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THE RELATIONSHIP BETWEEN PARTICIPATION IN GLOBAL PRODUCTION NETWORKS AND ENVIRONMENTAL POLLUTION ORIGINATING FROM THE LOGISTICS INDUSTRY

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Abstract: Determining environmental pollution and the factors causing this pollution is important for the sustainability of economic activities. While this study deals with the environment within the framework of the logistics sector, it tries to understand logistics by placing it within the framework of production networks theory. So, this study examined the environmental pollution caused by the logistics industry, which mediates participation in global production networks. The sample of the study consists of 38 Islamic countries and time range of the data covers 2000-2018. The research method is panel cointegration. The results show that the participation of Islamic countries in global production networks is not environmentally friendly. A linear relationship has been determined in the long run between participation in global production networks and gases that are harmful to the environment originating from the logistics industry. Accordingly, the results show that CO2 and GHG arising from logistics industry and imports of intermediate goods, which represent participation in global production networks, move together in the long run. This result indicates that participation in global production networks for economic development may harm the sustainability of Islamic countries and hinder their development in the long run.

Keywords: Logistics, Green Logistics, Global Production Networks, Panel Cointegration, Economic Development

JEL: N70, Q5, F15, L14, C23, O19

Öz: *Çevre kirliliği ve bu kirliliğe neden olan faktörlerin belirlenmesi ekonomik faaliyetlerin sürdürülebilirliği açısından önemlidir. Bu çalışma lojistik sektörü çerçevesinde çevreyi ele alırken, lojistiği üretim ağları teorisi çerçevesine yerleştirerek anlamaya çalışmaktadır. Bu nedenle, bu çalışmada küresel üretim ağlarına katılıma aracılık eden lojistik sektörünün neden olduğu çevre kirliliği incelenmiştir. Çalışmanın örneklemi 38 İslam ülkesinden oluşmakta ve verilerin zaman aralığı 2000-2018 yıllarını kapsamaktadır. Araştırma yöntemi panel eşbütünleşmedir. Sonuçlar, İslam ülkelerinin küresel üretim ağlarına katılımının çevre dostu olmadığını göstermektedir. Küresel üretim ağlarına katılım ile lojistik sektöründen kaynaklanan çevreye zararlı gazlar arasında uzun dönemde doğrusal bir ilişki tespit edilmiştir. Buna göre sonuçlar, küresel üretim ağlarına katılımı temsil eden lojistik sektörü ve ara malı ithalatından kaynaklanan CO2 ve GHG'nin uzun vadede birlikte hareket ettiğini göstermektedir. Bu sonuç, ekonomik kalkınma için küresel üretim ağlarına katılımın İslam ülkelerinin sürdürülebilirliğine zarar verebileceğini ve uzun vadede kalkınmalarını engelleyebileceğini göstermektedir. 38 İslam ülkesinin küresel üretim ağları aracılığıyla uluslararası iş bölümüne katılımının sağlanması, lojistik operasyonların ve tedarik zinciri yönetiminin çevre dostu hale getirilmesi gerekmektedir.*

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1. Introduction

One of the most important questions of recent years is how global production takes place, works and managed as well as how countries, firms and individuals are affected by the results of global production. There are three theoretical answers to this question in the literature: Global Commodity Chains (GCC), Global Value Chains (GVC) and Global Production Networks (GPN).

These theoretical approaches contain differences that seem to be built on top of each other. The GCC approach centers the question of how global industries are organized. This question brings the firms that make up the industries to the center of the theory. Thus, the GCC approach enhances its understanding of global production by revealing the production and distribution relationships between firms that ultimately result in the production of a good or service. In the GVC approach, just as in the GCC approach, the question of industries in which firms are the main actors and how they are managed is central. In the GVC approach, however, this critical question is expanded by the difference in knowledge structures between industries and how this is reflected in the management of industries. The GPN approach significantly benefits from the wealth of information created by the GCC and GVC approaches and uses this information as a basis. The contribution of the GPN approach is to explain the multidimensional and multi-actor structure of global production by centered on the concepts of power and value (Coe, Dicken and Hess, 2008).

The differences between the explanations of all three approaches are so broad that the scope of this study is not appropriate for such a discussion. However, it would be appropriate to reveal the superiority of the network approach over the chain approaches in some respects. First, unlike chain approaches that try to understand global production in terms of hierarchical and linear relations, the network approach provides a more convenient basis for revealing the complex relations of global production and the competition that takes place in the context of these relations (Peter, 2002). On the other hand, the understanding that is stuck between inter-firm relations in chain approaches is no longer a constraint in the network approach. The network approach activates intuitions that things which happen outside the firm, as well as intra-firm and inter-firm relations, may be important in understanding global production. Because global production, which operates with the mobility of goods and, to a large extent intermediate goods, is not just a simple trade-off. It includes the information flow of multidimensional R&D, formal/informal organizations and consumers that make this trade-off possible (Hughes, 2000). In addition, moving away from the perspective of chain approaches and adopting the perspective of the network approach makes it possible to think about intangible elements such as culture that may be important for the operation of the production network (Barrett, Browne, & Ilbery, 2004). Finally, the network approach reminds us of the existence of very important service areas that enable the operation of the global production network, especially logistics services, which are denied or underestimated in chain approaches (Coe et al., 2008).

It is accepted that there is a linear relationship between the participation of countries in global production networks and the welfare level of the country. For example, World Bank put forward that these chains or networks are important derivers of growth performance, employment creation, and welfare. Participation to these enables countries to transfer new technology and production information. So, countries gets chance to produce higher value added goods at agriculture, manufacturing and services with the help of participation to these chains or networks (World Bank, 2021).

Considering that the most important indicators of welfare level are GDP and per capita income, participation in the GPN means that it has a positive effect on these indicators. All actors in the GPN act in a complementary relationship with each other and constitute the basic dynamic of economic development (Coe, Hess, Yeung, Dickens and Henderson, 2004). All actors in the global production network produce the par or parts of the final product that they are the most specialized in. As firms increase their flexibility and operate their production organizations more effectively, they become more competitive in global markets. Outsourcing is a form of relationship that is becoming common in companies' flexibility and transformation of production organizations. This form of relationship offers companies the opportunity to flexibly and activate their production processes without huge new investments and obligations. This form of relationship has been widely used in industries such as electronics, where modular manufacturing is easier, and has gradually spread to other industries. This form allows each actor to focus only on his own area of expertise, leave all the other stages that do not fall into their main field of activity to other actors who are experts in these stages, and finally, each actor works with high efficiency. This organizational change experienced by companies to reach a more competitive level means more growth opportunities at both regional and national level and increases development paths (Coe ve Yeung, 2015). In addition, it contributes to social developments as well as measurable economic developments such as increase in total output amount, wage level and per capita income, regardless of company, region and country level (Barrientos, Gereffi and Rossi, 2010), (Knorringa and Pegler, 2006), (Milberga and Winkler, 2011).

As modularization becomes widespread, it doesn’t surprise to see increase of relations among firms, regions and countries, and the share of intermediate goods in the total products. The development of each actor in this production organization, which causes an increase in the import and export of intermediate goods, their contribution to the production network and the benefit from this production network are directly affected by the production of other actors and the movement of these products on the space. In other words, the harmony of time and space becomes very important for the actors in GPN (Yeung, 2009). This importance is not only due to the delivery of the produced product to the final consumer. The increasing importance of time-space harmony in the production process is due to the fragmentation of the production process over space. Therefore, the logistics industry performs important functions in eliminating the contradictions between time and space for a GPN (Hall, Hesse and Jean-Paul, 2006) (Rodrigue and Hesse, 2006) (Rodrigue J.-p. , 2005).

Participation in global production networks becomes dependent on the activities that fall within the field of the logistics industry. Logistics connects manufacturers, suppliers, and consumers within the complex network that GPN creates. While the logistics industry performing its operations, it may cause a decrease in the growth potential of the country by damaging the environment and risking the long-term sustainability of resources. The actors aim to develop by participating in global production networks develop by using the advantages of these networks. However, this development has the potential to be prevented by the damage to the environment and the long-term sustainability of resources. For example, (Hamelinck, Suurs and

Faaij, 2005) stated that logistics operations cause environmental challenges. These environmental challenges cause bad economic performance in long run. Making logistics operations greener, results reduction of carbon emission and increase competitive capacity of exporter (Kee-hung and Wong, 2012). In addition, (Boukherroub, Ruiz, Guinet and Fondrevelle, 2015) showed that actors which remove bad effects of carbon emissions derived from logistics operations achieved better economic performance, new market opportunities and environmental sustainability. Similar suggestions can be seen in research such as (Nassani, Aldakhil, Abro and Zaman, 2017), (Khan, Qianli, SongBo, Zaman and Zhang, 2017), (Bekhet and Othman, 2018) and (Li, Sohail, Majeed andAhmad, 2021).

Although it is a widely known fact that the logistics industry causes environmental pollution, the question of how this industry affects the environment through the functions it performs in the operating of global production networks has not been clearly answered in the literature. This is a question that needs to be answered for different countries, country groups and periods. However, as stated previously, participation in global production networks is an issue in which underdeveloped and developing countries are encouraged because of being associated with economic growth and welfare increase. For this reason, it would be meaningful to prioritize the question of how the logistics industry affects the environment in the process of participation in environmental pollution, global production networks, in favor of underdeveloped and developing countries. The aim of this study is to shed light on the relationship between participation in global production networks and carbon emissions derived from the logistics industry, which makes this participation possible. For this, 38 Islamic countries, which are generally accepted as underdeveloped or developing countries, are selected. The next chapter is about explanations of the data set and estimation method. In the estimation section, there will be reports and evaluations of the results of the model. This study will be completed with a conclusion section that includes the evaluations and suggestions of the analysis results.

2. Literature Review

In the logistics literature, the relationship between logistics and the environment has been studied mainly in the last 10 years, and it corresponds to the concepts of green logistics, closed-loop logistics, closed-loop supply chain, reverse logistics and environmental (Islam, Moeinzadeh, Tseng and Tan, 2020). According to (Srivastava, 2007), logistics activities cause environmental pollution through the raw materials used, distribution and storage. However, when we remember the role of logistics in the movement of freights on space, it would not be wrong to say that carbon emission is the primary factor in environmental pollution caused by logistics activities. Because a significant part of the logistics activities that bring movement to the freights work with vehicles that consume fossil fuels.

Looking at the studies in the literature chronologically will also make it possible to follow the development of studies in this field. For this reason, it would be appropriate to start the literature section with one of the earliest studies (Tang, Wang, Yan and Hao, 2015). In this study, the authors examined the relationship between logistics operations and firms' carbon emissions using firm data. The results in the study are remarkable although the use of microdata leads to narrow inferences, since it increases the importance of many parameters such as the route where the operations are carried out, the combination of logistics modes, the quality of the transported or stored cargo, According to the results, companies can reduce their carbon emissions to a moderate extent without causing an increase in total costs by reducing the frequency of operations and re-evaluating their stock control decisions. Another inference from the findings is that the order costs per unit and delivery times are the costs that come with reducing carbon emissions. This result contrasts with the widely accepted inverse relationship between storage and carbon emissions.

Another study that contributes to the literature between logistics and environment is (Zaman and Shamsuddin, 2017). The researchers examined the relationship between logistics performance indicators and national economic indicators as well as the environment within the framework of 27 European Union member countries. The data used by the authors cover the years 2007-2014. According to the findings, the amount of energy used per output increases as the logistics performance increases. When we look at the sub-components of logistics performance, there is a linear relationship between the success in tracking the freights and carbon emissions. It has been determined that there is an inverse relationship between the quality of customs transactions, which have a significant effect on freight flow, and carbon emissions. On the other hand, carbon emissions decrease as the logistics infrastructure is improved. Another important finding obtained from the study is about how the competitiveness of the logistics sector effects the environment. Accordingly, the competitiveness of countries in the field of logistics reduces environmental pollution by reducing the use of fossil fuels and contributes to sustainable economic development.

(Khan and Qianli, 2017) examined the relationship between per capita GDP and foreign direct investment in the country, as well as environmental indicators, fossil fuels used in the logistics sector and renewable energy in England. The data used in the analyzes performed with the Auto-Regressive Distributed Lag (ARDL) method cover the years 1981-2016. As a result of the analysis, the authors revealed that renewable energy is effective in transforming logistics operations into a form that is less harmful to the environment. As expected, a linear relationship was found between fossil fuels and environmentally harmful logistics operations. Lastly, it was determined that foreign direct investments also have a reducing effect on logistics activities that pollute the environment.

Asia is one of the regions with the greatest interest in the logistics sector. (Liu, Yuan, Hafeez and Yuan, 2018) examined the relationship between logistics operations and environmental sustainability, which is closely related to environmental pollution, on 42 Asian countries. The data used in the study cover the years 2007-2016 and the estimation method was determined as the Generalized Method of Moments (GMM), in which the lagged values of the dependent variable are included in the estimation model as the independent variable. The results revealed that the existence of a direct relationship between the quality of logistics operations and environmental degradation. Based on the findings, the authors especially emphasized the importance of the inverse relationship between the quality of international logistics operations and total carbon emissions.

Another study using multi-country samples (Khan, Zhang, Anees, Golpîra, Lahmar and Qianli, 2018). In this study, the relationship between logistics operations that cause environmental pollution and energy need, economic growth and environmental sustainability was examined for a group of 43 countries consisting of developed and developing countries, using the data between 2007 and 2013. The method of the study was the GMM method like in (Liu, Yuan, Hafeez and Yuan, 2018). The results showed that logistics operations increase non-renewable energy consumption and thus harm economic sustainability by causing environmental pollution. Another remarkable result obtained in the study is that weak logistics infrastructure also causes environmental pollution that will increase carbon and greenhouse gas emissions.

Similarly to Zaman and Shamsuddin (2017) but with a different method, (Magazzino, Mele and Schneider, 2022) examined the impact of logistics operations on environmental pollution in the context of supply chain management, using the data of 27 European Union member states between 2007 and 2018. The method of the study was determined as Artificial Neural Networks. The variables used in the study are the Logistics Performance Index and its sub-components, petroleum products used by the transportation sector, GDP, carbon emissions from the transportation sector and value-added commercial activities. Based on the results, the authors revealed that the consumption of petroleum products and carbon emissions have significant effects on the logistic indices. On the other hand, it has been emphasized that the change in oil usage is not only due to the performance of the supply chain.

One of the most recent studies is belong to (Karaduman, Karaman-Akgül, Çağlar and Akbaş , 2020). Researchers examined the relationship between logistics and carbon emissions, one of the primary causes of environmental pollution, within the framework of 11 Balkan countries, using the data between 2007 and 2016. The Logistics Performance Index published by the World Bank was used to represent logistic quality. Carbon emission per capita was used for carbon emission. According to the results, an outstanding and statistically significant relationship was determined between logistics performance and carbon emissions.

We would like to conclude the literature section with the study (Liu, He, Shi and Li, 2021). In this study, using the data between 2009-2019, the relationships between logistics centers, technological development and air pollution were examined for the sub-regions of the city of Chongqing, China. The results indicated that logistics centers are statistically significant factors in reducing air pollution under the conditions of technological developments. In addition, it was revealed that the reducing effect of logistics centers on air pollution varies according to the concentration in the sub-regions.

According to this summarized literature, there are some gaps in the literature, both empirical and methodological. As explained in detail in the introduction, the logistics sector is an important component that enables countries to participate in global production networks. How the logistics sector harms the environment while enabling countries to participate in global production networks remains an unasked question in the existing literature. As stated before, the most important indicator of countries' participation in these networks is the trade of international intermediate goods. Therefore, the question of how the logistics industry harms the environment while ensuring the participation of countries in the global production networks is technically different from the question of how the logistics industry harms the environment. Knowing the answer to this question is very important in terms of how participation in global production networks, which is recommended by many groups to developing and underdeveloped countries for economic development and development, will affect the long-term sustainable development of the countries that are subject to the recommendation.

On the other hand, the Logistics Performance Index was mainly used to represent the logistics performance in the studies. However, this index, which measures the logistics performance of countries, consists of sub-components of *infrastructure*, *customs*, *tracking* and *tracing*, *timing*, *international shipment,* and *logistics competence*, which is a very subjective evaluation. The consistency of these components in measuring the logistics performance of countries is controversial, as noted in (Beysenbaev & Dus, 2020). Moreover, and more importantly, this index does not measure emissions from the activities of the sector. Environmental effects of logistics are not included in this index. In addition, the variable that is mainly used as a measure of carbon emission in studies is total emission and it measures the emission resulting from the activities of all parts of the society. For this reason, it is methodologically not possible to make a complete and consistence inference about the emissions from the logistics sector from the studies using the Logistics Performance Index in the literature.

Another gap in the literature concerns the country group. It is seen that the studies in the literature are mainly carried out on the developed countries of Asia and Europe. However, it is widely known that it is possible to harm the environment more easily in underdeveloped countries with low environmental standards. However, it is seen that no study has been conducted in the literature, where the sample consists predominantly of developing and underdeveloped countries. Conducting such a study will not only fill the gap in terms of sample in the literature, but also reveal the chances of countries whose most important goals are economic development to achieve their long-term goals.

3. Data and Methodology

The impact of human behavior on the environment does not occur in the short run. For this reason, the most important aim of the study is to analyze the long-term movement of environmental and economic sustainability through participation in global production networks with the most appropriate method. As will be explained in the following lines, the estimations about the long-term movement of the parameters in certain conditions correspond methodologically to the cointegration tests. Also, the sample chosen in this study consists of the countries[1] and the observations of the selected indicators in these countries between the years 2000-2018, the details of which are presented in table 1. So, the sample shows the characteristics of panel data. Therefore, the relationship between participation in the GNP and carbon and greenhouse gas emissions originating from the logistics industry is analyzed by panel cointegration method in this study.

Participation of a country in the GNP is represented by import of intermediate goods. In addition, total output (GDP), population and international foreign direct investments are used as explanatory variables. The data and its explanations are presented in the table 1 below.

[1] Those countries are Azerbaijan, Bahrain, Bangladesh, Benin, Brunei, Burkina Faso, Cameroon, Cote d'Ivorie, Egypt, Gambia, Guinea, Guyana, Indonesia, Iran, Jordan, Kazakhstan, Kuwait, Kyrgyzstan, Lebanon, Malaysia, Maldives, Mali, Mauritania, Morocco, Mozambique, Niger, Nigeria, Oman, Pakistan, Qatar, Saudi Arabia, Senegal, Suriname, Togo, Tunisia, Turkey, Uganda, and United Arab Emirate.

Table 1. Variables and explanations

Variables	Explanation	Unit	Source
CO2	Carbon dioxide	Micromole mol^{-1}	climatewatchdata.org
GHG	Greenhouse Gases	Parts per million	climatewatchdata.org
InterImport	Import of intermediate goods	Thousand $	World Bank Data Base
GDP	Gross Domestic Product	Constant Price USD-2015	Sesric Data Base
POP	Population	Body count	Sesric Data Base
FDI	Foreign Direct Investment	Current Prices in Millions $ (inward flow)	World Bank

The following two models are estimated by the above data:

$$CO2_{it} = \alpha_1 + \alpha_2 InterImport + \alpha_3 GDP + \alpha_2 POP + \alpha_2 FDI + \varepsilon_{it} \qquad (1)$$

$$GHG_{it} = \alpha_1 + \alpha_2 InterImport + \alpha_3 GDP + \alpha_2 POP + \alpha_2 FDI + \varepsilon_{it} \qquad (2)$$

In panel data analysis, cross-section dependency testing should be done both for the variables and the model/models. The Pesaran (2004) CD test is performed for cross-section dependency in this study. This test is used when $N \to \infty$ and $T \to \infty$. The test statistics are calculated as follows:

$$CD = \sqrt{\left(\frac{2T}{N(N-1)}\right)} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}\right) \qquad (1)$$

$$\hat{\rho}_{ij} = \frac{\sum_{t=1}^{T} \hat{u}_{it}\hat{u}_{jt}}{\left(\sum_{t=1}^{T} (\hat{u}_{it})^2\right)^{1/2} \left(\sum_{t=1}^{T} (\hat{u}_{jt})^2\right)^{1/2}} \qquad (2)$$

In the CD test, the null hypothesis is no cross-sectional dependence, while the alternative hypothesis assumes that there is cross-sectional dependence. The cross-section dependence requires second-generation unit root tests. CADF (Cross-sectional augmented Dickey-Fuller) test, one of the second-generation unit root tests, was used in this study. The CADF test statistic is as follows:

$$\Delta y_{it} = a_{i0} + a_{i1}t + a_{i2}y_{i,t-1} + a_{i3}\bar{y}_{i,t-1} + \sum_{j=0}^{p} d_{ij}\Delta\bar{y}_{t-j} + \sum_{j=0}^{p} \delta_{ij}\Delta y_{t-j} + v_{it} \qquad (3)$$

$$H_0: a_{i2} = 0 \; for \; i = 1,2, \ldots N$$

$$H_1: \begin{cases} a_{i2} = 0 \ \ for\ i = 1,2, \dots N_1 \\ a_{i2} < 0\ for\ \ i = \ N_1 + 1, N_1 + 2 \dots\dots N \end{cases}$$

Regression analyzes cause spurious regression problem with non-stationary variables at level. However, long-term relationship can be tested with variables which are not stationary at the level but stationary at first difference. Panel cointegration tests are used to test long-term relationship. Panel cointegration tests are divided into first and second generation. The generation is selected depending on the results of the cross-section dependency test. In case of cross-section dependency, second generation panel cointegration tests are performed. Otherwise, first generation panel cointegration tests are performed. The first generation Pedroni (1999) and Kao (1999) panel cointegration tests were performed according to the result of cross-section dependence in this study.

Pedroni (1999) generates seven panel cointegration test statistics. Four of them are based on within-dimension and three of them are based on between-dimension test statistics. The null hypothesis of cointegration for within-dimension statistics is as follow:

$$H_0: \gamma_i = 1\ for\ all\ i$$

$$H_1: \gamma_i = \ \gamma < 1\ for\ all\ i$$

The null hypothesis of cointegration for between-dimension statistics is as follow

$$H_0: \gamma_i = 1\ for\ all\ i$$

$$H_1: \gamma_i \ < 1\ for\ all\ i$$

Distinctly Pedroni (1999), Kao (1999) generates two specifications under the null hypothesis of no cointegration. One of them is Dickey-Fuller and the other is Augmented Dickey-Fuller type. Hypothesis of Dickey-Fuller and Augmented Dickey-Fuller are respectively as follow:

Dickey-Fuller;

$$y_{it} = \alpha_i + \beta x_{it} + e_{it} \tag{4}$$

$$y_{it} = y_{it-1} + u_{it} \tag{5}$$

$$x_{it} = x_{it-1} + \varepsilon_{it} \tag{6}$$

y_{it} and x_{it} are random walks, and under the null hypothesis of no cointegration. In addition, the residual (e_{it}), shouldn't be stationary. According to these specifications Dickey-Fuller test is estimated as follow:

$$\hat{e}_{it} = \rho \hat{e}_{it-1} + v_{it} \tag{7}$$

and Augmented Dickey-Fuller;

$$\hat{e}_{it} = \rho \hat{e}_{it-1} + \sum_{j=1}^{p} \gamma_j \Delta \hat{e}_{it-j} + v_{itp} \tag{8}$$

The null and alternative hypotheses for Dickey-Fuller and Augmented Dickey-Fuller test which examine whether x_{it} and y_{it} are cointegrated or not as follow:

$$H_0: \rho = 1\ (no\ cointegration\ for\ panel)$$

$$H_1: \rho < 1 \ (cointegrated\ panel)$$

4. Estimation

Estimates without detecting the cross-sectional dependence may cause biased results (Breusch and Pagan, 1980), (Pesaran, 2004). Therefore, firstly it should be tested cross-section dependence for the variables. Because of the structure of data (N>T) Pesaran (2004) cross-section dependency test is preferred in this study.. Pesaran (2004) cross-section dependency test results are presented in the table 2.

Table 2. Pesaran (2004) Cross-Section Dependence test results for variables

	CD-test	p-value	average joint T
GDP	99.736	0.000	19.00
Import	44.376	0.000	19.00
CO2	89.127	0.000	19.00
GHG	83.685	0.000	19.00
POP	113.63	0.000	19.00
FDI	40.762	0.000	19.00

Note: *%10,**%5 and ***%1

According to the cross-sectional dependency test results, the probability values of all variables are less than 0.05. This result means that the H_0 hypothesis, which has no cross-sectional dependence, is rejected for all variables. According to this result, all the variables are cross-section dependent. The presence of cross-sectional dependence requires second generation unit root tests. So, the results of the CADF which one of the second-generation unit root tests are reported in the table 3.

Table 3. CADF unit root test results.

	Constant		Constant+Trend	
	I(0)	I(1)	I(0)	I(1)
GDP	-1.169	-2.345***	-1.185	-2.980***
Import	-2.409**	-	-2.542	-4.242***
CO2	-2.214	-4.726***	-2.666	-4.738***
GHG	-1.938	-4.275***	-2.527	-4.501***
POP	-2.352**	-	-1.292	-3.225***
FDI	-2.255	-4.190***	-3.278	-5.634***

Note: *%10,**%5 and ***%1

The CADF test was performed for both constant and constant+trend. It is seen that the import of intermediate goods and the population variables are stationary at level with constant terms. Except for the two variables, the other variables are not stationary in level but stationary at the first difference. However, when this test is repeated with constant and trend, it is seen that all variables are not stationary in level. And all the variables are stationary at first difference with 0.01 significance level.

Performing regression analysis according to the unit root test results of the variables leads to spurious regression results and causes biased estimates. However, the stationary of the variables at the first difference makes it possible to test the long-term relationships between the variables. Cointegration test reveal whether the variables move together or not in the long run. Cointegration tests are divided into two as first and second-generation tests, depending on cross-section dependency for the models. For this reason, cross-sectional dependence should be tested for models to decide generation of cointegration test. Cross-section dependency test results of Model-1 and Model-2 are reported in the table 4.

Table 4. Cross-Section Dependence for Models

	Model-1		Model-2	
LM	946.6***	937.8***	883.2***	879.3***
LM adj	4.766***	1.932	1.516	-0.8691
LM CD	-0.3437	0.4375	0.07	1.066
	No trend	Trend	No trend	Trend

Note: *%10,**%5 and ***%1

Cross-section dependency tests for each model are performed in two steps with trend and non-trend. The LM test statistic is used for T>N, the LM adj test statistic is used both for N>T and N<T. LM CD is used only for N>T. So, LM adj and LM CD test statistics are important for this study because of the data structure. For the first model, LM and LM adj test statistics show that there is a cross-sectional dependence at 0.01 significance level, while LM CD shows that there is no cross-sectional dependence in the non-trend estimation. However, when the trend is added to the model, the LM adj and LM CD test statistics show that there is no cross-sectional dependence. For the second model, the LM adj and LM CD test statistics show that there is no cross-sectional dependence in both with trend and non-trend estimations. Its means that sections (countries) have not affected each other. That is, when an unexpected shock occurs in a country, this shock remains limited to that country. In addition, this result allows to perform first generation cointegration tests. According to cross-section dependence test results, Kao (1999) and Pedroni (1999) cointegration tests are performed.

Table 5. Kao (1999) Cointegration test results

	Model-1	Model-2
Modified Dickey-Fuller t	0.4767	0.6026
Dickey-Fuller t	-1.0423	-0.9464
Augmented Dickey-Fuller t	-1.5249**	-1.9852**
Unadjusted modified Dickey-Fuller t	-0.6726	-0.0820
Unadjusted Dickey-Fuller t	-1.8749**	-1.4586*
Info Criteria	(AIC)	
Lag (Newey West)	1.66	
Number of Panels	38	
Number of Periods	17	

Note: *%10,**%5 and ***%1

Modified Dickey-Fuller provides the adjusted statistics for the autocorrelation problem with the Newey-West approach. Dickey-Fuller-t (DF) and Augmented Dickey-Fuller-t (ADF) are test statistics used in time series analysis. Unadjusted modified Dickey-Fuller-t shows unadjusted versus autocorrelation. Unadjusted Dickey-Fuller-t shows unadjusted results versus autocorrelation at the table 5.

P-Value values < 0.05 for all statistics means that there is cointegrated variables. However, this condition is not met in the models. Therefore, the Modified Dickey-Fuller-t or Augmented Dickey-Fuller-t statistics, which corrects the autocorrelation problem, is accepted as a sufficient condition to show the existence of a long-term relationship between the variables. As seen in the table 5, the probability of Augmented Dickey-Fuller-t statistics in both models are 0.05. This result shows that there is a long-run relationship between CO2 and GHG originating from the logistics industry and imports of intermediate goods which represent participation in global production networks, GDP, population and FDI.

Table 6. Pedroni Cointegration Test Results

	Model-1		Model-2	
Test Statistics	Panel	Group	Panel	Group
v	-0.1052	-	0.1086	-
rho	0.842	3.278	0.7455	3.191
t	-7.288	-7.288	-6.857	-7.48
adf	-30.27	2.434	-2.557	-2.036
No. of panel units.	38		38	
No. of panel obs.	722		722	
Lag select	AIC		AIC	

Note: *%10,**%5 and ***%1

Pedroni (1999) cointegration test calculates two statistical classes. They are Panel and Group statistics. Four (v, rho, t, adf) statistics are calculated in the Panel column and three (rho, t, adf) statistics are calculated in the Group column., At least 5 statistics must be significant for alternative hypothesis that there is cointegration. According to the standard normal distribution, the 0.05 critical value is 1.96. Each of these statistics is compared to this critical value as an absolute value. It is checked for how many statistics are greater than the critical value.

In the first model, it is seen that the statistics of panel t (-7.288), panel adf (-30.27), group rho (3.278), group-t (-7.288) and group adf (2.434) are significant when compared to the 0.05 critical value. A similar result is valid for the second model which only the dependent variable different from first model. In the second model, it is seen that the statistics of panel t (-6.857), panel adf (-2.557), group rho (3.119), group-t (-7.48) and group adf (2.036) are significant compared to the 0.05 critical value. Thus, Pedroni (1999) cointegration test results support Kao (1999) test results. That is, there is a long-run relationship between CO2 and GHG originating from the logistics industry and imports of intermediate goods, GDP, population and FDI.

As can be seen, both Pedroni (1999) and Kao (1999) cointegration tests for both of the models show that there is a long-term relationship. This is very important result. However, it does not provide any information about which explanatory variables move together with CO2 and GHG originating from the logistics industry in the long run. So, it is necessary to obtain long-run cointegration coefficients. Cointegration coefficients can be obtained with different estimators. But Kao, Chiang and Chen, (1999) emphasizes that the Dynamic Ordinary Least Square (DOLS) estimator is superior to other estimators, because of the DOLS estimator eliminates the problem of estimating bad parameters (Kao, Chiang and Chen, 1999: 703).

Table 7. Long Run Coefficients (DOLS)

	Model-1 (Dep. Var.: CO2)	**Model-2 (Dep. Var.: GHG)**
Import	0.000171*** (5.18E-05)	0.000342*** (0.000102)
GDP	0.000336*** (2.57E-05)	0.000674*** (5.04E-05)
POP	0.005839*** (0.000707)	0.012059*** (0.001385)
FDI	0.000106 (0.000123)	0.000255 (0.000241)
$\boldsymbol{R^2}$	0.699824	0.709678
$\boldsymbol{Adjusted\ R^2}$	0.697444	0.709152

Note: *%10,**%5 and ***%1

The results of the DOLS estimator are presented in the table 7. It is seen that. $R^2$and $Adjusted\ R^2$ are within reasonable level. FDI is statistically insignificant for both of the models. All other explanatory variables have a statistically significant effect on CO2 and GHG originating from the logistics industry in both the first and second models. In addition, the coefficients of all explanatory variables are positive. Therefore, there is a linear relationship between imports of intermediate goods, GDP and population, and CO2 and GHG originating from the logistics industry. This result shows that participation in global production networks increases the harmful results of CO2 and GHG arising from the logistics industry, which are expected to negatively affect sustainability in the long run.

5. Conclusions and Recommendations

Global production networks, which are one of the production organizations created by globalization and the globalization of production, provide development potential to countries, regions, and companies. So, participation in global production networks is among the most important goals of countries, regions, and companies. And these economic units welcome all developments that facilitate participation in global production networks. But as global production networks expand and deepen, they affect many other parameters. This study examined the impact of global production networks on environmental pollution originating from the logistics industry.

The countries that are the subject of the study are 38 Islamic countries. At the same time, almost all these countries are evaluated in the category of either underdeveloped or underdeveloped countries. One of the transformations that will help the economic development of these countries is participation in global production networks. This participation takes place through the services provided by the logistics industry. Although participation in global production networks contributes to the economic development of countries in the short term, there are many question marks on its long-term results.

This study examined the environmental pollution caused by the logistics industry, which mediates participation in global production networks, with the data of 38 Islamic countries. The results show that the participation of 38 Islamic countries in global production networks is not environmentally friendly. A linear and positive relationship has been determined between participation in global production networks and gases that are harmful to the environment originating from the logistics industry in the long run. This result indicates that participation in global production networks for economic development may harm the sustainability of the resources of those countries and hinder their development in the long run.

This is a result that should be considered in detail. Developing or underdeveloped countries must participate in the international division of labor via global production networks in order to achieve economic development and raise it to high levels. Renounce is not an option. However, the result shows that participation in the international division of labor through global production networks has long-term drawbacks for countries in this category. Therefore, as an option, it remains to make participation in the international division of labor more environmentally friendly through global production networks.

When considered in the context of logistics, it is necessary to make participation in the international division of labor through global production networks and transform logistics operations and supply chain management more environmentally friendly. The results show that CO2 and GHG originating from logistics and imports of intermediate goods, which represent participation in global production networks, move together in the long run. Making logistics operations and supply chain management greener can be accomplished in two ways. Replacing the vehicles used in these operations with more environmentally friendly ones is one of the options. Vehicles that do not pollute the environment are generally vehicles with the latest technology. Therefore, it is not possible or easy to acquire these tools without high-budget investments. Considering the country group that is the subject of this study, it is difficult to say that these countries have the financial facilities to purchase vehicles that will make their logistics operations more environmentally friendly. In addition, the logistics (highway, port, railway, etc.) infrastructures of these countries must be compatible with environmentally friendly vehicles. This means that replacing the vehicles used in logistics operations with more environmentally friendly ones is insufficient. In addition to replacing the vehicles used in logistics operations with more environmentally friendly ones, these countries must adapt their logistics infrastructures to these more environmentally friendly vehicles. Again, considering the country group, it is not possible to say that countries have the financial means to transform their logistics infrastructure in the short term.

The second option which makes logistics operations more environmentally friendly is ecologic logistics management. This requires developing operational methods that will reduce the share of vehicles and modes that contribute greatly to CO2 and GHG emissions in logistics operations. From this point forth, the share of road transport becomes important. Because road transport is the method that contributes the most to environmental pollution although it provides operational flexibility. Considering the amount of cargo carried, less cargo is transported by roads compared to sea, inland waterway, and railway. Therefore, although it is difficult to participate in the international division of labor through global production networks with more environmentally friendly way due to the inadequacy of financial opportunities, it may be an important step to replace the types of operations that contribute greatly to CO2 and GHG emissions in logistics operations with other (environmentally friendly) types. This can be an important transformation not only for 38 Islamic countries but also for other developing and underdeveloped countries.

As a result, it should be noted that the governments of the countries have important duties. Governments should take steps to make both logistics operators and logistics infrastructures greener. Incentives and financing opportunities can be provided for logistics operators to replace their existing environmentally polluting operational tools with more environmentally friendly ones. Passing documents, transport permits and licenses may be granted to operators whose licenses are more environmentally friendly. Logistics infrastructure can be transformed to be compatible with environmentally friendly logistics tools.

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