FOREIGN DIRECT INVESTMENTS, TRADE OPENNESS AND CO2 EMISSIONS RELATIONSHIP: THE CASE OF 1995-2019 EU COUNTRIES

INVERSIONES EXTRANJERAS DIRECTAS, APERTURA COMERCIAL Y RELACIÓN DE EMISIONES DE CO2: EL CASO DE LOS PAÍSES DE LA EU 1995-2019

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ABSTRACT

Foreign Direct Investments (FDI), which are very important in the economic development of countries, prefer regions with free trade. Since the share of international trade in the world economy is constantly increasing, trade openness and foreign direct investments have become more important for countries. However, the increase in trade and FDI entries can have negative effects on the environment. Although many different variables are included in the literature as determinants of carbon emission, foreign direct investments are mostly taken as an explanatory variable with the effect of the economic globalization process.

The aim of this paper is to analyze the relationship between FDI, trade openness and CO2 emission for the 1995-2019 period in 24 EU countries. The relationship between variables was estimated by applying panel AMG estimator and Emirmahmutoglu and Kose causality tests to series with cross-sectional dependency. Empirical results for the overall panel show that there is unidirectional causality from carbon emission to trade openness and FDI. There is a directional causality from FDI to trade openness for the general panel has been determined.

When analyzed on a country basis, there is unidirectional causality from carbon emission to trade openness for Bulgaria, Italy, Latvia, Poland, Portugal and Slovenia. Likewise, for Austria, Denmark, Estonia, Finland, France, Germany, Poland, Portugal, Spain and Switzerland, there is unidirectional causality from carbon emission to FDI. In addition, when analyzed on a country basis, there is a one-way causality relationship from foreign direct investments to trade openness for Bulgaria, Italia, Latvia, Poland, Portugal and Slovenia. For Bulgaria, Finland and Germany, there is a one-way causality from trade openness to foreign direct investment. The importance of this study derives from the emphasis on the need for environmentally protective FDIs to reduce carbon emissions.

Keywords: Carbon emission; foreign direct investment (FDI); trade openness; environmental Kuznets curve; pollution haven hypothesis; halo effect.

Cómo citar:
Kamaci , Ahmet; Gul, Ekrem; Torusdag, Mustafa. (2021). Foreign direct investments, trade openness and CO2 emissions relationship: the case of 1995-2019 eu countries. *Revista de Investigaciones Universidad del Quindío*, 33(2), 56-73. https://doi.org/10.33975/riuq.vol33n2.637

Información del artículo:
Recibido: 23 junio 2021; Aceptado: 04 agosto 2021

RESUMEN

Las Inversiones Extranjeras Directas (IED), que son muy importantes en el desarrollo económico de los países, prefieren regiones con libre comercio. Dado que la participación del comercio internacional en la economía mundial aumenta constantemente, la apertura comercial y las inversiones extranjeras directas se han vuelto más importantes para los países. Sin embargo, el aumento del comercio y las entradas de IED pueden tener efectos negativos sobre el medio ambiente. Aunque en la literatura se incluyen muchas variables diferentes como determinantes de la emisión de carbono, la Inversión Extranjera Directa se toma principalmente como una variable explicativa del efecto del proceso de globalización económica.

El objetivo de este trabajo es analizar la relación entre la IED, la apertura comercial y la emisión de CO2 para el período 1995-2019 en 24 países de la EU. La relación entre variables se estimó aplicando el estimador de panel AMG y las pruebas de causalidad de Emirmahmutoglu y Kose a series con dependencia transversal. Los resultados empíricos del panel general muestran que existe una causalidad unidireccional entre la emisión de carbono y la apertura comercial y la IED. Se ha determinado una causalidad direccional de la IED a la apertura comercial para el panel general.

Cuando se analiza por país, existe una causalidad unidireccional de la emisión de carbono a la apertura comercial para Bulgaria, Italia, Letonia, Polonia, Portugal y Eslovenia. Asimismo, para Austria, Dinamarca, Estonia, Finlandia, Francia, Alemania, Polonia, Portugal, España y Suiza, existe una causalidad unidireccional de la emisión de carbono a la IED. Además, cuando se analiza por países, existe una relación de causalidad unidireccional entre las inversiones extranjeras directas y la apertura comercial para Bulgaria, Italia, Letonia, Polonia, Portugal y Eslovenia. Para Bulgaria, Finlandia y Alemania, existe una causalidad unidireccional entre la apertura comercial y la inversión extranjera directa. La importancia de este estudio se deriva del énfasis en la necesidad de IED protectoras del medio ambiente para reducir las emisiones de carbono.

Palabras clave: Emisión de carbono, Inversión Extranjera Directa (IED), apertura comercial, curva de Kuznets ambiental, hipótesis de refugio de contaminación, efecto halo.

JEL Classification: *F18, Q56, C33*

INTRODUCTION

Foreign Direct Investment plays an important, determinative key role in the economic development of countries. Countries with high trade openness attract more FDI as they are more integrated with the world. However, FDIs increase CO2 emission. CO2 emission, which is an important indicator of global warming, is also an important indicator of environmental pollution. Therefore, it is important to handle the impact of openness and FDI on CO2 emissions.

According to the World Development Indicator, the share of international trade in the world economy, which was 25% in the 1960s, increased to 58% in 2015. Greenhouse gas emissions, 73% of which are CO2 emissions, have also increased rapidly due to the increase in trade openness. In this direction, in order to reduce greenhouse gas emissions and control global warming, the Kyoto Protocol was signed in 1997 and it was accepted with the agreement of the countries that make up more than 95% of global emissions (Zhang et al., 2017: 17616).

Kuznets (1955), in his study of the relationship between economic growth and income distribution inequality, argued that the increasing income inequality started to decrease after a certain turning point due to the continuation of economic development and this change was in the form of reverse-U (Kuznets, 1955: 14). This hypothesis revealed by Kuznets Grossman and Krueger (1991) adapted it to economic growth and environmental pollution. In later studies, the relationship between income and environment was named as the environmental Kuznets curve (EKC) hypothesis (Grossman and Krueger, 1991).

The EKC hypothesis suggests that in the early stages of economic growth, environmental pollution will increase and environmental improvement will occur with an increase in income levels. This means that the environmental impact indicator is an inverted U-shaped function of per capita income (Stern, 2004: 1419).

The theoretical basis of the EKC hypothesis is the scale, composition and technical effect (Grossman and Krueger, 1995: 355): The scale effect means that fluctuations in trade lead to an increase in production and CO2 emissions. It also states that the expansion in the markets will increase the production and consumption, and the increase in pollution will increase. Composition effect, on the other hand, shows the allocation of traded goods and the effects of trade on pollution, Technical effect, on the other hand, increases the technological innovation with the trade openness, decreases the emission intensity, decreases the pollution and provides a cleaner environment (Barrett, 2000; Cole et al., 2006; Chebbi et al., 2011: 32; Dauda et al., 2021: 3).

FDI ensures that the technology is transferred to the host country. FDI contributes to both technological knowledge transfer and physical capital stock. At the same time, with the effect of technology transfer developing with trade openness, it helps companies to develop and make technological upgrading in the country where FDI has entered. The impact of technology transfer on environmental degradation through FDI depends on the inputs used in the production process (Shahbaz et al., 2019: 57).

As a result of foreign companies in developed countries that create pollution, shifting their production to developing countries, environmental degradation in these countries is called the Pollution Haven Hypothesis (Copeland and Taylor, 1994). In other words, FDI input increases CO2 emissions and environmental degradation. However, Pollution Halo Hypothesis which tests the increase in environmental quality in the host country with FDI entry, is also being investigated (Dauda et al., 2021: 3). According to Pollution Halo hypothesis, countries with high technology levels will have better management and less CO2 emissions (Shahbaz et al., 2011). Many studies have been carried out to support the Halo effect, which states that FDI entries reduce CO2 emissions by providing a cleaner environment.

To analyze the impact of FDI and trade openness on CO2 emissions, countries' share of CO2 emissions should be looked at. As a matter of fact, according to the data obtained from British Petroleum (BP) 's Statistical Review of World Energy 2017, (British Petroleum (BP) 's Statistical Review of World Energy, 2017). In 2019, the share of CO2 emissions from non-OECD countries was 64.8%, and China (Pacific Asia's total 50.5%) ranks first with a share of 28.8%. EU's share is 9.7% (BP, 2019).

Therefore, the impact of trade openness and FDI entries on CO2 emissions can be either positive or negative. In this study, the effect of trade openness and FDI entries on CO2 emissions will be tested in 24 EU countries (with the exception of Luxembourg, Cyprus and Malta).

LITERATURE REVIEW

In this study, the literature review is examined in 3 parts. In the first part, the relationship between trade openness and carbon emission is discussed and the existence of the EKC hypothesis is tested. In the second stage, studies dealing with the relationship between FDI and CO2 emission, which is another variable, are included. In the last stage, studies that take FDI and trade openness together and compare them with CO2 emission are included.

The studies of Shahbaz et al. (2013), Akin (2014), Sbia et al. (2014), Kasman and Duman (2015), Zhang et al. (2017), Salman et al. (2019), Shahbaz et al. (2019), Lv and Xu (2019), Essandoh et al. (2020) support the EKC hypothesis and state that there is a negative relationship between trade openness and CO2 emission. One of these studies, Akin (2014) examined the period of 1990-2011 for 85 countries and found that the EKC hypothesis was valid in the long run and a positive relationship between CO2 emissions and trade openness in the short term. Examining the period 1992-2012 for 55 middle-income countries, Lv and Xu (2019) found that the EKC hypothesis was valid in the short term and there was a positive relationship between the variables in the long run.

There are also studies that don't support the EKC hypothesis and find a positive relationship between trade openness and CO2 emission for example Farhani et al. (2013), Ertugrul et al. (2016), Shahbaz et al. (2017), Dauda et al. (2021). Among these studies, Ertugrul et al. (2016) examined the impact of trade openness on CO2 emissions in 10 developing countries for the period 1971-2011. In conclusion, Turkey, India, China and Indonesia that the trade openness for the positive effects of CO2 emissions and for Brazil and China found that a bi-directional causality between trade openness with CO2 emissions.

In some of the studies between trade openness and CO2 emissions, the direction of the variables was determined by causality analysis. While Kasman and Duman (2015) found a one-way causality from trade openness to CO2 emissions. Akin (2014) found a one-way causality from CO2 emission to trade openness. In the study of Dogan and Turkekul (2016), it was found that there is no causality relationship between trade openness and CO2 emission. In some studies, foreign trade variable was used instead of trade openness. For example, Salman et al. (2019).

In the second stage, there are studies on the relationship between FDI and CO2. Most of the studies dealing with the relationship between FDI and CO2 test the existence of the pollution haven hypothesis (PHH). Shahbaz et al. (2015), Sun et al. (2017), studies supporting the PHH hypothesis were conducted. Among these studies, Shahbaz et al. (2015) examined the relationship between FDI and CO2 with three heterogeneous panels as high, middle and low income for 99 countries in the period 1975-2012. As a result of the study, they found a long-term relationship between variables and found that FDI entries increased CO2 emissions. In addition, Pollution Halo Hypothesis which tests the increase in environmental quality in the host country with FDI entry, is also being investigated (Dauda et al., 2021: 3).

Zubair et al. (2020) is among the studies supporting the Halo effect, which states that FDI entries reduce CO2 emission by providing a cleaner environment. Hoffmann et al. (2005) and Lee (2013) found that neither of these hypotheses were valid, and that there was no causality between FDI and CO2. There are also studies that investigated the direction of causation and identify a causality between variables. Omri et al. (2014) determined a bi-directional causality between FDI and CO2 emissions in 54 countries for the period 1990-2011; Dhrifi et al. (2020) found a unidirectional causality from FDI to CO2 emissions in 98 developing countries for the period 1995-2017.

Huang et al. (2019) is among the studies that examine the relationship between FDI and trade openness for China and its provinces and compare FDI and trade openness relation with CO_2 emissions. Ren et al. (2014) examined the impact of foreign trade, trade openness and FDI on CO_2 emissions in industrial sectors in China for the period 2000-2010. As a result of the study, it has been determined that increases in foreign trade, trade openness and FDI increase CO_2 emissions. 1% increase in total trade increases the CO_2 emission by 0.4%; It was determined that a 1% increase in the FDI input increased the CO_2 emission by 22.3%.

In the literature it is seen that the studies are mostly directed at developing countries. For example, Kaya et al. (2017) studied the Turkey. Kaya et al. (2017) for the 1974-2010 period, FDI and trade openness in Turkey examined the impact of CO_2 emissions on. The results of the study found that the increase in FDI and trade openness increased CO_2 emissions, but there was a negative relationship between FDI and CO_2 emissions in the short term.

For developed countries, these studies are not very common and have not been studied much. Among these studies, Shahbaz et al. (2019) examined the effect of FDI and trade clearance on CO_2 emissions in the USA for the period 1965-2016. According to the results of the study, FDI has a positive effect on CO_2 emission. This effect shows that the scale effect of FDI has a repressive effect. There is a negative impact between trade openness and CO_2 emissions in the short and long term. In the long run, a 10% increase in trade openness reduces CO_2 emissions by 1.45%.

In some studies, the relationship between variables was tested by using foreign trade data instead of the trade openness variable. For example, Essandoh et al. (2020). Essandoh et al. (2020) examined the impact of FDI and foreign trade on CO_2 emissions in 52 countries for the period 1991-2014. According to the results of the study, there is a positive relationship between FDI and CO_2 emissions in low-income countries, while there is a negative relationship between trade openness and CO_2 emissions in high-income countries.

ECONOMETRIC ANALYSIS

In this study, 24 EU member countries (Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Switzerland), for the period 1995-2019, the relationship between foreign direct investments, trade openness and CO_2 emission is examined for 24 EU member countries. Foreign direct investments, trade openness and CO_2 emission data were obtained from the World Bank (data.worldbank.org). Econometric analyzes were analyzed using Stata 12.0 and Gauss 10.0 econometric programs.

For the econometric analysis of the study, Breusch and Pagan (1980) cross-section dependency, Pesaran and Yamagata (2008) Swamy test was used to test the homogeneity of variables. Im, Pesaran and Shin (CIPS) Panel Unit Root Test, which was later developed by Pesaran (2007), and for the estimation of long-term parameters of the long-term relationship between variables. The data were analyzed with the AMG (Extended Mean Group) estimator developed by Eberhardt and Bond and the panel causality test developed by Emirmahmutoglu and Kose (2011) were used.

Cross Section Dependency Test

In testing the cross-sectional dependency, in the LM test developed by Breusch and Pagan (1980), the CD test developed by Pesaran (2004) and the CDLMadj tests developed by Pesaran and Yamagata (2008), the mentioned hypotheses are as follows: While there is no cross section dependency according to the null hypothesis; according to the alternative hypothesis, there is a cross section dependence. Based on this, as can be seen in Table 1, in this study, it was first checked whether there is cross-sectional dependency in the variables and the model. In line with the results obtained, the hypothesis stating that there is no cross sectional dependency in the variables and the model was rejected. In other words, it is seen that there is cross-sectional dependency in the variables and model discussed in the study (Sahin & Durmus, 2019: 191).

In this study, where the relationship of foreign direct investments, trade openness and CO2 emission is examined for 24 EU countries, it is primarily necessary to test whether there is cross-section dependence in variables, that is, whether there is a correlation between units, in order to determine which unit root test should be used. CDLM test developed by Pesaran (2004) and Breusch-Pagan (1980) CDLM1 tests are used to determine the correlation between units. The CDLM1 test is the predictor that tests the correlation between units in the case of T>N, and the CDLM test is the predictor that tests the correlation between units in the case of T<N (Dam, 2014: 108).

$$CD = \sqrt{2T/N(N-1)}\left(\sum_{i=1}^{N-1}\sum_{J=i+1}^{N}\bar{P}y\right) \quad (1)$$

In the equation 1, it is suggested that the cross section dependency test statistic expressed by (Pesaran, 2004) shows a normal distribution. Pesaran (2004) defines the null hypothesis of the CDLM test as “No Cross Section Dependence”. In the case of examining the correlation between units with Pesaran (2004) CDLM test, finding a probability value less than 0.05, the null hypothesis expressed as “No Cross Section Dependence” is rejected at the 5% significance level. If the null hypothesis is rejected, it is concluded that there is a cross-sectional dependency between the variables in the panel (Recepoglu et al., 2020: 73, 74).

It is important in determining the cointegration and causality analyzes that are required to be used in the analysis aimed at determining whether the coefficients are homogeneous or heterogeneous in studies conducted with panel data analysis.

All countries / regions etc. which will be tested for homogeneity testing. It is expressed as the slope coefficients β_i calculated for the equation to β, which is a single slope coefficient. Heterogeneity is explained as the difference of at least one of the slope coefficients β_i. Pesaran and Yamagata (2008) interpret the homogeneity of the coefficients with two different statistics: $\tilde{\Delta}\ (delta\_tilde)\ ve\ \widetilde{\Delta_{adj}}\ (delta\_tilde\_adj)$ (Gul and Inal, 2017). The homogeneity tests of the slope coefficients were made with the help of the delta test developed by Pesaran and Yamagata (2008) and calculated as in equations 2 and 3 below (Doganay and Deger, 2017: 133):

$$\tilde{\Delta} = \sqrt{N}\,\frac{N^{-1}\check{S}-K}{\sqrt{2K}} \quad (2)$$

Equation 3 gives the corrected form of the delta test statistic:

$$\tilde{\Delta}_{adj} = \sqrt{N}\,\frac{N^{-1}\check{S}-E(\tilde{Z}_{it})}{\sqrt{Var(\tilde{Z}_{it})}} \quad (3)$$

For the delta test, it is tested by establishing two different hypotheses, H_0: The slope coefficient is homogeneous and H_1: he slope coefficient is not homogeneous. If the test statistics obtained from Equation 3 are less than 5%, the H_0 hypothesis is rejected and the slope coefficients are said to be heterogeneous (Doganay and Deger, 2017: 133).

Tab.1. Cross section dependency test results in variables

Variables:	Co2		FDI		Trade	
Tests	**stat.**	**P-value**	**Stat.**	**P-value**	**stat.**	**P-value**
CDLM1 (Breusch, Pagan,1980)	1928.753	0.000	1344.528	0.000	1996.842	0.000
CDLM2 (Pesaran, 2004 CDlm)	70.346	0.000	45.480	0.000	73.244	0.000
CDLM (Pesaran, 2004 CD)	-2.286	0.011	-2.58	0.012	-3.070	0.001
Bias-adjusted CD test	68.405	0.000	6.027	0.000	23.241	0.000

Source: own research

In Tab. 1, various cross-section dependency tests were applied to variables, including Breusch and Pagan (1980) LM, Pesaran (2004) LM and CD and Baltagi, Feng and Kao (2012) LM cross-section dependency tests, and the homogeneity coefficients of the variables used in the analyzes, probe for each variables. Since (probability) values are less than $p < 0.05$ for the variables used in the analysis, there is a cross-sectional dependency in the variables. Pesaran CADF (2007) Panel Unit Root Test was applied, which is one of the second generation panel unit root tests.

Tab. 2. Cross section dependency test results in models

Test	**Model 1**		**Model 2**		**Model 3**	
	Y: Co2 X: Trade		Y: Trade X: Co2		Y: Trade X: Fdi	
	Test statistics	p-value	Test statistics	p-value	Test statistics	p-value
Delta_tilde	18.157	0.000	17.838	0.000	1.017	0.015
Delta_tilde_adj	19.304	0.000	18.966	0.000	1.081	0.014
Test	**Model 4**		**Model 5**		**Model 6**	
	Y: Fdi X: Trade		Y: Fdi X: Co2		Y: Co2 X: Fdi	
	Test statistics	P-value	Test statistics	p-value	Test statistics	P-value
Delta_tilde	1.156	0.012	4.683	0.000	4.751	0.000
Delta_tilde_adj	1.229	0.011	4.979	0.000	5.052	0.000

Source: own research

While determining the appropriate unit root test and cointegration test for panel data analysis, besides the cross-section dependency, homogeneity test results are also important as determining which unit root and cointegration tests will be used. As can be seen from Tab. 2, Pesaran and Yamagata (2008) homogeneity test findings are given. Since each variable is taken as the dependent variable, the model is constructed and according to the homogeneity coefficients for each model, probability) values $p < 0.05$ are small, it is concluded that the coefficients of β_i for each model are not homogeneous, that is heterogeneous.

The cross-sectional dependency between the units forming the panel and the stationary properties of the variables were examined by the Im, Pesaran and Shin (CIPS) Panel Unit Root test developed by Pesaran (2007). Pesaran, Cross-Sectionally Augmented Dickey Fuller (CADF) test is applied to the panel regression model stated below and the stationarities of the variables are examined by using the t statistics values of the $\hat{b}_i$ coefficients for the estimated model (Pesaran, 2007: 267- 269):

$$\Delta y_{i,t} = a_i + b_i y_{i,t-1} + c_i \bar{y}_{i,t-1} + d_i \Delta \bar{y}_{i,t-1} + e_{it} \quad (4)$$

The hypothesis that "each cross section is not stationary" is tested against the hypothesis that "some of the cross sections are stationary". Pesaran names the arithmetic mean of the CADF test statistics as Cross-sectionally Augmented IPS (CIPS) test statistics and uses this test to examine the stationarity properties of the panel data series. CIPS test has a standard normal distribution asymptotically and is calculated as follows (Acaravcı et al., 2015: 124):

$$CIPS = N^{-1} \sum_{i=1}^{N} CADF_i \quad (5)$$

Tab. 3. Im, Pesaran and Shin (CIPS) panel unit root test

Variables	CIPS test		
	I(0)	Z (t-bar)	p-value
Fdi	-4.719**	-15.146	0.000
Trade	-4.320**	-13.114	0.000
Co2	-4.784**	-15.477	0.000
Critical Value	%1: -2.300 %5: -2.150 %10: -2.070		

Source: own research

Tab. 3 shows the CIPS test results. Since the t-bar (CIPS) statistic is larger in absolute value than the critical values given at the 90% (cv10), 95% (cv5) and 99% (cv1) confidence level, the series is interpreted as stationary at the level for all three variables. In addition, according to the probability values of the Z [t-bar] statistic, it is seen that the series are stationary at the level.

Eberhardt and Bond recommend AMG estimator, one of the second generation estimators (Baysal Kar, 2019: 423, 430), to estimate the long-term parameters of the long-term relationship between variables for the models used to make the analysis. As a result of the homogeneity and cross-section dependence tests performed to estimate the long-term coefficients, it was determined that the model is heterogeneous and includes cross-section dependence. Therefore, using a method that takes into account the cross-sectional dependency between countries and the heterogeneous structure of the countries while making estimates will make it possible to obtain more accurate results. For this reason, the AMG estimator, which takes these two cases into account, was used for estimation. AMG estimator; It is a method that takes into account common dynamic effects as well as common factors in series. It also allows the calculation of different coefficients for cross sections. This estimator calculates a coefficient belonging to the entire panel in homogeneous models, and in heterogeneous models, it calculates a unit coefficient for each unit and the group average for the panel based on the weighted averages of these coefficients (Polat, 2018: 519). In Tab. 4, 5 and 6, the results of the analysis are interpreted by establishing three different models in which the variables of foreign direct investments, trade deficit and CO2 emission are taken as dependent variables, respectively, for the estimation results of AMG.

Tab. 4. AMG prediction results

Model 1: FDI = a+ β1Trade + β2 co2+ u				
Countries	**Trade**		**Co2**	
	coefficient	**p-value**	**coefficient**	**p-value**
Austria	-.3490	0.588	.51727	0.379
Belgium	2.2273	0.003**	.43063	0.488
Bulgaria	.15423	0.137	-.0445	0.822
Croatia	-.0331	0.531	.6972	0.012**
Czech Rep.	-.0530	0.522	-.2803	0.064
Denmark	-.1259	0.673	-.1181	0.613
Estonia	-.0256	0.749	-.3839	0.587
Finland	-.1121	0.676	-.1443	0.482
France	.3540	0.000**	-.0102	0.480
Germany	.0530	0.850	.0062	0.849
Greece	.0089	0.744	-.0291	0.171
Hungary	-.9121	0.022**	-.9324	0.571
Ireland	-.4604	0.188	1.6770	0.263
Italy	.11137	0.264	.01150	0.453
Latvia	.12502	0.044**	.66179	0.351
Lithuania	-.0763	0.117	.9499	0.012**
Netherland	.1533	0.888	.5581	0.462
Poland	.09756	0.104	.0146	0.407
Portugal	.01954	0.923	-.1355	0.324
Romania	-.3963	0.688	-.0042	0.928
Slovakia	-.0518	0.500	-.1296	0.847
Slovenia	.0917	0.378	-.9260	0.180
Spain	.2555	0.001**	.00017	0.989
Switzerland	.4454	0.086*	.6569	0.078*
Panel General	.0774	0.476	.1267	0.276
Wald chi2 : 1.51				
Prob > chi2: 0.469				

Source: own research

It is seen that the model in which foreign direct investment is taken as the dependent variable expressed in Tab. 4 is insignificant since it is 0.469> p = 0.05 for the panel in general. A positive and statistically significant relationship was found for France, Latvia, Spain and Switzerland from trade openness to foreign direct investment. A positive and statistically significant relationship was found for Croatia, Lithuania and Switzerland among foreign direct investments from CO2 emissions.

Tab. 5. AMG prediction results

Model 2: Trade = a+ β1Fdi+ β2co2+ u				
Countries	**FDI**		**Co2**	
	coefficient	**p-value**	**coefficient**	**p-value**
Austria	-0.436	0.588	.53206	0.002**
Belgium	.14014	0.003**	.04518	0.774
Bulgaria	.67688	0.137	.58479	0.137
Croatia	-.6102	0.531	1.2220	0.364
Czech Rep.	-.3981	0.522	.25675	0.566
Denmark	-.0738	0.673	-.1859	0.288
Estonia	-.2080	0.749	3.9555	0.029**
Finland	-.0811	0.676	-.1809	0.292
France	1.6282	0.000**	.0518	0.074*
Germany	.03531	0.850	-.0836	0.000**
Greece	.61856	0.744	.1998	0.265
Hungary	-.2359	0.022**	-1.976	0.005**
Ireland	-.1814	0.188	2.2837	0.005**
Italy	.55273	0.264	.00130	0.970
Latvia	1.4094	0.044**	.78598	0.746
Lithuania	-1.501	0.117	3.902	0.024**
Netherland	.0068	0.888	-.3628	0.009**
Poland	1.253	0.104	-.1118	0.059*
Portugal	.0254	0.923	.1287	0.415
Romania	-.2128	0.688	.2525	0.005**
Slovakia	-.4503	0.500	-.7633	0.700
Slovenia	.4283	0.378	.2600	0.868
Spain	1.476	0.001**	.0012	0.966
Switzerland	.3014	0.086*	-.4349	0.168
Panel General	.1989	0.201	.4318	0.106
Wald chi2 : 6.45				
Prob > chi2: 0.039				

Source: own research

It is seen that trade openness is taken dependent variable in Tab. 5 since the model in which the 0.039 <p = 0.05 is significant. A positive and statistically significant relationship was found for Belgium, France, Hungary, Latvia and Spain from trade openness to foreign direct investment. A positive and statistically significant correlation was found for Austria, Estonia, France, Germany, Hungary, Ireland, Lithuania, the Netherlands, Poland and Romania from CO2 emission to trade openness.

Tab. 6. AMG prediction results

Model 3: Co2 = a+ β1Fdi+ β2Trade+ u				
Countires	**FDI**		**Trade**	
	coeficient	**p-value**	**coefficient**	**p-value**
Austria	.0756	0.379	.6222	0.002**
Belgium	.0572	0.488	.0954	0.774
Bulgaria	-.0594	0.822	.1779	0.137
Croatia	.3567	0.012**	.0339	0.364
Czech Rep.	-.5447	0.064*	.0664	0.566
Denmark	-.1121	0.613	-.3013	0.288
Estonia	-.0397	0.587	.0505	0.029**
Finland	-.1759	0.482	-.3049	0.292
France	-2.510	0.480	2.773	0.074*
Germany	.3027	0.849	-6.044	0.000**
Greece	-3.075	0.171	.30700	0.265
Hungary	-.0178	0.571	-.1461	0.005**
Irlanda	.0369	0.263	.1277	0.005**
Italy	2.503	0.453	.0572	0.970
Latvia	.0661	0.351	.0069	0.746
Lithuania	.2603	0.012**	.0543	0.024**
Netherlands	.0495	0.462	-.7242	0.009**
Poland	2.378	0.407	-1.413	0.059*
Portugal	-.3586	0.324	.2619	0.415
Romania	-.1021	0.928	1.149	0.005**
Slovakia	-.0149	0.847	-.0101	0.700
Slovenia	-.0931	0.180	.0056	0.868
Spain	.06000	0.989	.0747	0.966
Switzerland	.21369	0.078*	-.2090	0.168
Panel General	-.0310	0.891	-.1370	0.644
Wald chi2 : 0.32				
Prob > chi2 : 0.853				

Source: own research

It is seen that the model in which the CO2 emission expressed in Tab. 6 is taken as the dependent variable is not significant since it is 0.853> p = 0.05. A positive and statistically significant relationship was found for Croatia, Czech Republic and Switzerland from foreign direct investments to CO2 emissions. On the other hand, from trade openness to CO2 emission, a positive and statistically significant relationship was found for Estonia, France, Ireland, Lithuania, Poland and Romania, while a negative and statistically significant relationship was found for Germany, Hungary and the Netherlands.

Emirmahmutoglu and Kose (2011) panel causality test is a causality test on the assumption of heterogeneity of the coefficients. It does not matter whether the variables are stable or cointegrated. Due to the characteristics of heterogeneous panel data models, estimates are made for each section in the panel and for all cuts in terms of time dimension. The panel is a heterogeneous test and the VAR model parameters can be estimated for each section in the panel. In this test, causality analysis of level variables can be performed without taking into account the time series properties of variables in the VAR model. Granger causality analysis can be performed separately and in general for each section in the panel. Emirmahmutoglu and Kose (2011) panel causality test since it is an extended form of Toda-Yamamoto (1995) test to heterogeneous panel data, there is no need to apply unit root and cointegration tests, which is the advantage of Toda-Yamamoto (1995) test, also valid for Emirmahmutoglu and Kose (2011) test. (Emirmahmutoglu and Kose, 2011: 103). In Emirmahmutoglu and Kose (2011) test, VAR model for each section is estimated as indicated in equation 6:

$$Y_{it} = \mu_i + A_{1i} y_{i(t-1)} + \cdots + A_{pi} y_{i(t-pi)} + \cdots + A_{(p+d)i} y_{i(t-pi-di)} + \varepsilon_{it} \quad (6)$$

Where y_{it} is the vector of endogenous variables. μ_i is the p-dimensional vector of constant effects, p_i is the optimal delay and d_i is the maximum cointegration degree of the variables. In order to test the Granger causality hypothesis for panel data analysis, Fisher statistics is expressed as in equation 7:

$$\lambda = -2 \sum_{i=1}^{N} \ln(\pi_i) \quad (7)$$

Tab. 7. Emirmahmutoglu and Kose panel causality test results

Causality Direciton	Panel Fisher	P-val	Causality
Trade → Co2	15.602	1.000	No
Co2 → Trade	97.287	0.000**	Yes
Fdi → Trade	66.318	0.041**	Yes
Trade → Fdi	59.108	0.131	No
Co2 → Fdi	265.105	0.000**	Yes
Fdi → Co2	47.729	0.484	No

Source: own research

In Tab. 7, panel causality test results are given for the panel in general. It is concluded that there is a unidirectional causality relationship from CO2 emissions to trade openness, from foreign direct investments to trade openness, and from CO2 emissions to foreign direct investments.

Tab. 8. Emirmahmutoglu and Kose panel causality test results

	Trade to Co2			Co2 to Trade		
i	**Lag**	**Wald**	**p-val**	**Lag**	**Wald**	**p-val**
Austria	1.000	0.380	0.538	1.000	1.985	0.159
Belgium	1.000	0.323	0.570	1.000	1.699	0.192
Bulgaria	1.000	0.006	0.940	1.000	3.093	0.079*
Croatia	1.000	0.001	0.974	1.000	2.092	0.148
Czech Rep.	1.000	0.002	0.966	1.000	1.553	0.213
Denmark	1.000	0.017	0.896	1.000	0.916	0.399

Estonia	1.000	0.015	0.902	1.000	1.336	0.248
Finland	1.000	0.099	0.753	1.000	0.895	0.344
France	1.000	0.064	0.801	1.000	1.356	0.244
Germany	1.000	0.039	0.844	1.000	1.655	0.198
Greece	1.000	0.001	0.973	1.000	2.066	0.151
Humgary	1.000	0.064	0.801	1.000	1.944	0.163
Ireland	1.000	0.001	0.980	1.000	2.242	0.134
Italy	1.000	0.591	0.442	1.000	3.466	0.063*
Latvia	1.000	0.165	0.684	1.000	3.767	0.052*
Lithuania	1.000	0.025	0.875	1.000	2.706	0.100
Netherlands	1.000	0.152	0.697	1.000	2.430	0.119
Poland	1.000	0.554	0.457	1.000	4.949	0.026**
Portugal	1.000	0.028	0.866	1.000	3.211	0.073*
Romania	1.000	0.069	0.792	1.000	2.308	0.129
Slovakia	1.000	0.224	0.636	1.000	2.382	0.123
Slovenia	1.000	0.159	0.690	1.000	4.057	0.044**
Spain	1.000	1.003	0.317	1.000	1.878	0.171
Switzerland	1.000	0.279	0.597	1.000	1.364	0.243
Panel Fisher : 15.602				Panel Fisher : 97.287		
p-value : 1.000				p-value : 0.000**		

Source: own research

In Tab. 8, panel causality test results, causality relationship analysis findings from commercial openness to CO2 release and from CO2 release to trade openness are analyzed on country basis. Since the causality relationship from CO2 release to trade openness is significant for the panel overall (p-value: 0.000 <0.05), there is a causality relationship in EU countries. In addition, when examined on the basis of countries, a causality relationship from CO2 emission to trade openness was found for Bulgaria, Italy, Latvia, Poland, Portugal and Slovenia.

Tab. 9. Emirmahmutoglu and Kose panel causality test results

	FDI to Trade			Trade to FDI		
i	**Lag**	**Wald**	**p-val**	**Lag**	**Wald**	**p-val**
Austria	1.000	0.254	0.614	1.000	1.530	0.216
Belgium	1.000	2.093	0.148	1.000	0.001	0.975
Bulgaria	1.000	4.000	0.045**	1.000	4.298	0.038**
Croatia	1.000	0.751	0.386	1.000	0.032	0.857
Czech Rep.	1.000	0.209	0.647	1.000	0.517	0.472
Denmark	2.000	4.063	0.131	2.000	3.659	0.161
Estonia	2.000	0.258	0.879	2.000	2.351	0.309
Finland	2.000	3.053	0.217	2.000	9.111	0.011**
France	1.000	0.027	0.870	1.000	0.022	0.883
Germany	1.000	3.941	0.047**	1.000	8.200	0.004**
Greece	1.000	4.270	0.039**	1.000	2.091	0.148

Hungary	1.000	0.068	0.795	1.000	0.110	0.740
Ireland	1.000	0.012	0.911	1.000	0.027	0.868
Italy	1.000	0.054	0.816	1.000	1.252	0.263
Latvia	2.000	1.425	0.490	2.000	0.158	0.924
Lithuania	2.000	0.268	0.605	2.000	0.838	0.360
Netherlands	1.000	4.236	0.120	1.000	0.392	0.822
Poland	2.000	1.903	0.386	1.000	1.350	0.509
Portugal	1.000	0.376	0.540	1.000	0.513	0.474
Romania	1.000	4.162	0.041**	1.000	0.196	0.658
Slovakia	1.000	8.315	0.004**	1.000	0.464	0.496
Slovenia	1.000	0.147	0.702	1.000	1.684	0.194
Spain	1.000	0.365	0.546	1.000	0.023	0.880
Switzerland	1.000	0.864	0.353	1.000	1.308	0.253
Panel Fisher : 66.318				Panel Fisher : 59.108		
p-value : 0.041**				p-value : 0.131		

Source: own research

In Tab. 9, panel causality test results, causality relationship analysis findings from foreign direct investments to trade openness and from trade openness to foreign direct investments are analyzed on a country basis. Since the causality relationship from foreign direct investment to trade openness is significant for the panel overall (p-value: 0.041 <0.05), there is a causality relationship in EU countries. In addition, when analyzed on the basis of countries, there is a causality relationship from foreign direct investments to trade openness for Bulgaria, Germany, Greece, Romania and Slovakia. Again, the causality relationship from trade openness to foreign direct investments on country basis is valid for Bulgaria, Finland and Germany.

Tab. 10. Emirmahmutoglu ve Kose panel causality test results

	Co2 to FDI			**FDI to Co2**		
i	**Lag**	**Wald**	**p-val**	**Lag**	**Wald**	**p-val**
Austria	2.000	20.380	0.000**	2.000	2.694	0.260
Belgium	1.000	0.396	0.529	1.000	0.183	0.669
Bulgaria	1.000	0.235	0.628	1.000	1.736	0.188
Croatia	1.000	0.223	0.637	1.000	0.653	0.419
Czech Rep.	1.000	0.586	0.444	1.000	0.579	0.447
Denmark	3.000	44.736	0.000**	3.000	1.317	0.725
Estonia	3.000	51.937	0.000**	3.000	2.236	0.525
Finland	3.000	30.923	0.000**	3.000	7.189	0.066*
France	3.000	29.243	0.000**	3.000	4.733	0.192
Germany	2.000	7.839	0.020**	2.000	3.427	0.180
Greece	1.000	0.174	0.676	1.000	0.186	0.666
Hungary	1.000	0.661	0.416	1.000	0.060	0.807
Ireland	1.000	0.213	0.644	1.000	0.000	0.997
Italy	1.000	0.863	0.353	1.000	0.194	0.659
Latvia	1.000	0.588	0.443	1.000	0.201	0.654

Lithuania	1.000	0.103	0.748	1.000	0.523	0.470
Netherland	1.000	0.997	0.318	1.000	0.059	0.808
Poland	3.000	18.094	0.000**	3.000	0.229	0.973
Portugal	1.000	5.206	0.023**	1.000	1.314	0.252
Romania	1.000	1.435	0.231	1.000	3.862	0.049**
Slovakia	1.000	0.627	0.428	1.000	3.690	0.055*
Slovenia	1.000	0.955	0.328	1.000	0.272	0.602
Spain	3.000	35.962	0.000**	3.000	1.003	0.800
Switzerland	2.000	15.515	0.000**	2.000	2.473	0.290
Panel Fisher : 265.105				Panel Fisher : 47.729		
p-value : 0.000**				p-value : 0.484		

Source: own research

In Tab 10, panel causality test results, causality relationship analysis findings from CO2 emissions to foreign direct investments and from foreign direct investments to CO2 emissions are analyzed on a country basis. Since the causality relationship from CO2 release to foreign direct investments is significant for the panel general (p-value: 0.000 <0.05), there is a causality relationship in EU countries. In addition, when examined on the basis of countries, there is a causality relationship from CO2 emissions to foreign direct investments for Austria, Denmark, Estonia, Finland, France, Germany, Poland, Portugal, Spain and Switzerland. Again, the causality relationship from foreign direct investments to trade openness on a country basis is valid for Finland, Romania and Slovakia.

CONCLUSIONS

In terms of its economic dimension, foreign direct investments have important contributions to the economic growth and development processes of countries. In times when country savings are insufficient, as Omisakin (2009) stated, foreign direct investments provide foreign resources for the investments of countries by providing capital formation. Trade openness plays a key role for countries that want to take advantage of foreign direct investment. While the level of commercial openness of countries has an effect on capital mobility, it also serves as an important indicator for countries to gain competitive advantage.

Foreign direct investments have advantages for countries as well as disadvantages. While foreign direct investments provide advantages by increasing the employment and production level of countries as well as technological development and competition levels, they also have negative effects on human health by causing environmental degradation by increasing the CO2 emission. While foreign direct investments are important for underdeveloped and developing countries in terms of their positive effects on countries, they are not preferred by developed countries due to their negative aspects.

In this study, the relationship between foreign direct investments, trade openness and Co2 emissions was cross-section dependency and Emirmahmutoglu and Kose (2011) panel causality tests for the estimation of long-term parameters.

According to the panel causality test findings of Emirmahmutoglu and Kose (2011), when the panel is interpreted in general, it is found that there is a one-way causality relationship from CO2 emission to trade openness, from foreign direct investments to trade openness and from CO2 emission to foreign direct investments for 24 EU member countries.

When the panel causality test results were examined on the basis of countries, a causality relationship from Co2 emission to trade clearance was found for Bulgaria, Italy, Latvia, Poland, Portugal and Slovenia. For Bulgaria, Germany, Greece, Romania and Slovakia, there is a causal relationship from foreign direct investment to trade openness. The causality relationship from trade openness to foreign direct investment applies to Bulgaria, Finland and Germany. For Austria, Denmark, Estonia, Finland, France, Germany, Poland, Portugal, Spain and Switzerland, there is a causal relationship from Co2 emissions to foreign direct investments. It is concluded that the causality relationship from foreign direct investment to trade openness is valid for Finland, Romania and Slovakia.

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