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Is Global Climate Change Affecting Intra-Industry Trade? Econometric Evidence for the Fisheries Sector in Turkey

Summary: The main objective of this study was to investigate whether the intra-industrial trade structure of the Turkish fisheries sector has been affected by global climate change. Therefore, the surface temperatures of the Black Sea, Marmara, Mediteranean and Aegean seas and the Grubel-Lloyd index values related to the sector for the period 1985-2017 were used as variables in the study. The Auto-Regressive Distributed Lag (ARDL) bounds test was used to determine the cointegration relationship between variables and to predict long-term coefficients. The Error Correction Model (ECM) method was used to determine the short-term coefficients. According to the results of the analyses: (i) There is a long-term relationship between the variables; (ii) Increases in the surface temperature of the Aegean, Mediterranean and Marmara seas have reduced intra-industrial trade in the long-term; (iii) The increase in the Black Sea surface temperature has increased intra-industry trade in the long-term; (iv) The increase in sea surface temperatures has shown a tendency to increase intra-industry trade from the southern seas towards the northern seas in Turkey. Consequently, global climate change can be considered as a change in intra-industry trade for both the country and the industry.

Keywords: Global climate change, Intra-industry trade, Grubel-Lloyd index, Fisheries sector, Turkey.

JEL: F14, F18, Q17, Q22, Q54, Q56.

Global climate change is a current issue affecting all segments of society, which has arisen due to natural and anthropogenic processes. Since the Industrial Revolution, the increase in greenhouse gas emissions due to increased energy needs has resulted in increased surface temperature in terrestrial and marine areas. The increase in surface temperature in marine areas causes changes in the physiological structures of sea species. Furthermore, sea species that are unable to adapt to the changes are looking for a more favorable environment. Therefore, differences can be seen between regions in the distribution of fish stocks because of migrating fish species of commercial value due to global climate change. Consequently, global climate change can lead to changes in socioeconomic factors such as food supply security, employment structure and intra-industry trade, in addition to back-and-forth sectors linked to the fishing industry.

This study examines whether the intra-industrial trade structure of Turkey's fisheries sector has been affected by global climate change. In the study, the surface temperatures of the Black Sea, Mediteranean, Aegean and Marmara Seas, which are the coastal seas of Turkey, were determined as independent variables reflecting the climate changes in the period 1985-2017. Grubel-Lloyd index values for the fisheries sector were used to measure intra-industrial trade as a dependent variable. The study can be considered to contribute to the literature in several ways. First of all, the subject is quite up-to-date, and according to literature reviews, there has been no previous research on this subject. In the study, advanced econometric methods such as the ARDL bounds test were used for cointegration relationships between variables and short-long-term coefficient estimates of variables. The study focused on the period 1985-2017 as surface temperatures began to increase in the 1990s in terms of the geographical location of Turkey. Finally, according to the results of the study, it can be emphasized that global climate changes are a factor affecting intra-industry trade.

The work consists of 6 sections. The first section will examine the interaction between global climate change and the fisheries industry. The second section will focus on the impact of global climate change on the Turkish fisheries industry. In the third part, the development of intra-industrial trade and the Grubel-Lloyd index will be explained within the scope of foreign trade theories. In the fourth section, the data and the econometric method will be examined, and in the fifth section, the stages of ARDL and ECM analysis will be applied to the relevant series. The conclusion will be included in the last section.

1. The Interaction of Global Climate Change and Fisheries Industry: A Literature Survey

Climate can be defined as the average of meteorological activities and weather conditions experienced in any region of the Earth over a given period of time (Intergovernmental Panel on Climate Change 2007). In the long-term, deviations observed in the average of climatic factors (precipitation, humidity, temperature and pressure) due to various reasons indicate climate change. The widespread occurence of deviations in all regions of the world due to instrumental measurements has brought climate change to a global dimension. Global climate change occurs due to natural processes, including internal and external factors, as well as anthropogenic processes. The internal processes are periodic changes of the climate system self-interacting, and El-Nino Southern Oscillation (ENSO) is one of the main factors (Anastasios Tsonis, Allen Hunt, and James B. Elsner 2003). The ENSO concept is used for anomalies experienced in surface temperatures in the Eastern Tropical Pacific Ocean. The surface temperatures in the region are above normal during the El-Nino period, and below normal during the La-Nina period. In addition, natural processes that develop due to external factors have an effect on climate change. Examples of these factors include volcanic activities, continental shifts, Milankovitch cycles, changes in sunspots and eruptions due to solar minimum periods (Bimal P. Mohanty et al. 2010). Since the Industrial Revolution (1760s), there have been different causes of global climate change. In particular, international trade competition has led to increased diversification of production. The increasing energy needs of industry have been met by using fossil (non-renewable) energy resources, which are far from advanced technology and where the environment is placed second. Thus, an increase in carbon dioxide density was observed in the atmosphere due to anthropogenic causes. The increase in average carbon dioxide density from 273 ppm in 1780 to 408 ppm in 2018 proves this statistically (National Oceanic and Atmospheric Administration 2018)[1]. In addition to this dangerous increase, the persistence of carbon dioxide gas in the atmosphere is quite high compared to other greenhouse gases. This causes the thermal radiation generated by the sun's heating of the Earth to be trapped in the atmosphere due to greenhouse gases and the greenhouse effect to become stronger (Hasan H. Atar and A. Burak Kızılgök 2018). These increases in the strengthening of the greenhouse effect cause an increase in the surface temperature of the Earth within the scope of global warming. Increases in surface temperature are one of the main causes of climate change globally, and the consequences of this have a negative effect on all ecosystems and biodiversity.

Living organisms in the ocean and sea are one of the ecosystems adversely affected by global climate change, as global climate change causes both physical and chemical changes in ocean and marine environments (Graema Macfadyen and Edward H. Allison 2009). These changes include increases in sea surface temperature, a rise in sea levels, changes in the direction and frequency of currents, variations in salinity rates due to evaporation, and changes in the frequency and intensity of cyclones (Elena M. Finkbeiner et al. 2018). The socioeconomic impact of these changes on the water ecosystem and in terms of industry can be examined in Table 1.

Table 1 The Socioeconomic Effects of Global Climate Change in Terms of the Water Ecosystem

Ocean/sea effect	Ecosystem effect	Socioeconomic effect
Surface temperature ıncrease	Plankton structure and level change	Profit/loss of companies differences
Sea level ıncrease	Fish stock distribution ınequality	Food supply security and health risk ıncrease
Salinity rate ıncrease	Gender and size differentation	Livelihood strategies changes
Dissolved oxygen level decrease	Species migration delays/ırregularities	Adaptation costs changes
Current direction and frequency change	Invasive and sedentary species competition	Market balance and employment structure deteriorations
Extreme weather events ıncrease	Parasitic disease ıncrease	Accessing fish stock difficulties
	Commercial value of species loss/occurence	Intra-industry trade structure differences

Source: Prepared by the author.

As seen in the information in Table 1, the upward trend in sea surface temperature has an important effect on the physiological development stages of all marine species (Allison et al. 2009). In particular, each fish species has different temperature prefences, and increases in sea temperature affect the size, reproduction and sex structures of the fish. For example, an increase of 2 degrees Celsius in ocean temperature is predicted to lead to 20-30% reductions in the body size of the Atlantic Bluefin tuna (Daniel Pauly and William W. L. Cheung 2017). In addition, in areas where the increase in sea temperature is strong, the amount of oxygen dissolved in water decreases

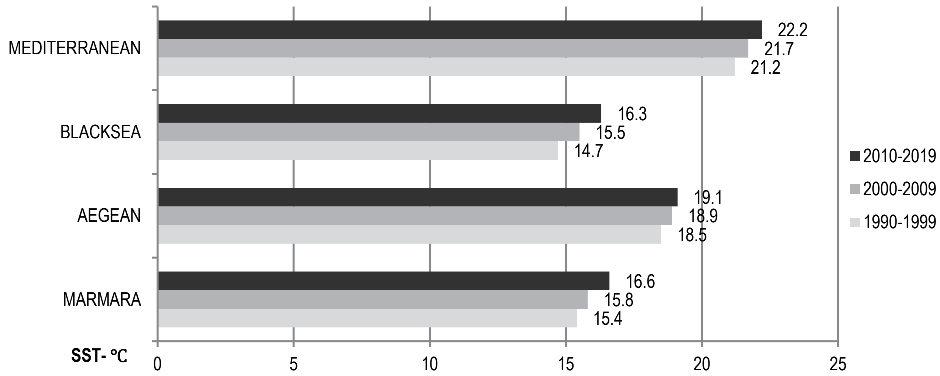
[1] **National Oceanic and Atmospheric Administration (NOAA).** 2018. CO_2 Concentrations. https://www.esrl.noaa.gov/gmd/ccgg/trends/data.html (accessed June 20, 2020).

and salinity rates rise. Moreover, extreme weather events and heavy rains due to global climate change cause nutrient degeneration though the transport of harmful chemicals on land. These factors lead to disease, resulting in the threat of extinction of species in the marine ecosystem. The damage to the food chain caused by global climate change increases competition between resident fish species and invasive species. Sea creatures that have difficulty adapting to this situation migrate to more favorable environments, differentiating the distribution of fish stocks between regions. According to previous studies, fish stock is distributed northward from tropical regions and is expected to increase by 30-70% in high latitutdes and decrease by 40% in tropical regions (Allison Perry et al. 2005).

As a result of global climate change, regional differences in fish stock affect the socioeconomic factors of countries. The most important of these factors can be listed as food supply security, livelihoods, trade, and employment structures within the fishing sector (Marie-Caroline Badjeck et al. 2010; Robert Blasiak et al. 2017). Fish is an important food for human metabolism, primarily in terms of the protein and unsaturated fatty acid content (Food and Agriculture Organization - FAO 2018). Especially in countries with limited economic development and unsuitable for agriculture (such as Sub-Saharan African countries), the fishing sector ensures the livelihood of the community. Under this importance, global climate change differentiates gains and losses for the fisheries sector, causing negatively affected countries to change their livelihood strategies (Essam Y. Mohammed and Zenebe Bashaw Uraguchi 2013). In addition, the fishing sector is a sector with a forward-backward connection, thereby creating employment. The vulnerability of the fishing sector due to global climate change may lead to employment losses for the sector. The regional economic impact of global climate change on the fisheries sector depends on the geographical location and adaptation skills of countries. The displacement of fish stocks due to global climate change both causes the emergence of new species and necessitates adaptation of countries in terms of fishing techniques. Poor countries that are unable to keep up with the changing conditions and unlucky countries in terms of new species will be more likely to lose their comparative advantage. This situation will lead to a differentiation of foreign trade balances and intra-industry trade between countries in terms of the fisheries sector.

2. Situations in the Turkish Fisheries Sector under the Threat of Global Climate Change

The global warming trend, which occurs due to anthropogenic trends, is not observed with equal effect in all latitudes of the world, but is more severe especially at 40-70 degrees north latitudes (Murat Türkeş 2007). As Turkey is located at 36-42 degrees north latitudes, the surface temperature has increased significantly since the 1990s. This upward trend has an effect on marine areas as well as terrestrial areas. The sea temperature change of Turkey, which is surrounded by the Black Sea, Mediterranean, Aegean and Marmara seas, can be examined with the help of Figure 1 below.



Notes: The acronym SST refers to sea surface temperatures. The data was obtained by the Turkish State Meteorological Service (TSMS)[2] in 2019 with the help of nearly 80 marine automatic meteorological observation stations.

Source: The author's elaboration on the basis of TSMS (2020) statistics.

Figure 1 Periodic Change in Surface Temperature in Turkish Seas

According to the data in Figure 1, the surface temperature in all of the seas off surrounding Turkey has increased with each passing decade since the 1990s. Compared to the 2000-2009 period, it can be observed that the Marmara and Black Sea are ahead of the other seas with 0.8 degrees in terms of temperature increase rates in 2010-2019. In parallel with this, changes in migration movements have been observed due to the increase in temperature in the areas where the species have economic value. For example, Turkey's anchovy (Engraulis Encrasicolus) fish, which has important economic value in terms of marine fishing, is a pelagic species (living near the surface of the sea) and is highly sensitive to surface temperature. It has been stated that the anchovy is located in areas further north of the Black Sea during periods when there is not enough snow and sea temperatures are not low enough (Naciye E. Sağlam, Ertuğ Düzgüneş, and İsmet Balık 2008). This negatively affects the employment structure of the Black Sea region, which earns a large part of its livelihood from fishing, periodically. As a result of the sea warming, the existing species migrate to the north and are replaced by fish species located in the south. The fact that fish such as sardine (sardina pilchardus), conger eel (conger conger) and barracuda (sphyraena sphyraena), which are mostly of Mediterranean origin, can now be seen in the Marmara Sea and Black Sea is proof of this situation (Turkish Marine Research Foundation 2017). It is clear that the Mediterraneanization of the Black Sea will become more intense as a result of the trend for continuous increases in temperature and many thermophilic species will be located in the Black Sea.

The Mediterranean Sea is one of the seas with a subtropical climate due to its large continental shelf and geographical location. Although surface temperature increase in the Mediterranean is not severe, it shows an increase of about 0.5 degrees per

[2] **Turkish State Meteorological Service (TSMS).** 2020. Deniz Suyu Sıcaklıkları. https://mgm.gov.tr/veridegerlendirme/il-ve-ilceler-istatistik.aspx?k=K (accessed May 18, 2020).

10-year period (Turkish State Meteorological Service 2020). This indicates that the Mediterranean climate is becoming more and more tropical over time. In addition, it is connected to the Red Sea by the Suez Canal and the Atlantic Ocean by the Gibraltar Strait and is in close contact with seas of different biodiversity. Therefore, the spread of Indian and Atlantic origin lesepsian species in the Mediterranean is highly expected with the increase in temperature (FAO 2018). According to previous research, it has been reported that the number of alien species migrating only from the Red Sea into the Mediterranean is close to 300 (Turkish Marine Research Foundation 2017). While some of the lesepsian species located in the Mediterranean have commercial value, others have no commercial value. Even more dangerously, some species with no commercial value are destroying established fish stocks, damaging the blue economy that includes the fishing and tourism sector. Surveys conducted with the people of the region have reported that the puffer fish (Lagocephalus Sceleratus) originating from the Red Sea is now more common in the region (Turkish Foundation for Combating Soil Erosion, for Reforestation and the Protection of Natural Habitats 2015). In addition to venomous and invasive species, foreign species with commercial value have become huntable. One of the fish species known as Mahi Mahi (Coryphaena Hippurus) in Turkey, especially located in the Mediterranean Sea, has recently been reported recently to have been seen in the Northern Aegean. In terms of fishing in Turkey, the Mediterranean has less share than other seas, and it is thought that this share will increase with commercial fish migrating from other seas.

The Marmara and Aegean Seas, which have a significant share in fishing after the Black Sea, are negatively affected by the increase in sea temperature and pollution. The increase in chemical compounds (nitrogen and phosphorus) transported from land to sea with heavy rains due to global climate change, especially in spring and summer, leads to excessive plankton proliferation (Atar and Kızılgök 2018). This event has the meaning of nutrient richness for marine species. However, the increasing temperature in the Marmara Sea together with pollution reduces the amount of dissolved oxygen, causing the sudden death of plankton without much shelter in the seas. The sudden death of plankton covers the sea surface in different colors (white, brown and red), endangering the extinction of fish species with commercial value and making fishing dificult (Turkish Marine Research Foundation 2017). Such events create a risk for the Marmara Sea, which acts as a biological corridor for the Aegean and Black Sea.

Aquaculture production in Turkey is made depending on the fishing and aquaculture techniques. The amount of fishery products obtained by fishing from sea and inland water resources has a fluctuating structure and decreases are noticeable since the 2000s (Turkish Statistical Institute 2018)[3]. Global climate change, environmental pollution, unconscious and overfishing can be listed as the main reasons for these decreases. In recent times, the fluctuating and limited fish production obtained from sea fishing has increased the importance of aquaculture (culture fishing) in Turkey. In 2018, the ratio of total aquaculture farming in Turkey remained around 50% (General Directorate of Agricultural Research and Policy 2019). However, studies have shown that aquaculture is negatively affected due to increasing sea water temperatures.

[3] **Turkish Statistical Institıte (Turkstat).** 2018. Su Ürünleri İstatistikleri. http://www.tuik.gov.tr/PreTablo.do?alt_id=1005 (accessed May 20, 2020).

According to the international trade data from the fisheries sector, exports are increasing continuously in terms of quantity and value, whereas there is significant fluctuation in imports, depending on the production of fish. According to 2017 data, the value of exports was approximately 854 million dollars, while the value of imports was approximately 230 million dollars (Turkish Statistical Institute 2018). Most of the exports, consisting largely of aquaculture products, are made to European countries (Netherlands, Italy and Russia). The main import countries are Norway, Morocco and Spain, and Norway has an advantage in terms of imports. Salmon, tuna, frozen mackerel fish species, crustaceans and molluscs constitute the most important import items for Turkey's fisheries sector (General Directorate of Agricultural Research and Policy 2019).

3. Intra-Industry Trade: Backgrounds and Grubel-Lloyd Index

The Heckscher-Ohlin theory, based on the theory of comparative advantages, is of great importance in international economics literature. According to this theory, the reason for trade between countries is the differences in the intensity of production factors that countries have (Donald R. Davis 1995). In this context, the relative abundance of a production factor in a country will provide that country with an export advantage of that product compared to other countries, where the abundant factor is used. Within the scope of the Heckscher-Ohlin theory, international trade between countries according to different factor densities indicates the validity of inter-industry trade (David Greenaway and Chris Milner 1983). However, the fact that countries with the same factor equipment both export and import similar goods due to increases in product diversity after the Second World War contradicts the predictions of the Heckscher-Ohlin theory. In addition, in terms of empirical tests, the Heckscher-Ohlin theory has been found to be invalid for some countries, weakening the belief in the theory. For example, according to the Leontief paradox, which is one of these empirical tests, it has been determined that the USA is epected to export capital-intensive goods, but that it exports labor-intensive goods (Wassily Leontief 1953). Consequently, new foreign trade theories have emerged instead of classical foreign trade theories, which have assumptions such as perfect competitive market, fixed returns to scale, and homogeneous production of goods (Marius Brülhart 1995). The new theories of international trade are based on product differentiation, economies of scale and an imperfect market, and are very effective in explaining the structure of intra-industry trade.

Intra-industry trade can be defined as countries with similar factor intensity simultaneously exporting and importing differentiated or similar products (Antonio Aquino 1978). In parallel, the total trade volume of the country is formed by the combination of intra-industrial trade and inter-industrial trade volumes. The increase in intra-industrial trade volume in a particular product group of the country will mean a decrease in inter-industrial trade volume due to the decrease in the comparative advantage in that product group. Empirical studies have attempted to identify factors affecting intra-industrial trade (Bela Balassa 1986; Greenaway and Milner 1987). The most important of these factors can be listed as market concentration of the industry, product differentiation, existence of economies of scale and the share allocated for R&D in the industry. Accordingly, the R&D share of the traded product group, economies of scale and the intensity of product differentiation are positively correlated with intra-industry trade (Rudolf Loertscher and Frank Wolter 1980). In particular, even if the production of goods subject to import is available in the country, differences in appearance, quality and brand of goods subject to trade can cause consumer preferences to favor imported goods. In addition, although they have similar factor intensity, some countries can realize the same production composition at a lower cost (Paul Krugman 1980; Brülhart 1995). In other words, the differences in the level of return by scale between countries are the determinants of intra-industry trade volume. The level of concentration in the industry negatively affects intra-industry trade. More than one producer producing the same product can lead to diversity and eliminate the differences between domestic production and imported production. Intra-industry trade volume may be affected by some country-specific characteristics, such as *per capita* income level, income differences, commercial structure, geographical distance, common borders, cultural affinity and integration level. While factors such as *per capita* income, commercial structure, common border, culture affinity and intergration level positively affect intra-industry trade, the differences in geographical distance and income per capita have a negative effect (Loertscher and Wolter 1980).

Many indices have been developed to measure the level of intra-industry trade, and each index has its own advantages and disadvantages. However, the Grubel-Lloyd index is one of the most preferred indices in studies in the literature. The value of intra-industry trade in terms of a certain product group (i) in an industry can be calculated according to the Grubel-Lloyd index (GL) as follows (Herbert Grubel and Peter J. Lloyd 1971).

$$L = 1 - \frac{|X_i - M_i|}{X_i + M_i} \; ; \quad (1)$$

$$0 \leq GL \leq 1 \, . \quad (2)$$

The X_i term in the Equation (1) above refers to the export value of the product (i) of the country and the M_i term refers to the import value of the same product. The GL index varies between 0 – 1. As a result of the calculation, if the value is zero or close to zero, it is understood that foreign trade in the product has an inter-industry character (i). If the value is close to one or one, foreign trade has an intra-industry character. If the index value is between 0.5-1, it means that intra-industry trade is high in the product (i) and a value between 0 – 0.5 means that intra-industry trade is low.

4. Data and Methodology

The purpose of this article was to examine whether the intra-industry trade structure of Turkey's fisheries sector for the period 1985-2017 has been affected by global climate change. In particular, increases in the surface temperature of the seas around the coast of Turkey have caused sea species with commercial value to migrate towards more favorable environments. In addition, warming in the seas may make it possible for some non-resident commercial marine species to be hunted. This situation can change the structure of intra-industry trade by differentiating Turkey's comparative advantage over the countries with which it trades fish. In this context, the independent variables of the Black Sea, Marmara, Mediterranean and Aegean sea surface temperatures and the Grubel-Lloyd index for the fishing industry as the dependent variable were used for the period 1985-2017 in order to examine the interactions. The explanations, units, sources and transformations of the variables used are presented in Table 2.

Table 2 Explanations of the Variables Used in the Study

Variables	Explanations	Sources	Units	Transformations
LKARA	Black Sea surface Temperature	TSMS	Celsius	Logarithmic
LAKD	Mediterranean Sea surface Temperature	TSMS	Celsius	Logarithmic
LEGE	Aegean Sea surface Temperature	TSMS	Celsius	Logarithmic
LMAR	Marmara Sea surface Temperature	TSMS	Celsius	Logarithmic
LGRU	Grubel-Lloyd index	FAO	$0 \leq x \leq 1$	Logarithmic

Notes: Conversion to annual value was made by taking the average of sea surface temperatures for 12 months.

Source: Prepared by the author.

In line with the information in Table 2, export and import data related to Turkey's fisheries sector were obtained in thousand dollars from FAO-Fishstat. The Grubel-Lloyd formula in Equation (1) was applied to the related data. The Grubel-Lloyd index has been heavily favored in studies conducted of the determination of intra-industry trade, so it was deemed appropriate for this study. The results obtained in terms of the fisheries sector and the development of intra-industry trade by years can be analyzed with the help of Table A1 in the Appendix[4]. The independent variables LKARA, LAKD, LEGE and LMAR in the table express the annual values of sea surface temperatures[5]. Sea water temperature is the most accurate indicator of climate changes, as it is a meteorological parameter that is not immediately affected by atmospheric changes and both warms and cools later than terrestrial areas. The changes of sea water temperature affect the people, who benefit from the sea economically as well as changing the ecological structure of the seas. Sea water surface temperatures were used as an independent variable in the article due to the pelagic origin of the fish produced in Turkey.

In the study, the stages of the ARDL (Auto-Regressive Distributed Lag) cointegration test developed by M. Hashem Pesaran, Yongcheol Shin, and Richard J. Smith (2001) were followed in the examination of the relationships between variables. The co-integration test was used to examine the long-term relationship between variables. Since the ARDL method has many advantages compared to the cointegration tests of Robert F. Engle and Clive W. J. Granger (1987), Søren Johansen (1988), Johansen and Katarina Juselius (1990), which are widely used in the literature, the use of this technique was deemed appropriate in this study. First of all, compared to classical cointegration tests, ARDL analysis can be applied when variables such as I(0) or I(1) are

[4] For the measurement of intra-industry trade, aggregated data of 2 or 3 digit products are generally used according to the Standard Industrial Trade Classification (SITC). However, there were seen to be meat, fish, crustaceans and molluscs in 017, which are below 01 digit in the SITC. Again, the presence of fish and other seafood in digit 03 is remarkable. The use of FAO-Fishstat data was deemed appropriate due to the presence of the same products in different steps.

[5] Sea surface temperatures of the Black Sea, Mediterranean, Marmara and Aegean between 1985-2017 can be examined in Table A2 in the Appendix.

stationary in different degrees (Abdullah E. Çağlar and Mehmet Mert 2019). However, since the upper bound critical values are determined according to the I(1) value, the variables should be tested with unit root tests against the possibility of being I(2). In addition, since the ARDL method uses the unconstrained error correction model, statistically more robust results can be obtained (Fahad M. Adamu and Ergun Doğan 2017). Other advantages of the ARDL method include using a single reduced form equation, being more suitable for cointegration analysis of small samples, and allowing variables to have different delays (Paresh K. Narayan 2005). The rearrangement of the variables used in the study according to the equation system in the ARDL method is as follow:

$$LGRU = \beta_0 + \beta_1 LKARA + \beta_2 LAKD + \beta_3 LMAR + \beta_4 LEGE + \varepsilon_i . \tag{3}$$

In the above Equation (3), a linear assumpton equation was created in terms of the variables used in the study. With the help of this equation, calculations are made by taking the logarithms of the variables. Then the single reduced form equation is obtained. The mentioned form equation can be examined with the help of Equation (4):

$$\begin{aligned} LGRU = \alpha_0 &+ \sum_{i=1}^{m} \beta_{1i} \Delta LGRU_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta LKARA_{t-i} + \sum_{i=0}^{P} \beta_{3i} \Delta LAKD_{t-i} \\ &+ \sum_{i=0}^{r} \beta_{4i} \Delta LMAR_{t-i} + \sum_{i=0}^{s} \beta_{5i} \Delta LEGE_{t-i} + \gamma_1 LGRU_{t-1} + \gamma_2 LKARA_{t-1} \\ &+ \gamma_3 LAKD_{t-1} + \gamma_4 LMAR_{t-1} + \gamma_5 LEGE_{t-1} + \varepsilon_i . \end{aligned} \tag{4}$$

The long-term relationship is tested using the bounds test with the help of Equation (4). If the existence of cointegration is proved after the bounds test, the short-and long-term coefficients related to the model will be determined (Narayan and Russell Smyth 2006). In this respect, the Wald test (F-statistics) is used for the bounds test. However, the F-statistic used is sensitive to the lag length. Therefore, Akaike (AIC), Schwarz (SIC), Hannan-Quinn (HQ) information criteria are used for delay values of differenced variables in Equation (4). After the delay values are determined, and hypotheses related to the test are formed. The hypotheses formed are listed below.

$$H_0: \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0$$
$$H_1: \gamma_1 \neq \gamma_2 \neq \gamma_3 \neq \gamma_4 \neq \gamma_5 \neq 0$$

The F-statistic value calculated in terms of variables was compared with the significance levels in the study by Pesaran, Smith, and Shin (2001) and was derived asymptotically. The critical values according to the variables are classified as lower bound I(0) and upper bound I(1). Accordingly, if the calculated F-statistic is greater than the critical value of the upper bound, the H_0 hypothesis is rejected and it is assumed that there is a cointegration relationship between the variables. If the calculated F-statistic is less than the critical value of the lower bound, then the H_0 hypothesis is accepted. Finally, if the calculated F-statistic is between the critical values of the lower and upper bound, there can be no comment on whether there is cointegration. If there is a cointegration relationship in the model, the stage of determining the long-term coefficients can be started. At this stage, long-term coefficients can be estimated using Equation (5):

$$LGRU = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i} LGRU_{t-i} + \sum_{i=0}^{n} \alpha_{2i} LKARA_{t-i} + \sum_{i=0}^{P} \alpha_{3i} LAKD_{t-i} + \sum_{i=0}^{r} \alpha_{4i} LMAR_{t-i} + \sum_{i=0}^{s} \alpha_{5i} LEGE_{t-i} + \varepsilon_i. \quad (5)$$

After estimating the Equation (5), various diagnostic tests must be performed to determine whether the relevant model is appropriate. In an appropriate model, there should be no serial correlation, no heteroscedasticity, no specification error, and the residues of the model should have a normal distribution. In addition, the Cumulative Sum Test (CUSUM) and Cumulative Sum of Squares (CUSUMSQ) tests can be used to test whether the predicted parameters are stable. Then, an error correction model based on the ARDL process is created to detect short-term relationships between variables. The mentioned model can be shown with the help of Equation (6):

$$\Delta LGRU = \alpha_0 + \sum_{i=1}^{m} \delta_{1i} \Delta LGRU_{t-i} + \sum_{i=0}^{n} \delta_{2i} \Delta LKARA_{t-i} + \sum_{i=0}^{P} \delta_{3i} \Delta LAKD_{t-i} + \sum_{i=0}^{r} \delta_{4i} \Delta LMAR_{t-i} + \sum_{i=0}^{s} \delta_{5i} \Delta LEGE_{t-i} + \delta_6 ECM_{t-1} + \varepsilon_i. \quad (6)$$

The variable ECM_{t-1} in the system of Equations (6) refers to the error correction term. The term is derived by taking a lag of the residuals of the long-term predicted model. The coefficient of the term refers to how much of a shock effect that occurs in the short-term will disappear in the long-term (Pesaran, Shin, and Smith 2001). If the coefficient is between 0 and -1, it converges to the long-term balance value of the short-term shock without fluctuation. If the coefficient is between -1 and -2, short-term shocks reach the long-term equilibrium values with decreasing fluctuations.

5. Empirical Results

The aim of this section is to examine the long and short-term relationships between the LGRU, LMAR, LEGE, LAKD and LKARA variables for Turkey. In this context, stages of the ARDL cointegration test were followed in order to examine the relationship. After investigating the cointegration relationship with the help of the bounds test, short and long-term coefficient estimates of the variables were made. An error correction model was used to determine the short-term relationship. Finally, various diagnostic tests were applied to the model to determine whether the established model was suitable.

5.1 Unit Root Test

The ARDL cointegration test can be used where variables are stable to different degrees, such as I(0) or I(1). However, in terms of boundary tests, since the upper limit value is determined according to the value of I(1), it is necessary to test the variables with the stationarity tests against the possibility of being I(2). Therefore, the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) stationary tests will be applied to the variables. Since these tests do not take into account structural breaks, the Lee-Strazicich test (Junsoo Lee and Mark C. Strazicich 2003) test, which is the two break structural unit root test, will be used in addition to these tests.

The ADF unit root test utilizes the AR(p) process. By adding *p* delays to the relevant equations, the high-order correlation relationship in series is examined. The H_0 hypothesis established in the ADF test shows that there is unit root in the series, and the H_1 hypothesis shows that there is no unit root in the series. If the calculated test statistic is greater than the critical value, the H_0 hypothesis is rejected. The PP test is an alternative approach that aims to keep the serial correlation under control by adding the MA(q) variable, which is not included in the ADF test (Çağlar and Mert 2019). The hypothesis structures of the PP test and the ADF test are equivalent. If the calculated test statistic is greater than the critical value, it is understood that the series is stationary. The main purpose of the KPSS unit root test is to eliminate the deterministic trend in variables (Denis Kwiatkowski et al. 1992). Lagrange multiplier (LM) is used in the test, and the hypothesis structure is the opposite of ADF and PP tests. In this respect, the H_0 hypothesis indicates that there is no unit root in the series, and the H_1 hypothesis indicates the existence of the unit root in the series. If the calculated LM value for the variable is greater than the critical value, it is understood that the series is not stationary by rejecting the H_0 hypothesis. In addition to the ADF, PP and KPSS tests, the series may change depending on the external shocks experienced at the moment. In order to be able to more robustly test the stability processes of variables, it is necessary to test the relevant series with unit root tests that take into account structural breaks. Therefore, the Lee-Strazicich (2003) two-break structural unit root test, which takes structural breaks into account, was used in the study. The Lee-Strazicich (2003) unit root test determines the break times in variables internally. There are three types in terms of the variables tested and the level breaks of the series are shown by model A, and slope breaks are shown by model B. Both slope and level breaks are illustrated by model C, which is superior to the other two models. The Lee-Strazicich (2003) test is based on the LM statistic. If the test statistic calculated in terms of variables is greater than the critical value, it is understood that the series is stationary. The ADF, PP, KPSS and Lee-Strazicich (2003) structural unit root tests were applied to the series used in the study with the help of Eviews 10 program. Since each stationary test has its own advantages and disadvantages, more than one unit root test was used in the study. The ADF, PP and KPSS unit root test results applied to the variables are presented in Table 3.

Table 3 Results of the Stationary Tests Applied to the Variables

Series	Intercept and trend level value			Intercept and trend 1st difference		
	ADF	PP	KPSS	ADF	PP	KPSS
LGRU	-2.97(8) (0.158)	-4.02(4) (0.017)	0.26(1)	-3.95(3) (0.029)	-6.36(3) (0.000)	0.14(1)
LKARA	-4.32(0) (0.008)	-4.28(2) (0.009)	0.06 (1)	-7.26(0) (0.000)	-7.93(3) (0.000)	0.10 (6)
LEGE	-5.64(0) (0.000)	-5.65(2) (0.000)	0.10(3)	-5.76(2) (0.000)	-23.89(20) (0.000)	0.08(3)
LMAR	-4.04(0) (0.017)	-4.05(3) (0.016)	0.08(3)	-5.29(4) (0.001)	-8.34(3) (0.000)	0.05(3)
LAKD	-3.90(0) (0.023)	-3.77(4) (0.031)	0.07(1)	-7.13(0) (0.000)	-15.73(30) (0.000)	0.06(3)

Notes: The values in parentheses next to the ADF test statistic indicate the lenght of delay relative to the AIC. The values in parentheses next to the PP and KPSS test statistics represent the Newey-West bandwidth according to the Barlett-Kernel model. The values in parentheses under the ADF and PP test statistics show the probability (prob.) values at the significance level of 1%. The critical value of the KPSS test at 1% significance level is 0.21.

Source: Calculated by the author using Eviews 10 program.

According to the ADF results in the table, since the probability value of the LGRU variable is greater than 1%, it is understood that there is a unit root in the series. The LGRU variable with a difference is stable at 5% probability level according to the ADF test. It can be seen that LKARA and LEGE variables are stable at 1% probability level in terms of the ADF test. LMAR and LAKD variables do not carry unit root at 5% probability level according to the ADF test. When the difference of the same variables is taken, it is stable at the probability level of 1%. The PP test shows that LKARA, LEGE variables are stable at 1% probability leven and LGRU, LMAR, LAKD variables are stable at 5% probability level. It is understood that LGRU, LMAR and LAKD variables do not have a unit root at the 1% probability level where the difference is taken. With the exception of the LGRU variable, the test statistic calculated for all the other variables according to the KPSS test is less than the critical value of 1%. This shows that all other series are stationary, except the LGRU variable. The LGRU variable is stable according to the KPSS test when its difference is taken. In addition to these tests, the two-break Lee-Strazicich (2003) test, which takes structural breaks into account, was applied to the variables used in the study through Eviews 10 program. The results of that test are presented in Table 4.

Table 4 Two-Break Lee-Strazicich (2003) Unit Root Test Results

Series	Model	Lag	Break times	Test statistic (Tau)	Critical value
LGRU	Model A	1	1989, 1992	-1.09	-4.07
	Model C	0	1989, 2000	-5.33	-7.19
LMAR	Model A	2	1994, 2005	-5.22	-4.07
	Model C	2	1993, 2014	-5.18	-6.82
LKARA	Model A	0	1989, 1997	-4.51	-4.07
	Model C	1	1989, 1996	-5.65	-6.75
LEGE	Model A	0	1989, 1991	-5.25	-4.07
	Model C	2	1995, 2008	-8.57	-6.69
LAKD	Model A	0	1992, 1998	-4.76	-4.07
	Model C	2	1993, 1999	-5.95	-7.19

Notes: Critical values indicate 1% significance level.

Source: Calculated by the author using Eviews 10 program.

According to the results of the Lee-Strazicich (2003) test in Table 4, Model A takes into account the level breakdown of the series. Accordingly, it is seen that the absolute value of the test statistic calculated in all the variables is greater than the critical value, except for the LGRU variable. This indicates that all variables are stationary in terms of Model A, except for the LGRU variable. It can be understood that the LGRU variable is not stationary in terms of Model A. According to Model C, with the exception of the LEGE variable, the test statistics calculated for all the other variables are less than the critical value, indicating that the LEGE variable is stationary. It also indicates the existence of a unit root in all other variables, except LEGE. As a result, it is seen that LGRU variable is I(1), LKARA variable is I(0), LEGE variable is I(0), LMAR variable is I(1) and LAKD variable is I(1). ARDL cointegration analysis can be performed in the study because the series I(2) is not available according to the unit root test results applied again to the variables whose first order difference has been taken.

5.2 ARDL Bounds Test

The ARDL(m,n,p,r,s) model will be estimated, with the dependent variable LGRU series and independent variables LMAR, LEGE, LKARA, LAKD. The lag length is taken as 4 for estimation. Model 4 (unrestricted constant and restricted trend) is the most suitable ARDL(4,0,3,0,4) model according to the AIC criteria of a possible 1024 models. The forecast results can be reviewed in Table A3 in the Appendix. Then, with the help of Equation (4), the boundary test was used to investigate whether there is a long-term relationship between the variables. The Wald test was used for the boundary test. The test results are presented in Table 5.

Table 5 ARDL Bound Test Results

Estimated equity: LGRU = f(LAKD, LEGE, LMAR, LKARA)
Optimal lag: (4, 0, 3, 0, 3)
Null hypothesis: No levels relationship

Test statistic	Value	Significant	I(0) Bounds*	I(1)Bounds*
F-statistic	70.229	10%	3.097	4.118
k	4	5%	3.715	4.878
		1%	5.205	6.640

Notes: Statistic on the bounds of I(0) and I(1), denoted by * in the table, are critical values produced by Narayan (2005) for n = 30.

Source: Calculated by the author using Eviews 10 program.

According to the information in the table, the F-statistic value was calculated as 70.229. The F-statistical value was compared by Narayan (2005) to the critical values I(0) and I(1) at various levels of significance derived for n = 30. In this respect, it is seen that the F-statistic is greater than the upper critical value of I(1) at the 1% significance level. Therefore, the H_0 hypothesis is rejected and it is understood that there is a cointegration relationship between the variables.

5.3 Long-Run Estimates and Short-Run Dynamics

Since there is a cointegration relationship between the variables, the stage of determining the long-term coefficients can be started. The long-term coefficients are estimated using Equation (5). The forecast results are presented in Table 6.

Table 6 Long-Term Forecast Results of ARDL Model

Case 4: Unrestricted constant and restricted trend
Dependent variable: LGRU

Variable	Coefficient	Std. error	t-statistic	Prob.
LEGE	-5.993	1.106	-5.417	0.000
LAKD	-19.839	2.952	-6.720	0.000
LKARA	6.224	1.404	4.446	0.000
LMAR	-2.968	0.886	-3.348	0.005
@TREND	0.040	0.005	7.810	0.000

Source: Calculated by the author using Eviews 10 program.

The long-term coefficients of all the variables in Table 6 have a statistically significant 1% level. It is seen that the relationship between LEGE, LAKD, LMAR variables and the LGRU variable is negative. In this respect, a 1% increase in the LEGE variable leads to a 5.99% decrease in the LGRU variable. While a 1% increase in LAKD variable causes a 19.83% decrease in LGRU variable, a 1% increase in LMAR variable results in a 2.96% decrease in LGRU variable. In other words, increases in the surface temperature of the Marmara, Mediterranean and Aegean seas decrease the Grubel-Lloyd index, intensifying inter-industry trade in terms of the fishing sector. It is noteworthy that there is a positive relationship between the LKARA variable and the LGRU variable. A 1% increase in the LKARA variable causes a 6.22% increase in the LGRU variable. Therefore, increasing the surface temperature of the Black Sea increases the Grubel-Lloyd index, leading to the intensification of intra-industrial trade.

An error correction model based on the ARDL process was estimated in order to determine short-term relationships between the variables. The forecast results are presented in Table 7.

Table 7 ARDL (4, 0, 3, 0, 3) Error Correction Model Estimation Results

ECM regression
Case 4: Unrestricted constant and restricted trend

Variable	Coefficient	Std. error	t-statistic	Prob.
C	52.310	2.163	24.176	0.000
D(LGRU(-1))	0.214	0.035	6.036	0.000
D(LGRU(-2))	0.046	0.033	1.360	0.196
D(LGRU(-3))	0.182	0.033	5.521	0.000
D(LAKD)	-0.285	1.095	-0.260	0.798
D(LAKD(-1))	7.442	1.075	6.920	0.000
D(LAKD(-2))	6.593	1.187	5.550	0.000
D(LMAR)	-2.998	0.455	-6.584	0.000
D(LMAR(-1))	-1.953	0.479	-4.076	0.001
D(LMAR(-2))	-1.820	0.452	-4.021	0.001
CointEq(-1)	-0.76	0.031	-24.154	0.000
R-squared	0.979	Akaike criterion	-2.325	
Adj. R-squared	0.967	Schwarz criterion	-1.807	
F-statistic	84.071	Hannan-Quinn criterion	-2.163	
Prob (F-statistic)	0.0000	Durbin-Watson statistic	2.462	

Notes: The F-statistic calculated in terms of error correction coefficient is the same as the F-statistic value in Table 5.

Source: Calculated by the author using Eviews 10 program.

Table 7 contains the short-term regression results of the error correction model. The error correction coefficient (CointEq(-1)) was calculated as -0.76. This coefficient must be negative and statistically significant for its functionality. According to the information in the table, the coefficient is negative and has a statistical significance of 1%. In addition, since the coefficient is between 0 and -1, it will converge to the long-term balance value of the short-term shock without fluctuation. The deviations from the balance that will be experienced in the short-term will recover after about 1-3 (1/0,76) years and reach the long-term balance. The negative and significant error correction coefficient will give consistent results in terms of coefficient estimates of variables in the short-term. Accordingly, except for the LAKD variable, the short-term coefficients of the other variables have a statistically significant 1% level. The lags of LAKD variable have a positive relationship with the LGRU variable. Therefore, increases in LAKD(-1) and LAKD(-2) variables in the short-term increase the Grubel-Lloyd index and increase the level of intra-industry trade. The LMAR variable and its lags have a negative relationship with the LGRU variable. Therefore, as in the long-term, the increases in the LMAR, LMAR(-1) and LMAR(-2) variables in the short-term decrease the level of intra-industry trade.

5.4 Diagnostic Tests

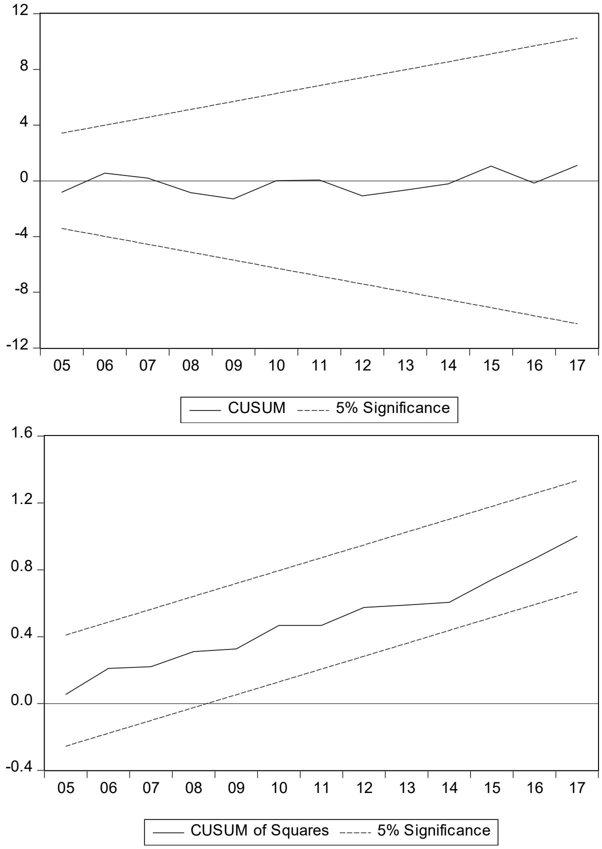
It is necessary to decide whether there is a problem of serial correlation and heteroscedasticity in the residues of the estimated ARDL (4,0,3,0,3) model. In addition, a number of diagnostic tests are required in terms of specification error, normality problem and parameter stability. The results of the diagnostic tests related to the model are presented in Table 8.

Table 8 Diagnostic Tests

Test	Specification	Test statistics	d.f.	Probability
Serial correlation	Breusch-Godfrey LM test	1.40	(2,11)	0.286
Normality	Jarque-Bera	0.677	2	0.712
Heteroscedasticity	Breusch-Pagan-Godfrey	0.910	2	0.573
	ARCH	2.82E-05	1	0.995
Functional form	Ramsey Reset Test	3.190	(1,12)	0.099

Source: Calculated by the author using Eviews 10 program.

According to the information in the table, the serial correlation of the estimated model was investigated. To determine this relationship, Breusch-Godfrey LM test was conducted up to 2 lags. Since the probability value of the test is greater than 5%, there is no serial correlation problem in the model. The Breusch-Pagan-Godfrey test and Auto-Regressive Conditional Heteroscedasticity (ARCH) test were used to examine whether there is a heteroscedasticity problem. Since the probability value of both tests is greater than 5%, there is no problem of heteroscedasticity in the model. The Jarque-Bera test was used to investigate whether the normality assumption is valid in the model. Since the probability value of the test is greater than 5%, it is understood that the residuals of the model are normally distributed. The Ramsey Reset test was used to determine whether there was specification error in the model. It is seen that the probability value of the relevant test is greater than 5%. Therefore, it is concluded that there is no specification error in the model. Finally, the stability of the estimated parameters needs to be examined. The CUSUM and CUSUMSQ charts, which examine the structural breaks in terms of variables by using squares of reversible error terms, were used. If the calculated values for both charts are within the critical limits of 5% significance level, it is understood that the coefficients in the ARDL model are stable.



Source: Calculated by the author using Eviews 10 program.

Figure 2 CUSUM and CUSUMSQ Charts of the Model

The CUSUM and CUSUMSQ charts related to the model are shown in Figure 2. The lower and upper dashed lines in Figure 2 represent 95% confidence limits, and straight lines show parameter estimates. Accordingly, since the parameter estimates in both charts are within the confidence limits, it is understood that there is no structural break related to the variables. Therefore, the parameters estimated for the model provide the stability condition.

6. Conclusion

The simultaneous export and import of goods produced by countries with similar factor intensity is known as intra-industry trade. In this respect, the increase in intra-industrial trade means that the country loses comparative advantage in terms of the goods produced by that industry. Intra-industry trade may vary for country or industry specific reasons. One of these reasons may be global climate change, which can vary depending on the degree of impact on both the country and the industry. For example, in the fisheries sector, global climate change causes physical and chemical changes in marine environments. A trend of increasing sea surface temperatures can alter the physiological structure and habitat of fish species. This may lead to a change in many socioeconomic factors by differentiating gains and losses between countries. Because of this importance, it was investigated whether the Turkish fisheries industry intra-industry trade structure was affected by global climate change for the period 1985-2017. In the study, sea surface temperatures of the Black Sea, Marmara, Mediterranean, Aegean seas, which are one of the most accurate indicators of climate change, and the Grubel-Lloyd index were used. The ARDL test developed by Pesaran, Shin, and Smith (2001) was used to determine the cointegration relationship between variables and to obtain long-term coefficients. The ECM test was used to estimate the short-term coefficients. Various diagnostic tests, especially the CUSUM and CUSUMSQ test, were applied to determine whether the predicted model was appropriate.

According to the cointegration test results of the study, there was seen to be a long-term relationship between the variables. According to the long-term coefficient analysis of the variables, it was determined that the surface temperature increases in the Aegean, Mediterranean and Marmara seas decrease the Grubel-Lloyd index. Therefore, the increase in the surface temperature of the aforementioned seas causes a decrease in intra-industry trade. Increases in the Black Sea surface temperature in the long-term were determined to increase the Grubel-Lloyd index. In this respect, it can be said that the increase in the Black Sea surface temperatures increases the intra-industrial trade, thus reducing Turkey's comparative advantage in the fishing sector. In addition, interestingly, the increase in sea surface temperatures appears to increase intra-industry trade from the southern seas to the northern seas (respectively Mediterranean, Aegean, Marmara and Black Sea). In the short-term, one-and two-period delayed surface temperatures in the Mediterranean increase intra-industrial trade. One and two period delayed surface temperatures of the Marmara sea reduce intra-industry trade as in the long-term. Important conclusions from the study are: (i) Global climate change can alter intra-industry trade in sectors affected by these changes; (ii) Global climate change, as an element specific to both country and industry, is a factor that changes intra-industry trade; (iii) As every country and every industry may be affected by global climate change at different rates, changes in the level of intra-industry trade can be observed.

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Appendix

Table A1 Grubel-Lloyd Index Values

YEARS	EXPORT (thousand dollars)	IMPORT (thousand dollars)	|X-M|	X+M	|X-M|/X+M	GL INDEX
1985	47223	534	46689	47757	0.977636786	0.022363214
1986	74230	1637	72593	75867	0.956845532	0.043154468
1987	64751	3445	61306	68196	0.898967681	0.101032319
1988	67054	1871	65183	68925	0.945709104	0.054290896
1989	69214	11310	57904	80524	0.719089961	0.280910039
1990	69575	27828	41747	97403	0.428600762	0.571399238
1991	60996	24770	36226	85766	0.42238183	0.57761817
1992	59988	30557	29431	90545	0.325042796	0.674957204
1993	29067	18483	10584	47550	0.222586751	0.777413249
1994	70697	38149	32548	108846	0.299027984	0.700972016
1995	87232	50857	36375	138089	0.263417072	0.736582928
1996	101510	60975	40535	162485	0.249469182	0.750530818
1997	124644	84852	39792	209496	0.189941574	0.810058426
1998	94483	76286	18197	170769	0.106559153	0.893440847
1999	98196	59207	38989	157403	0.247701759	0.752298241
2000	90902	51881	39021	142783	0.273288837	0.726711163
2001	73587	30291	43296	103878	0.416796627	0.583203373
2002	115827	28981	86846	144808	0.599732059	0.400267941
2003	148837	45566	103271	194403	0.531221226	0.468778774
2004	212297	92230	120067	304527	0.394273743	0.605726257
2005	243287	101464	141823	344751	0.411378067	0.588621933
2006	205368	148217	57151	353585	0.161632988	0.838367012
2007	221325	175014	46311	396339	0.116846942	0.883153058
2008	435361	198576	236785	633937	0.373515034	0.626484966
2009	342477	187013	155464	529490	0.293610833	0.706389167
2010	357160	241579	115581	598739	0.193040707	0.806959293
2011	432555	270905	161650	703460	0.229792739	0.770207261
2012	443784	313277	130507	757061	0.172386373	0.827613627
2013	567949	373066	194883	941015	0.207098718	0.792901282
2014	689685	372200	317485	1061885	0.29898247	0.70101753
2015	695245	429315	265930	1124560	0.23647471	0.76352529
2016	803056	390009	413047	1193065	0.346206619	0.653793381
2017	857688	445350	412338	1303038	0.316443573	0.683556427

Source: Author's calculation.

Table A2 Sea Surface Temperatures by Years (Degrees Celsius)

Years	Marmara SST	Black Sea SST	Mediterranean SST	Aegean SST
1985	14.7	14.5	21.2	18.2
1986	15.1	14.8	21.5	18.4
1987	14.4	13.8	20.9	18.2
1988	15.2	14.5	21.2	18.6
1989	15.5	15.1	21.1	18.4
1990	15.9	14.7	21.2	18.7
1991	15.7	15	21.2	18.5
1992	15.5	14.2	20.6	18.2
1993	15.4	14	20.7	18.2
1994	15.8	14.8	21.4	18.7
1995	15.2	14.4	21.1	18.1
1996	15	14.4	21	18.4
1997	14.8	14.5	21	18.1
1998	14.9	15.1	21.7	19
1999	15.5	15.5	22	18.8
2000	15.6	15.5	21.5	18.3
2001	16.2	15.9	21.8	18.8
2002	15.9	15.7	21.9	19.2
2003	14.9	14.8	21.6	18.6
2004	15.6	15.1	21.4	18.9
2005	15.6	15.4	21.2	19.2
2006	15.4	15.6	21.7	19.2
2007	16.4	15.9	21.6	19.2
2008	16.2	15.4	21.9	19.3
2009	15.8	15.8	21.9	18.5
2010	16.3	16.2	22	19.4
2011	15.2	15.5	21.8	18.6
2012	16	16	21.9	18.8
2013	15.9	15.7	21.8	18.9
2014	16.7	16.2	22	19.4
2015	16.7	16.2	22.2	19
2016	17.2	16.4	22.1	18.9
2017	16.4	15.6	22.3	18.8

Source: Author's calculation.

Table A3 ARDL(4, 0, 3, 0, 3) Model Estimation Results

Dependent variable: LGRU
Max dependent lags: 4 (automatic selection)
Model selection method: AIC
Fixed regressors: C @TREND
Number of models evaluated: 1024

Variable	Coefficient	Std. error	t-statistic	Prob
LGRU(-1)	0.450	0.038	11.622	0.000
LGRU(-2)	-0.168	0.040	-4.190	0.001
LGRU(-3)	0.136	0.040	3.380	0.004
LGRU(-4)	-0.182	0.033	-5.429	0.000
LEGE	-4.577	0.844	-5.419	0.000
LAKD	-0.285	1.339	-0.212	0.834
LAKD(-1)	-7.424	1.237	-6.001	0.000
LAKD(-2)	-0.849	1.057	-0.803	0.436
LAKD(-3)	-6.593	1.156	-5.701	0.000
LKARA	4.769	1.064	4.480	0.000
LMAR	-2.998	0.634	-4.726	0.000
LMAR(-1)	-1.221	0.521	-2.345	0.035
LMAR(-2)	0.133	0.431	0.309	0.762
LMAR(-3)	1.820	0.544	3.341	0.005
C	52.278	6.210	8.418	0.000
@TREND	0.031	0.004	7.154	0.000
R-squared	0.954	Akaike criterion	-1.981	
Adj R-squared	0.902	Schwarz criterion	-1.226	
F-statistic	18.189	Durbin-Watson stat.	2.462	
Prob (F-stat)	0.000			

Source: Calculated by the author using Eviews 10 program.