q'}\widehat{M}\left(\widehat{q^{-1}}\right)\hat{q} \qquad \widehat{M}(\hat{q}) = (X'Q_eX)^{-1} * \left(X'\widehat{\Omega^{-1}}X\right)^{-1}$$

(3.9)

3.3.3.2.Breusch Pagan LM Test

Breusch-Pagan (1980) developed the Lagrange Product (LM) test to test the suitability of the pooled least squares model against the random-effects model. In this test, the hypothesis that the variance of the random unit effects is zero ($H0$:$\sigma\mu 2$=0) is tested (Tatoğlu, 2018: 178).

LM statistic;

$$LM = \frac{NT}{2(T-1)}\left[\frac{\sum_{i=1}^{N}\left(\sum_{i=1}^{N}\left(\sum_{t=1}^{T} u_{it}\right)^2\right.}{\sum_{i=1}^{N}\sum_{t=1}^{T} u_{it}^2} - 1\right]^2$$

(3.10)

is displayed as above. As a result of comparing the LM test statistic with the $\chi 2$ table, if the null hypothesis is rejected, a random-effects model should be used instead of the pooled least squares test so that the estimation results can be more consistent.

3.3.3.3.F test

The F test compares the fixed-effects model and the pooled model. In this test, the null hypothesis states that there is no difference between the sum of the residual squares of the models, and the alternative hypothesis states that there is a difference between the sum of the residual squares of the models. The residual squares of the pooled model show the residual squares of the constrained model, and the residual squares of the fixed-effect model indicate the residual squares of the unconstrained model (Tatoğlu, 2018: 168-172).

F statistic;

$$F = (SSE_R - SSE_U)\frac{SSE_R - SSE_U}{SSE_U} \cdot \frac{NT - (K-1)}{q} \tag{3.11}$$

is displayed as above. If the F test statistic is greater than the F table value, the null hypothesis is rejected, concluding that the fixed effects model is appropriate.

3.3.4.Huber, Eicker and White Estimator

The Huber, Eicker, and White Estimator is one of the resistant estimators in the presence of heteroscedasticity, autocorrelation, and cross-sectional dependence. The first studies for robust standard errors were made by Huber (1967), Eicker (1967), and White (1980). In the case of independent distribution of the residuals, they proposed the following estimator for the estimation of variances, under the assumption that the Ω matrix is known and diagonal, but the diagonal elements are not equal, in other words, only heteroscedasticity (Tatoğlu, 2016: 252):

$$\begin{aligned} \text{Var}\,(\hat{\beta}) &= (X'X)^{-1}X'\text{VX}\,(X'X)^{-1} \\ \text{Var}\,(\hat{\beta}) &= (X'X)^{-1}X'\text{diag}\,(\hat{u}_i^2)X(X'X)^{-1} \end{aligned} \tag{3.12}$$

As can be understood here, it is $V = \sigma_u^2\Omega = \text{diag}(\hat{u}_i^2)$.This is the "heteroskedastic resistance variance estimator", known as the "White estimator" or the "Eicker estimator". MacKinnon and White (1985) and Hinkley (1977) made this estimator usable in small samples by correcting the degrees of freedom (Tatoğlu, 2016: 252):

$$\text{Var}(\hat{\beta}) = \frac{N}{N-k}(X'X)^{-1}\left(\sum_{i=1}^{N} \hat{u}_i^2 x_i' x_i\right)(X'X)^{-1}$$
$$= \frac{N}{N-k}(X'X)^{-1}X'\text{diag}(\hat{u}_i^2)X(X'X)^{-1}$$

(3.13)

In another approach proposed by the same researchers, a small sample correction is made with (1/1 -$h\,i$) ($h\,i$: diagonal elements of the prediction matrix) instead of (N/N –k). Long and Ervin (2000) use the $1/(1-h\,i)^2$ correction to improve small sample properties and give less weight to outlier observations, while Cribari-Neto (2004) also uses 1 to improve small sample properties, especially in the presence of outliers. He suggested the correction $1/(1-h\,i)^{\delta i}$. ($\delta_i = min\{4, h_i)/\bar{h}\}$) These proposed estimators for the variance-covariance matrix of the estimated parameters produce homoscedastic standard errors.

3.3.5.Empirical Results

3.3.5.1.Descriptive Statistics

Descriptive statistics for 37 OECD countries are presented in Table 5. These; The standard deviation values of the variables are the maximum and minimum values and the averages of the variables.

Table 5: Descriptive statistics of Variables

Variable	Obs	Mean	Std. Dev.	Min.	Max.
$LTRADE_{ijt}$	518	7.54348	1.61794	2.144488	10.66657
$LEXPORT_{ijt}$	518	6.871139	1.789864	-0.39909	10.25273
$LIMPORT_{ijt}$	518	6.645927	1.646242	2.062644	9.711419
$LGDP_{it}$	518	9.221624	0.14499	8.979924	9.395876
$LGDP_{jt}$	518	10.27773	0.678722	8.495005	11.62958
$LARGE_{it}$	518	-0.16258	0.109528	-0.36843	-0.04105
$LARGE_{jt}$	518	0.408408	0.709802	-1.68984	1.597525
$LPOP_{it}$	518	18.15409	0.062551	18.05801	18.25036
$LPOP_{jt}$	518	16.3222	1.506577	12.64937	19.61304

$LLPI_{it}$	518	1.192965	0.047432	1.147403	1.255616
$LLPI_{jt}$	518	1.264603	0.120469	0.916291	1.441248
$LDIST_{ijt}$	518	4854.991	4294.191	817.29	16821.33

Table 5 shows the descriptive statistics of the variables whose logarithms are taken. According to the Table 5, the panel average of foreign trade volume is 7.54348, the minimum value is Turkey-Costa Rica with 2.144488, and the maximum value is Turkey-Germany with 10.66657. While the average value of Turkey's exports to OECD countries is 6.87, the maximum value is Turkey-Germany with 10.25, the minimum value is Turkey-Costa Rica with -0.39. While the average value of Turkey's imports from OECD countries is 6.64, the maximum value is Turkey-Germany with 9.71, and the minimum value is Turkey-Costa Rica with 2.06. While the OECD group average of the GDP variable is 10.27773, Colombia has a minimum value of 8.495005, and Luxembourg has a maximum value of 11.62958. While the OECD average value of the POP variable is 16.3222, its minimum value is 12.64937 for Iceland, and its maximum value is 19.61304 for the USA. While the OECD group average of the R&D variable is 0.4084083, Columbia has a minimum value of -1.689835 $, and Israel has a maximum value of 1.597525. The OECD group mean of the overall LLPI variable is 1.264603, while Columbia has a minimum value of 0.9162908 and a maximum value of 1.441248 in Germany. While the group average of the DIST variable is 8.154686, its minimum value is 6.705994 km between Turkey and Greece, and its maximum value is 9.730403 km between Turkey and New Zealand.

3.3.5.2.Specification Tests of Model Estimation

It is necessary to use the estimators of the right model to predict the panel data analysis results correctly. Various tests have been developed to determine which of the Pooled OLS, Fixed Effects Model, and Random Effects Models will be used in model estimation. These;

- *F Test:* Making a choice between the Pooled OLS and the Fixed Effects Model,
- *LR Test:* Time effect, cross-section effect, and time /cross-section effect were tested against the classical model.
- *Breusch Pagan LM Test:* Making a choice between the Pooled OLS and the Random Effects model,
- *Hausman Test:* It chooses between the Random Effects Model and the Fixed Effects Model.

Likelihood Ratio Test (LR) Test

H_0: Pooled OLS Model

H_1: The Random-Fixed Effects or Two-way Model

Table 6: LR Test Results

Model	Likelihood-Ratio	Cross-section	Time	Both
Model 1	Chibar2	627.31	1.9e-12	638.44
	Probability	0.0000	1.0000	0.0000
Model 2	Chibar2	445.86	0.31	470.98
	Probability	0.0000	0.2882	0.0000
Model 3	Chibar2	875.61	2.3e-13	875.61
	Probability	0.0000	1.0000	0.0000

Table 6 gives the test results of the cross-section effect, the time effect, and both against the classical model. It is seen that the probability values of the coefficients are significant at 1%, 5%, and 10% significance levels for all three models. Therefore, the H_0 hypothesis was rejected, and it was concluded that the pooled OLS model was unsuitable. When the LR result of the applied model specification test is evaluated, it is concluded that the classical model, one of the panel data models, cannot be used to examine the study effects on the foreign trade volume, export, import, and logistics performance effect between Turkey and OECD countries. In this case, the fixed or random-effects model will be decided according to the results of the Hausman test.

Breusch Pagan LM Test;

H_0: Pooled OLS Model

H_1: The Random Effects Model

Table 7: Breusch Pagan Test Results for Cross-Section Effects

	Breusch Pagan	Cross-section
Model 1	Chibar2	1982.37
	Probability	0.0000
Model 2	Chibar2	1476.55

	Probability	0.0000
Model 3	Chibar2	2472.64
	Probability	0.0000

When the results of the LM test are examined in the Table, it is seen that the probability values of the coefficients showing the cross-section effect are significant at the 1%, 5%, and 10% significance levels for all three models. Therefore, the H_0 hypothesis was rejected, and it was concluded that the pooled OLS model was unsuitable and the random-effects model should be used. Another essential point to be determined about the model is the test for the presence of autocorrelation, heteroskedasticity, and cross-sectional dependence.

Table 8: Levene, Brown and Forsythe Heteroskedasticity Test and Baltagi-Wu LBI, Durbin Watson Autocorrelation Test Results

		Levene, Brown and Forsythe	Baltagi-Wu LBI	Durbin-Watson
Model 1	w0	10.6226986 (0.000)	.83769007	.60224913
	w50	5.3763156 (0.000)		
	w10	9.3364248 (0.000)		
Model 2	w0	11.0734856 (0.000)	.69413951	.97990288
	w50	3.7168475 (0.000)		
	w10	8.4947428 (0.000)		
Model 3	w0	7.8196909 (0.000)	1.0393035	.7950454
	w50	4.5763158 (0.000)		
	w10	6.8885369 (0.000)		

Table 8 presents the autocorrelation and heteroskedasticity test results. In cases where the critical values of the Durbin-Watson and LBI test statistics are less than 2, it is accepted that there is an autocorrelation problem (Tatoğlu, 2016: 226). Since the DW and LBI critical values given in Table 8 , are below 2, it is seen that there is an autocorrelation problem in all models. According to the Levene, Brown, and Forsythe Heteroskedasticity Test result, (36, 481) degrees of freedom Snedecor F table is compared with the H_0 hypothesis that "variance between cross-section is equal" is rejected and heteroskedasticity exists for all three models. Another issue to investigate is cross-sectional dependence.

Table 9 : Cross-Sectional Independence Test Result

	Pesaran's test	**Cross-Sectional Independence**
Model 1	CD Statistics	16.428
	Probability	0.0000
Model 2	CD Statistics	22.573
	Probability	0.0000
Model 3	CD Statistics	5.734
	Probability	0.0000

According to the Pesaran test result, the H_0 hypothesis is rejected, and it is understood that there is a correlation between the units. After diagnosing the autocorrelation, heteroskedasticity, and cross-sectional dependence problem, the Hausman test should be performed to decide between random or fixed effects.

Table 10: Hausman Test Result

	Hausman	
Test: H_0: difference in coefficients not systematic	**chi2**	**Prob**
Model 1	10.79	0.2137
Model 2	18.58	0.0173
Model 3	13.61	0.0926

The Hausman test indicates the random effects according to 1%, 5%, and 10% for all three models. Since the distance variable is constant with respect to time, it drops out of the fixed-effect model. From this point of view, the random-effects model will be used since the Hausman test also allows the random-effects model.

3.3.5.3.Huber-Eicker-White Estimator

The random-effects model was chosen according to the Hausman test result from the model specification tests. In addition, since the problem of autocorrelation, heteroskedasticity, and cross-sectional dependence is diagnosed in the model, robust estimators should be used against these problems. Therefore, a robust Huber Eicker White estimator is used for model estimation.

Table 11: Estimation of Model 1

HUBER EICKER WHITE ESTIMATOR						
VARIABLE	**Coef.**	**Robust Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
$LTRADE_{ijt}$						
$LDIST_{ijt}$	-1.03249	0.13117	-7.87	**0.000***	-1.28958	-0.7754
$LGDP_{it}$	1.37012	0.410259	3.34	**0.001***	0.566028	2.174213
$LGDP_{jt}$	0.789526	0.194701	4.06	**0.000***	0.40792	1.171133
$LLPI_{it}$	0.988481	0.403878	2.45	**0.014****	0.196895	1.780068
$LLPI_{jt}$	0.155764	0.467192	0.33	0.739	-0.75992	1.071442
$LPOP_{it}$	-0.19962	1.194006	-0.17	0.867	-2.53983	2.140585
$LPOP_{jt}$	0.917646	0.060597	15.14	**0.000***	0.798879	1.036413
$LARGE_{it}$	-0.76846	0.304485	-2.52	**0.012****	-1.36524	-0.17168
$LARGE_{jt}$	0.15334	0.163529	0.94	0.348	-0.16717	0.47385
CONS	-17.7039	18.89167	-0.94	0.349	-54.7309	19.32306
	R-sq: overall = 0.8633			Wald chi2(10) = 536.81 Prob > chi2 = 0.0000		

$$LTRADE_{ijt} = -17.7039 - 1.03249\ LDIST_{ijt} + 1.37012 LGDP_{it} + 0.789526\ LGDP_{jt} + 0.988481 LLPI_{it} + 0.155764\ LLPI_{jt} - 0.19962 LPOP_{it} + 0.917646\ LPOP_{jt} - 0.76846 LARGE_{it} + 0.15334\ LARGE_{jt} \quad (3.14)$$

The model established according to the Wald test result in the table is significant as a whole. The R^2 value, which shows the explanatory power of the independent variables for the dependent variable, was found to be 86%.

According to the random-effects model applied for the relationship between the foreign trade volume and the logistics performance index between Turkey and OECD countries, Turkey's per capita real GDP increases positively and significantly affects the foreign trade volume. In other words, a 1% increase in Turkey's per capita real GDP will increase the foreign trade volume by 1.37%. A 1% increase in OECD country's per capita real GDP will increase Turkey's foreign trade volume by 0.78%.

When the analysis results of the R&D variable, which is an innovation indicator, are examined, it is seen that there is a negative and statistically significant relationship between Turkey's R&D expenditures and foreign trade volume. A 1% decrease in R&D expenditures in exporting countries reduces the foreign trade volume by 0.76%. Considering the effect of R&D expenditures made in OECD countries on the trade flow of the exporting country, no statistically significant relationship was found.

When the relationship between country populations and foreign trade volume is examined, it is observed that there is a positive and significant relationship between population growth and foreign trade volume in OECD countries. According to these results, while a 1% population increase in OECD countries increased Turkey's foreign trade volume by 0.91%, a statistically significant effect of the increase or decrease in Turkey's population on foreign trade volume was not found.

There is a negative and statistically significant relationship between the distance variable, which is one of the main variables of the gravity model, and the foreign trade volume, following the expectations. The increase in the distance between countries negatively affects trade flows by increasing transportation and transaction costs. According to the regression analysis of the distance variable, 1% increase in the distances between the countries subject to foreign trade reduces the foreign trade volume of Turkey by 1.03%.

Turkey's logistics performance index has a positive and statistically significant effect on Turkey's foreign trade volume. A 1% increase in Turkey's logistics performance score leads to an increase of 0.98% in foreign trade volume. The logistics performance index of OECD countries, on the other hand, did not have a statistically significant effect on Turkey's foreign trade volume.

Table 12: Estimation of Model 2

HUBER EICKER WHITE ESTIMATOR						
VARIABLE	**Coef.**	**Robust Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
$LEXPORT_{ijt}$						
$LDIST_{ijt}$	-1.14101	0.160582	-7.11	**0.000***	-1.45574	-0.82627
$LGDP_{it}$	0.469562	0.547788	0.86	0.391	-0.60408	1.543207
$LGDP_{jt}$	0.66001	0.200153	3.3	**0.001***	0.267718	1.052302
$LLPI_{it}$	2.393028	0.610038	3.92	**0.000***	1.197375	3.588681
$LLPI_{jt}$	0.149977	0.741929	0.2	0.84	-1.30418	1.60413
$LPOP_{it}$	0.865948	1.789988	0.48	0.629	-2.64236	4.37426
$LPOP_{jt}$	0.963054	0.0824	11.69	**0.000***	0.801553	1.124554
$LARGE_{it}$	-0.39687	0.448692	-0.88	0.376	-1.27629	0.482548
$LARGE_{jt}$	0.289401	0.178125	1.62	0.104	-0.05972	0.638519
CONS	-29.6047	28.97335	-1.02	0.307	-86.3914	27.18207
	R-sq: overall = 0.8321			Wald chi2(10) = 274.45 Prob > chi2 = 0.0000		

$$LEXPORT_{ijt} = -29.6047 - 1.14101LDIST_{ijt} + 0.469562LGDP_{it} + 0.66001LGDP_{jt} + 2.393028LLPI_{it} + 0.149977LLPI_{jt} + 0.865948LPOP_{it} + 0.963054\ LPOP_{jt} - 0.39687LARGE_{it} + 0.289401LARGE_{jt} \quad (3.15)$$

In Model 2, the model established according to the Wald test result in the table is significant as a whole. The R^2 value, which shows the explanatory power of the independent variables for the dependent variable, was found to be 83%.

In Model 2, according to the random-effects model applied for the relationship between the foreign trade volume and the logistics performance index between Turkey and OECD countries, Turkey's per capita real GDP has no statistically significant effects on foreign trade volume. But 1% increase in OECD country's per capita real GDP will increase Turkey's foreign trade volume by 0.66%.

In Model 2, when the analysis results of the R&D variable, which is an innovation indicator, are examined, it is seen that there is no statistically significant relationship between Turkey's or OECD country's R&D expenditures and Turkey's foreign trade volume.

In Model 2, when the relationship between country populations and foreign trade volume is examined, it is observed that there is a positive and significant relationship between population growth and foreign trade volume in OECD countries. According to these results, while a 1% population increase in OECD countries increased Turkey's foreign trade volume by 0.96%, a statistically significant effect of the increase or decrease in Turkey's population on foreign trade volume was not found.

In Model 2, there is a negative and statistically significant relationship between the distance variable, which is one of the main variables of the gravity model, and the foreign trade volume, following the expectations. The increase in the distance between countries negatively affects trade flows by increasing transportation and transaction costs. According to the regression analysis of the distance variable, the 1% increase in the distances between the countries subject to foreign trade reduces the foreign trade volume of Turkey by 1.14%.

In Model 2, Turkey's logistics performance index has a positive and statistically significant effect on Turkey's foreign trade volume. A 1% increase in Turkey's logistics performance score leads to an increase of 2.39% in foreign trade volume. On the other hand, the logistics performance index of OECD countries did not have a statistically significant effect on Turkey's foreign trade volume.

Table 13: Estimation of Model 3

HUBER EICKER WHITE ESTIMATOR						
VARIABLE	**Coef.**	**Robust Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
$LEXPORT_{ijt}$						
$LDIST_{ijt}$	-1.02416	0.141536	-7.24	**0.000***	-1.30157	-0.74676
$LGDP_{it}$	1.805422	0.520715	3.47	**0.001***	0.784839	2.826004
$LGDP_{jt}$	1.072956	0.250569	4.28	**0.000***	0.581849	1.564062
$LLPI_{it}$	0.057699	0.445059	0.13	0.897	-0.8146	0.929999
$LLPI_{jt}$	0.234738	0.495086	0.47	0.635	-0.73561	1.205089
$LPOP_{it}$	0.28574	1.097919	0.26	0.795	-1.86614	2.437621
$LPOP_{jt}$	0.943987	0.093964	10.05	**0.000***	0.759821	1.128153
$LARGE_{it}$	-1.16974	0.361465	-3.24	**0.001***	-1.8782	-0.46128
$LARGE_{jt}$	-0.00043	0.153616	0	0.998	-0.30151	0.300655
CONS	-33.8298	17.14364	-1.97	**0.048****	-67.4307	-0.22889
	R-sq: overall = 0.7718			Wald chi2(10) = 366.34 Prob > chi2 = 0.0000		

$$LEXPORT_{ijt} = -33.8298-1.02416LDIST_{ijt} + 1.805422LGDP_{it} + 1.072956LGDP_{jt} + 0.057699LLPI_{it} + 0.234738LLPI_{jt} + 0.28574LPOP_{it} + 0.943987LPOP_{jt} -1.16974LARGE_{it} - 0.00043LARGE_{jt} \quad (3.16)$$

In Model 3, the model established according to the Wald test result in the table is significant as a whole. The R2 value, which shows the explanatory power of the independent variables for the dependent variable, was found to be 77%.

In Model 3, according to the random-effects model applied for the relationship between the foreign trade volume and the logistics performance index between Turkey and OECD countries, Turkey's per capita real GDP increases positively and significantly affects the foreign trade volume. In other words, a 1% increase in Turkey's per capita real GDP will increase the

foreign trade volume by 1.80%. A 1% increase in OECD country's per capita real GDP will increase Turkey’s foreign trade volume by 1.07%.

In Model 3, when the analysis results of the R&D variable, which is an innovation indicator, are examined, it is seen that there is a negative and statistically significant relationship between Turkey's R&D expenditures and foreign trade volume. A 1% decrease in R&D expenditures in exporting countries reduces the foreign trade volume by 1.16%. Considering the effect of R&D expenditures made in OECD countries on the trade flow of the exporting country, no statistically significant relationship was found.

In Model 3, when the relationship between country populations and foreign trade volume is examined, it is observed that there is a positive and significant relationship between population growth and foreign trade volume in OECD countries. According to these results, while a 1% population increase in OECD countries increased Turkey's foreign trade volume by 0.94%, a statistically significant effect of the increase or decrease in Turkey's population on foreign trade volume was not found.

In Model 3, there is a negative and statistically significant relationship between the distance variable, which is one of the main variables of the gravity model, and the foreign trade volume, following the expectations. The increase in the distance between countries negatively affects trade flows by increasing transportation and transaction costs. According to the regression analysis of the distance variable, the 1% increase in the distances between the countries subject to foreign trade reduces the foreign trade volume of Turkey by 1.02%.

In Model 3, Turkey's or OECD country’s logistics performance index has no statistically significant effect on Turkey's foreign trade volume.

4.Presentation and Discussion

The phenomenon of liberalization in the Turkish economy has brought about essential changes in foreign trade policies. The first step towards liberalization and foreign trade in the economy was the decision of January 24, 1980. As a result of the January 24, 1980 decisions, stabilization policies were aimed at making transformation and structural reforms in the Turkish economy. In line with these targets, export-based economic policies were targeted instead of import substitution policies. Thus, it was planned to achieve economic growth by increasing net exports to the economy. In addition, foreign trade has also created the need to improve relations with other countries economically and politically. With the increase in ties, Turkey has searched for new markets.

While international trade transactions consist of a limited number of goods and services, nowadays, with the emergence of new needs and technological development, global communication, and transportation opportunities have increased the scope and size of international trade transactions. International trade aims to provide goods and services that are not available in the domestic market or that are of high cost or low quality. However, foreign trade is available to increase the level of welfare by transferring the surplus goods and services in the domestic market to the foreign market. The purpose and development of international trade has gained an important place for all researchers. Studies in the literature on the determinants of international trade have begun. One of the most important reasons for this has been the gravity model.

The gravity model has long been useful for explaining bilateral trade flows. Its popularity has increased in recent years. One of the reasons for this popularity is that the data used in the gravity models are easily accessible and reliable. Another reason is that various authors have widely discussed and developed the theoretical assumptions of gravity models. The basic idea in the trade gravity model is that trade will increase as the economic capacity of the trading partners increases and the distance between the partners gets shorter. While the national income variable represents financial capacity, market size is represented by the population variable. An increase in national income has a positive effect on trade. On the other hand, population size can affect trade flows sometimes negatively and sometimes positively. The large distance between the trading partners affects the trade negatively. This is because the distance variable represents transportation costs. The greater the distance, the higher the transport costs.

Gravity models include essential variables such as income, distance, and population, as well as some dummy variables such as regional trade agreements, common language, common border, and common currency. These dummy variables are factors that facilitate bilateral trading. Gravity patterns are usually estimated from cross-sectional data. However, there is a risk of selecting a year not represented in the cross-section estimate, and it is impossible to monitor individual country-specific effects. For this reason, the use of panel data has increased in recent years because panel data allows monitoring of individual unobserved effects and avoids the risk of choosing an unrepresented year.

The study's primary purpose is to analyze the foreign trade between Turkey and OECD countries with the gravity model, taking into account the logistics performance index criterion. For this purpose, the data of Turkey and 37 OECD countries between 2007-2020 were analyzed. Three different models were established in which the total foreign trade volume, Turkey's exports to OECD countries, and Turkey's imports with OECD countries are dependent variables. First, the descriptive statistics of the variables used in the study are included. Then, the LR test was used to choose between the pooled OLS model and the random-fixed effects or two-way model. According to the test results, the H0 hypothesis was rejected in all three models; the fixed-random effect or two-way effects model will be used. Then, the Breusch Pagan LM Test was used to choose between the random effects model or the pooled OLS model, and according to the result, the H_0 hypothesis was rejected in all three models; that is, the random-effects model was found suitable. Then the Hausman test was applied, which allows us to choose between the fixed effects and random effects model. Since the distance variable is constant with respect to time, it drops out of the fixed-effect model. From this point of view, the random-effects model will be used since the Hausman test also allows the random-effects model. It is essential to investigate the problems of autocorrelation, cross-section dependence, and heteroscedasticity, which are the causes of unreliability in estimations in econometric models. For this purpose, heteroscedasticity was analyzed with Levene, Brown, and Forsythe heteroskedasticity test, and according to the result, there is a heteroskedasticity problem in all three models. Afterward, the autocorrelation problem was analyzed with Baltagi-Wu LBI and Durbin Watson Autocorrelation Test, and according to the test results, the autocorrelation problem was also found in all three models. Finally, in all three models examined by cross-sectional independence Pesaran's test, the H_0 hypothesis was rejected, that is, there was a

correlation between the units. Therefore, the three models created were estimated with the Huber-Eicker-White Estimator, which is resistant to all these problems.

According to the first model results, a 1% increase in Turkey's per capita real GDP will increase the foreign trade volume by 1.37%. A 1% increase in OECD country's per capita real GDP will increase Turkey's foreign trade volume by 0.78%. A 1% decrease in R&D expenditures in exporting countries reduces the foreign trade volume by 0.76%. Considering the effect of R&D expenditures made in OECD countries on the trade flow of the exporting country, no statistically significant relationship was found. While a 1% population increase in OECD countries increased Turkey's foreign trade volume by 0.91%, a statistically significant effect of the increase or decrease in Turkey's population on foreign trade volume was not found. A 1% increase in the distances between the countries subject to foreign trade reduces the foreign trade volume of Turkey by 1.03%. A 1% increase in Turkey's logistics performance score leads to a rise of 0.98% in foreign trade volume. The logistics performance index of OECD countries, on the other hand, did not have a statistically significant effect on Turkey's foreign trade volume.

According to the results of the second model, Turkey's per capita real GDP has no statistically significant effects on foreign trade volume. But 1% increase in OECD country's per capita real GDP will increase Turkey's foreign trade volume by 0.66%. When the analysis results of the R&D variable, which is an innovation indicator, are examined, it is seen that there is no statistically significant relationship between Turkey's or OECD country's R&D expenditures and Turkey's foreign trade volume. A 1% population increase in OECD countries increased Turkey's foreign trade volume by 0.96%, and a statistically significant effect of the increase or decrease in Turkey's population on foreign trade volume was not found. A 1% increase in the distances between the countries subject to foreign trade reduces the foreign trade volume of Turkey by 1.14%. A 1% increase in Turkey's logistics performance score leads to a rise of 2.39% in foreign trade volume. On the other hand, the logistics performance index of OECD countries did not have a statistically significant effect on Turkey's foreign trade volume.

According to the results of the last model, a 1% increase in Turkey's per capita real GDP will increase the foreign trade volume by 1.80%. A 1% increase in OECD country's per capita real GDP will increase Turkey's foreign trade volume by 1.07%. A 1% decrease in R&D expenditures in exporting countries reduces the foreign trade volume by 1.16%. Considering the effect of R&D expenditures made in OECD countries on the trade flow of the exporting country, no statistically significant relationship was found. While a 1% population increase in

OECD countries increased Turkey's foreign trade volume by 0.94%, a statistically significant effect of the increase or decrease in Turkey's population on foreign trade volume was not found. According to the panel regression analysis of the distance variable, the 1% increase in the distances between the countries subject to foreign trade reduces the foreign trade volume of Turkey by 1.02%, and Turkey's or OECD country's logistics performance index has no statistically significant effect on Turkey's foreign trade volume.

As a result, the resulting three gravity model equations were obtained in accordance with the signs of the main variables used by Tinbergen in the Gravity Model. The significant variables were added to the model, and the final results were obtained for the models expressed as the augmented gravity model. The gravity model can also analyze data based on goods or sectors. In this way, trade flows can be tested with more detailed micro-analyses. Apart from the natural trade costs, researchers can easily integrate the trade policy tools that they want to see the effect of into the model and calculate the volume effect of these variables. Some gravity model studies can distinguish between potential-actual trade flows and estimate how far countries move away from potential trade with the model they define. In this way, a specific country can determine which countries they are in a trade loss or gain, thus differentiating policy proposals to promote or prevent the trade from country to country.

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