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YÜKSELEN PİYASA EKONOMİLERİNDE DOĞRUDAN YABANCI YATIRIMLAR, TİCARİ AÇIKLIK VE CO2 İLİŞKİSİ

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Öz

Bu çalışmada doğrudan yabancı yatırımların (DYY) ve ticari açıklığın (TA) çevre kirliliği üzerindeki etkisini araştırmak amaçlanmıştır. İnceleme, dış ticaret ve yatırımları kendilerine çekmek uğruna esnek uygulama ve koşullara maruz kalan Yükselen Piyasa Ekonomileri (EMEs) üzerinde yapılmıştır. IMF'in EMEs kategorisine aldığı 15 ülkenin 1990-2020 verileri şu yöntemler kullanılarak test edilmiştir: The cross-sectional autoregressive distributed lag estimator (CS ARDL), Main Group (MG), Common Correlated Effects Mean Group Estimators (CCE), Augmented Mean Group (AMG), Emirmahmutoğlu and Köse (2011) Causality Test. Kullanılan değişkenler DYY, TA, kişi başına GSYH ve karbondioksit (CO2) emisyonlarıdır. Katsayı tahmincilerinin sonuçlarına göre, hem kısa hem de uzun dönemde sadece GSYIH'nın CO2 üzerinde anlamlı ve pozitif bir etkiye sahip olduğuna, DYY-CO2 ve TA-CO2 arasında anlamlı bir ilişki olmadığına yönelik bulgular elde edilmiştir. Nedensellik testi sonuçlarına göre ise CO2'den DYY'a ve TA'dan CO2'ye tek yönlü, GSYH ve CO2 arasında ise çift yönlü ilişki tespit edilmiştir.

Anahtar Kelimeler: *Yükselen piyasa ekonomileri, Doğrudan yabancı yatırımlar, Ticari açıklık, CO2.*

Jel Kodu: *Q54, F18, O50.*

Relationship between Foreign Direct Investments, Trade Openness and CO2 in Emerging Market Economies

Abstract

In this study, it was aimed to investigate the effect of foreign direct investment (FDI) and trade openness (TO) on environmental pollution. The study was conducted on Emerging Market Economies (EMEs), which are subject to flexible practices and conditions to attract trade and investment. The 1990-2020 data of 15 countries included in the IMF's EMEs category were tested with the following methods: The cross-sectional autoregressive distributed lag estimator (CS ARDL), Main Group (MG), Common Correlated Effects Mean Group Estimators (CCE), Augmented Mean Group (AMG), Emirmahmutoğlu and Köse (2011) Causality Test. The variables used were FDI, TO, GDP per capita and carbon dioxide (CO2) emissions. According to the results of the coefficient estimators, it was found that only GDP had a significant and positive effect on CO2 in both the short and long term, and there was no significant relationship between FDI-CO2 and TO-CO2. According to the causality test results, it was determined that there is a unidirectional relationship from CO2 to FDI and from TO to CO2, and a bidirectional relationship between GDP and CO2.

Keywords: *Emerging market economies, Foreign direct investment, Trade openness, CO2.*

Jel Code: *Q54, F18, O50.*

1. Introduction

One of the important issues on a worldwide scale is undoubtedly climate change in recent years. The basis of this problem is based on anthropogenic sources. The desire of people to live in more prosperous conditions causes many economic activities such as industrial production, agricultural production, service production, urbanization, and technological progress to increase, and therefore, more energy and natural resources are used while trying to achieve this. In the beginning,

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the aim may be to increase welfare, but the result is the deterioration of the ecological system. The main actor of global warming is greenhouse gas (GHG) emissions, and one of the most important gases in GHG is carbon dioxide (CO2) (Gümüş Akar and Seçilmiş, 2019). Due to its significant negative impact on climate change, CO2 emission has been the subject of national and international regulations, and researching the factors that increase CO2 has become a matter of curiosity in the literature. The researches on the Pollution Haven Hypothesis on this subject are among the most studied and the results of which no consensus can be reached. Another hypothesis on the subject is the Pollution Halo Hypothesis.

Pollution Haven Hypothesis (PHH) is the fact that developed countries shift their commercial and investment activities towards developing countries where these restrictions are flexible due to the existence of restrictions on environmental protection, and as a result, environmental pollution increases in developing countries. In this case, since developed countries produce cleaner, environmental pollution is transferred to developing countries, and global environmental pollution continues to increase (Manga, 2021; Yılmazer & Ersoy, 2009; Yılmaz et al., 2017). Pollution Halo Hypothesis, on the other hand, is the hypothesis that greener technologies can be exported from developed countries to developing countries and production can be made without causing environmental pollution. Pollution Haven Hypothesis is also referred to as "race to the bottom", and Pollution Halo Hypothesis is also referred to as "bottom rise" (Zhang & Zhou, 2016; Benli & Acar, 2022; Zeren, 2015). In the first hypothesis, it is claimed that FDI has negative effects on the environment, and in the second, positive effects.

Another variable believed to influence carbon emissions and extensively examined in scholarly works is trade openness. It is believed that trade openness has an adverse effect on the environment, particularly within developing nations. Because these countries prefer industrial productions that pollute the environment at the expense of competing with developed countries and they subject these products to foreign trade (Şahin et al., 2019). However, of course, it is not only limited to developed countries, but with the increase in global trade, economic cooperation between countries increases, as a result, trade volumes increase and environmental problems that arise are of interest to all countries of the world (Topallı, 2022).

Countries with social and economic characteristics such as high performance and growth rates, flexible decision-making mechanisms, and adaptation to intense competition among developing countries are classified as a separate category under the name of Emerging Economies (EMs). One of the most striking features of these countries is that they switched from a closed economy to an open policy in order to increase their welfare. These economies, which tried to attract foreign capital as a result of some practices such as free trade zones, tax privileges, and flexible investment agreements, were also exposed to the conditions put forward by developed countries for investing (İspiroğlu & Taş, 2017; Elmas et al., 2011).

There is no consensus on the definition or classification of EMEs and different organizations have made some groupings involving different countries. The IMF evaluates the countries' systemic presence (nominal GDP, population, share of exports in worldwide trade), market access (share of a country's external debt in the global external debt) and income level (nominal GDP per capita) while classifying these markets. In the classification created by taking into account the values between 2010 and 2020, the following 20 countries, which forming 34% of the global nominal GDP in US $ and 46% in purchasing power parity (PPP), are classified as emerging economies: Turkiye, Russia, Argentina, Philippines, Brazil, Poland, Chile, India, Hungary, Indonesia, Iran, Colombia, Mexico, Saudi Arabia, the United Arab Emirates, South Africa, China, Thailand, Egypt and Malaysia (Duttagupta & Pazarbaşıoğlu, 2021).

Considering the existence of PHH, which suggests that environmental pollution is transferred from developed countries to developing countries, it brings to mind the idea that the sanctions that emerging economies are exposed to at the expense of attracting trade and investments may lead them to turn into a Pollution Haven. Based on this idea, the motivation of this study is to seek answers to the following questions: "Is the Pollution Haven Hypothesis valid for emerging economies?" and “Does trade openness increase environmental pollution in emerging economies?”. Therefore, the aim of the study was determined to investigate whether FDI/TO have an effect on CO2 emissions within emerging economies. In the literature review, no study was found on emerging economies as a whole before. With this aspect of the study, it is hoped that it will contribute to the literature.

The study is structured in the following manner: previous scientific research on the subject will be presented, the data set and methodology used will be explained, the findings of the study will be summarized and the conclusion part will be included.

2. Literature Review

There are many studies in the literature examining the effects of FDI and TO on CO2 separately or together. Yılmazer and Ersoy (2009), who tested the Pollution Haven Hypothesis with panel cointegration using the data of Malaysia, Thailand, Indonesia, Singapore, Philippines and Turkiye between 1975 and 2006, found evidence that there is absence of a cointegration relationship between FDI and CO2. On the contrary, Acharyya (2009) tested the relationship of GDP growth, FDI inflow and CO2 emissions using India's 1980-2003 data. In accordance with the findings from the cointegration analysis, FDI has a long-term and positive effect on GDP growth, and a stable and long-term growth effect on CO2. It is also among the study's results that FDI inputs increase CO2 emissions by 0.86% for every 1% growth in GDP. Similarly, in the Atay Polat (2015)’s study, the relationship between Turkiye's CO2 emissions-electricity consumption/FDI/GDP growth, was measured using 1980-2013 data. According to the Gregory-Hansen cointegration results, it was established that there exists a long-term cointegration among all variables and CO2. Utilizing the FOLS and CCR cointegration coefficient estimators, it was deduced that a 1% rise in FDI leads to a 0.002% decrease in CO2 emissions, so the Pollution Haven Hypothesis is not valid for Turkiye. It is also among the findings of the study that a 1% growth in GDP and electricity consumption results in a 0.10% increase in CO2 emissions, and 0.29%, respectively. And also, in the study where Kurt et al. (2019) measured the effect of FDI on CO2 with the ARDL limit test, using the data covering the years 1974-2015 in Turkiye, it was concluded that per capita GDP decreased CO2 emissions, while energy consumption (EC) and FDI increased. Accordingly, it has been demonstrated that the Pollution Haven Hypothesis is valid in Turkiye. Moreover, Benli (2020) tested the relationship between CO2 emissions, FDI and many other variables, using Turkiye's 1974-2014 data and the Directed Non-Cycle Graphs (DAGs) Method, and found that FDI indirectly affects CO2 emissions through foreign trade.

Omri et al. (2014) examined the correlation between GDP growth, FDI, and CO2 emissions (data from 54 economies the years 1990 to 2011). Based on the study's findings, a reciprocal cause-and-effect relationship exists between GDP growth and FDI for all nations. On the other hand, while there is causality in relation to FDI and CO2 for some countries, unidirectional causality has been determined for some countries. One of the study's findings is the presence of a unidirectional causality from CO2 to economic growth in certain countries, alongside bidirectional causality in others. Similarly, Zeren (2015) tested the relationship between FDI and CO2 using 1970-2010 data from the USA, France, England and Canada. According to the results of the Granger causality tests applied, the change in FDI has an effect on carbon emissions. In the review using FMOLS and CCR Methods, evidence is presented that the Pollution Halo Hypothesis is true for the first three nations and the Pollution Haven Hypothesis is applicable to the final country. In addition, Blanco et al. (2013) tested

the relationship between FDI and CO2 of 18 Latin American countries using Granger Causality. In the study covering 1980-2007 period data, FDI was separated by sector. According to the findings, there is causality from FDI to CO2 emissions per capita in pollution-intensive industries, but strong evidence of causality for other sectors was not found.

Utilizing panel data encompassing Chinese provinces from 1995 to 2010, Zhang and Zhou (2016) tested the impact of FDI on CO2 emissions at the national and regional level. According to the study findings, FDI has a CO2-reducing effect, and this effect is greater in the west than in the central and eastern regions. The findings indicate that the Pollution Halo Hypothesis is valid for China. Similarly, İskenderoğlu et al. (2023) tested the effects of FDI, renewable EC, economic growth and financial development on CO2 emissions with the help of panel data analysis, using data from 14 countries in the Environmental Performance Index between 1990 and 2018. The study's results demonstrate that all variables, except financial development, exert negative and statistically significant impacts on CO2 emissions, thus confirming the validity of the Pollution Halo Hypothesis.

Gökten et al. (2022) tested the relationship between growth, TO, globalization, industrialization, EC, local material consumption and CO2 for the top five countries with the highest emissions, using 1992-2018 data and panel data analysis method. According to the study findings, all variables increase CO2 except trade openness. Conversely, Çetin and Seker (2014) analyzed Turkiye's 1980-2010 period data and the effects of growth and TO on CO2 emissions with the ARDL limit test approach. According to the study findings, in the long run, economic growth and TO rise CO2 emissions. Similarly, Gülmez et al. (2021) analyzed the relationship between production, trade and energy and ecological footprint by using Pedroni FMOLS and DOLS methods of 1971-2015 data of G7 countries. According to the findings, a 1% increase in the independent variables increases the ecological footprint by 0.24%, 0.39%, and 0.72%, respectively. Moreover, Bağrıyanık (2021) tested the relationship between export diversity and CO2, 2002-2014 data of BRICS countries were used. According to the findings of the expanded average group (AMG) estimator, export diversity and economic growth positively affect CO2 emissions.

Sun et al. (2019) divided 49 high-emission countries into income groups and tested the relationship between trade openness and CO2 with the help of 1991-2014 data. According to panel cointegration findings, trade openness affects CO2 both positively and negatively in different country groups. Vector error correction model (VECM) causality findings show that a long-run causality relationship between trade, EC, GDP and CO2 emissions in Belt and Road, Europe, middle-income, high-income and low-income countries Environmental Kuznets curve (EKC) results indicate that there is an inverse U-shaped relationship between trade openness and CO2 emissions. Similarly, Yıldırım et al. (2021) examined the factors affecting CO2 emissions using the 1990-2018 data of MIST and BRICS countries with second generation panel data analysis methods. The study findings point to the relevance of the EKC Hypothesis for both MIST and BRICS countries. Furthermore, based on the outcomes, energy use and income increase CO2 emissions for both country groups; Globalization affects BRICS countries positively and negatively in MIST countries, openness has a reducing effect on CO2 in BRICS countries and a meaningless effect in MIST countries.

In the study of Topallı (2022), the relationship between CO2 and TO was examined using the data of Asia Pacific countries between 1960 and 2016 and the Fouirer Cointegration (FSHIN) test; Evidence is presented that for Malaysia, China, and Thailand, there isn't a long-term relationship between the variables, whereas Indonesia exhibits a positive relationship. Similarly, in the study of Wang and Zhang (2021), the effects of TO on CO2 were measured by panel data analysis method through the 1990-2015 data of 182 countries. It has been revealed that TO diminishes CO2 emissions

in high-middle income economies, does not have a significant effect on carbon emissions of middle-low-income countries, and even for low income economies, TO increases CO2 emissions.

There are also articles where the effects of both FDI and TO on CO2 were tested in the same study. Öztürk and Saygın (2020) examined the relationship between TO, real GDP per capita, FDI and CO2 in Turkiye during the 1974-2016 period, with ARDL bounds test and Toda-Yamamoto causality tests. The study's results suggest the presence of mutual causal relationships between all variables and CO2 emissions. On the other hand, Xu (2015) examined the effect of FDI and TO on CO2 emissions using data from Shandong province for the years 1995-2012. The findings reveal that FDI has an inhibitory effect on CO2, while trade openness has an encouraging effect. It is also given among the results that the incentive effect coefficient is 1.5 times higher than the inhibitory effect coefficient. Moreover, in the study of Baykul (2022), the determinants of CO2 emissions were determined by using the 1998-2014 data of the upper-middle-income countries in Europe and Central Asia. According to FMOLS long-term analysis results, a relationship was determined that urbanization, GDP growth, FDI and energy usage contribute to the rise in CO2 emissions, whereas international trade exerts a negative impact. Based on the outcomes of the long-term Granger causality test, it was uncovered that a significant relationship exists solely between FDI and income. Tiba and Belaid (2020) conducted an assessment of the impact of FDI and trade openness on CO2/NOx emissions by testing the data of 27 African economies from 1990-2013 with CCE-MG estimators, Westerlund (2007) panel cointegration and Granger causality methods. It is revealed a bidirectional relationship between TO, CO2 emissions, NOx emissions, GDP and foreign direct investment in their long-term causality results. According to the short-term findings, a one-way causality relationship was found from GDP and FDI to CO2. In addition, it is also among the results of the study that there is bidirectional causality between GDP- NOx and TO-NOx, causality from FDI to NOx unidirectionally.

Shahbaz et al. (2019) tested the impact of US TO, EC and FDI on emissions of CO2 for the period 1965-2016, taking into account scale, technique, and compositional effects. According to the study findings, there is cointegration between CO2 emission and other variables. In addition, it has been revealed that the scale effect is positive for CO2 emissions and the technical effect is negative, so the EKC Hypothesis is valid, but EKC Hypothesis is more pronounced in the long term than in the short term. The composition effect is negatively related to CO2 emissions. It is also among the results that trade openness reduces CO2 emissions, while FDI increases CO2 emissions, that is, the dirty country hypothesis is confirmed. Similarly, Zameer et al. (2020) used Indian data from 1985-2017 and ARDL bond testing and VECM methods to test the impact of TO, EC, technological innovation, FDI and GDP growth on CO2 emissions. According to the findings, the existence of cointegration is proven in the long term, and it is revealed that in the long run, TO, GDP growth and EC positively support CO2, while FDI supports it negatively. According to VECM findings, there is a long-term bidirectional relationship between innovation, TO and EC; There is a one-way relationship from GDP to carbon emissions/FDI/innovation/trade/EC. According to the short-run relationship results, there is a unidirectional relationship from FDI, innovation and EC to emissions, and a bidirectional relationship between TO and emissions of CO2.

3. Data and Methodology

In this study, the relationship between CO2 and FDI, trade openness and GDP per capita was investigated. In the analysis, the data of 15 countries (Turkiye, Brazil, India, Argentina, China, Colombia, Chile, Egypt, Indonesia, Malaysia, Mexico, Philippines, S. Arabia, S. Africa, Thailand) within the scope of IMF EMEs, whose data for the years 1990-2020 are available, were used. Detailed information about the data is given in Table 1.

Table 1. *Discription of indicators*

Indicators	Unit	Abbreviation	Source
CO2 emissions	metric tons per capita	lnCO2	World Bank
FDI	% of GDP	FDI	World Bank
Trade Openness	trade, % of GDP	TO	World Bank
GDP	per capita	lnGDP	World Bank

The model was created as follows:

$$lnCO2 = \alpha_0 + \beta_1 FDI_{it} + \beta_2 TRD_{it} + \beta_3 lnGDP_{it} + \varepsilon_{it} \quad (1)$$

In the model, CO2 dependent, FDI, TO and GDP were used as independent variables, ε_{it} was the standard error term and α was the constant term. Taking the logarithm of the series linearizes the variables and reduces the variance. For this reason, the use of logarithms in series that fluctuate differently and contain large numbers provides more convenient results for econometric analyses. In this context, logarithmic forms of GDP and CO2 series were used in the study.

In the study, firstly, the cross-section dependence was examined, and for this, the cross-section dependence test developed by Pesaran (2015), which was used to test the cross-section dependence of the series separately, was applied. Cross-sectional dependency between series in the panel which includes different countries means that a macroeconomic shock occurring in one country affects other countries. This situation is expected in the globalizing world economy. In other words, the existence of cross-sectional dependence means that a shock occurring in one country in the panel affects other countries in the same or later period.

Unit root analysis is performed to determine whether a series is stationary or unit rooted. Working with non-stationary series may cause spurious regression. For this reason, non-stationary series are made stationary by taking their differences. First generation panel unit root tests are based on the assumption that the horizontal sections forming the panel are independent of each other. Second generation unit root tests are based on the assumption that there is a correlation between series of units. Which test type to choose is determined by the presence of cross-sectional dependency. In this study Pesaran (2007), the second generation unit root test, was preferred, since the test results indicate that there is cross-section dependency. Then, Pesaran and Yamagata (2008) Slope Homogeneity Test was applied to determine whether the series were homogeneous/heterogeneous. As a prior test, the slope homogeneity test is used to investigate whether the slope coefficients are homogeneous or heterogeneous. This test reveals whether the other sections are affected at the same level by the change in one of the sections. Panel techniques which consider heterogeneity/homogeneity are used according to the test results.

The cross-sectional autoregressive distributed lags (CS ARDL) estimator developed by Chudik and Pesaran (2015), which allows panel heterogeneity and panel cross-section dependence, was used to reveal the existence of short- and long-term relationships between variables. In order to test the accuracy of the results obtained, the second generation panel estimators Mean Group (Pesaran and Smith, 1995), Augmented Mean Group (Eberhardt and Bond, 2009), and Common Correlated Effects Mean Group (Pesaran, 2006) were used.

In the last stage, Emirmahmutoğlu and Köse Causality Test was applied to explore the causal relationship between the variables. The model avoids the problem of cross-section dependence, as it uses the bootstrap critical values generated by itself instead of the asymptotic Granger Causality

critical values. Therefore, the cross-sectional dependency pretest is not needed and is more reliable than other causality tests (Emirmahmutoğlu and Köse, 2011).

4. Findings

With the cross-section dependency test Pesaran (2015), the permeability of shocks between horizontal sections is investigated. Since the H_0 hypothesis is constructed as there is no cross-sectional dependence, accepting the null hypothesis indicates that there is no cross-sectional dependence between series. According to Table 2, where cross-sectional dependence results presented, cross-sectional dependence was found in all series according to 1% significance level. The result indicates that tests that take cross-sectional dependency into account should be selected in the next stages.

Table 2. *Pesaran (2015) Cross-sectional dependence test*

	lnCO2	**FDI**	**TO**	**lnGDP**
CD	39.320***	7.523***	49.830***	18.705***

***1% significance level

Since cross-sectional dependence was detected between the series, the Pesaran (2015) CIPS unit root test one of the second generation unit root tests that eliminated this problem, was used and the results given in Table 3. The hypotheses are as follows; H_0: Series are not stationary, H_1: Series are stationary.

Table 3. *CIPS unit root test results*

Variables	**Constant**		**Constant and trend**	
	Level	**First Difference**	**Level**	**First Difference**
lnCO2	-1.748	-4.718***	-1.904	-4.729***
FDI	-3.091***		-3.565***	
TO	-1.413	-4.377***	-2.019	-4.464***
lnGDP	-2.006	-3.817***	-2.336	-4.084***

***1% significance level

Constant, Constant and Trend similar results were obtained in both cases. While the null hypothesis for FDI was rejected at level, the null hypothesis was rejected when the first differences of the series were taken for lnCO2, TO and lnGDP. Based on the outcomes of the unit root test, lnCO2, TO and lnGDP were found to be stationary at the first differences I(1), while FDI was found to be stationary at the level I(0).**Table 4.** *Pesaran and Yamagata (2008) slope homogenity*

	t stat	**p value**
$\tilde{\Delta}$	11.699***	0.000
$\tilde{\Delta}$adj	12.774***	0.000

***1% significance level

According to Table 4, where Pesaran and Yamagata (2008) Slope Homogeneity Test results presented, the series were heterogeneous according to the 1% significance level. According to the findings, the H_0 hypothesis based on the equation coefficient being homogeneous was rejected at the 1% significance level and the alternative hypothesis of heterogeneity was accepted. This result means that each country in the panel has its own specific shocks and are not affected at the same level.

Since it was determined that there was cross-sectional dependence, coefficient heterogeneity and that some of the variables were I (0) and some were I (1), the CS ARDL coefficient estimator was

used, which allows the analysis of the short and long-term relationship between the variables under these conditions.

Table 5. *CS ARDL estimation results*

	Dependent Variable: CO2				
	Long Run			Short Run	
Variable	Cofficient	St.Errors	Variable	Cofficient	St.Errors
FDI	.0004864	.0060994	ΔFDI	.0054084	.0102669
TO	.0012688	.0007857	ΔTO	.00118661	.0015828
lnGDP	.9929496**	.4997057	ΔlnGDP	1.353168**	.5908562
			Ect(-1)	-2.181376***	.1949828

***significance level of 1%, ** significance level of 5%.

According to the CS ARDL estimation results in Table 5, it was determined that there is a significant relationship between only GDP per capita and carbon emissions both in the short and long term. According to the Coefficient estimates in the table, when GDP per capita increased by 1%; CO2 emissions increase by 1.35% in the short term and by 0.99% in the long run. No significant relationship was found between CO2 and FDI and between CO2 and TO. It has been observed that the effect of GDP per capita on carbon emissions is greater in the short term than in the long term. There is no evidence that FDI and TO have a short or long-term impact on carbon emissions. The error correction coefficient is negative in the negative model, as expected, and is significant at the 1% level. If this coefficient is greater than 1, it means that long-term equilibrium is reached by decreasing each time and following a wavy path.

Table 6. *Panel MG, AMG, CCEMG estimation results*

Variable	MG Coefficients	AMG Coefficients	CCEMG Coefficients
FDI	.0098663	.005348	.0015072
TO	.0011653	.0004156	.001407
lnGDP	.8091688***	.7019572***	.5307987***

***significance level of 1%.

Panel MG, AMG, CCEMG estimation results are presented in Table 6. The results supported the CS ARDL results. That is, no significant relationship was found between FDI-CO2 and TO-CO2, only evidence that GDP per capita positively affects CO2 emissions. This effect was 0.80% for the MG estimator, 0.7% for the AMG estimator, and 0.53% for the CCEMG estimator.

In economic studies, causality refers to the existence of a delayed cause and effect relationship between variables. In order to understand whether the variables have a significant effect on each other, Emirmahmutoğlu and Köse (2011) Panel Causality Analysis was used, which allows causality analysis with heterogeneous, cross-sectional dependence and stationary series at different levels.

Table 7. *Emirmahmutoğlu and Köse (2011) panel causality test results*

Direction of Causality	Fisher Test Value	Bootstrap Critical Values		
		CV_1	CV_5	CV_10
FDI→CO2	24.513	65.960	54.332	48.731
CO2→FDI	53.818**	63.874	53.038	48.101
TO→CO2	58.286**	67.815	55.510	49.853

CO2→TO	49.377	70.314	57.811	52.88
GDP→CO2	50.131*	65.299	53.754	48.748
CO2→GDP	49.394*	65.344	54.291	48.924

**significance level of 5%, *significance level of 10%, the lag value was determined by AIC, the max. lag value was taken as 4 (since annual data), the Bootstrap value was 10,000.

Emirmahmutoğlu and Köse (2011) panel-wide causality results in Table 7 were found as follows: The direction of the relationship between FDI and carbon emissions was unidirectional from carbon emissions to FDI (at 5% significance level), the direction of the relationship between TO and carbon emissions was unidirectional from TO to emissinons (at 5% significance level), while the relationship between GDP and carbon emissions was found bidirectional (at 10% significance level). Here it has been revealed that GDP and TO are the cause of CO2, and CO2 is the cause of FDI and GDP. Additionally, FDI has no effect on CO2 and CO2 has no effect on TO.

5. Ethics of Research

Since all of the data used in the analysis is obtained from World Bank Data, which is accessible to all users, it does not require an ethics committee document. The rules required by scientific ethical rules were strictly followed at all stages of the study and during the reporting process.

6. Conclusion and Evaluation

As long as human beings continue to consume unconsciously, the problem of environmental pollution will continue to increase. It is necessary to determine the factors that cause environmental pollution and to implement sanctions in this direction in all countries of the world without exception. Neither the developed countries benefiting from the flexibility of constraints on climate change in developing nations, nor the developing countries driven by concerns of economic growth, have the right to usurp the rights of future generations. It should not be forgotten that climate change is a global problem that has taken over the whole world.

In this study, foreign direct investments and trade openness, which are considered as the factors that cause this important problem, were focused and it was aimed to measure the effect of these factors on carbon emissions in emerging economies. For this purpose, the data of the FDI, TO, GDP and CO2 variables of 15 countries, which are defined as EMEs by the IMF, for the years 1990-2020 were used.

The CS ARDL estimator was used to determine the long-term and short-term relationship between the variables. According to the estimation results, there was no significant finding that FDI and TO had a short- or long-term effect on carbon emissions. Only GDP has been proven to have a significant and positive effect on CO2 in both the short and long term. The coefficient estimates were found to be 1.35 and .99 for the short and long term, respectively. CCE, MG, AMG results applied as robustness check were similar to CS ARDL. The coefficient estimates for GDP's impact on CO2 were .80, .70 and .53, respectively. Emirmahmutoğlu and Köse (2011) causality test findings pointed to a one-way relationship from trade openness to carbon emissions and from carbon emissions to foreign direct investments, and a bidirectional relationship between GDP and carbon emissions.

These findings are consistent with the following studies in the literature: Yılmazer and Ersoy (2009), could not find cointegration between FDI and CO2; Blanco et al. (2013), did not find causality between FDI-CO2 in non-pollution-intensive industries; Omri et al. (2014), found that there are countries with causality from FDI to CO2; Atay Polat (2015), stated that GDP increases CO2; Çetin and Seker (2014), found that GDP and trade openness increase CO2 emissions; Yıldırım et al. (2021), revealed that GDP increases CO2; Topallı (2022), could not detect a long-run relationship between TO

and CO2 in China, Malaysia and Thailand; Tiba and Belaid (2020), found a bidirectional relationship between GDP and CO2. As it is understood, the effect of foreign direct investments and trade openness on carbon emissions is not certain in the literature. Results vary for each country or group of countries. The results from this study are binding for emerging economies.

Findings from the study show that neither the Pollution Haven nor the Pollution Halo Hypothesis is valid for EMEs. However, according to the causality analysis result, carbon emissions are a reason for foreign direct investments. Unlike the hypotheses, this could mean that FDIs flow into economies with high CO2. Considering that the sanctions of emerging economies on environmental pollution are more flexible, it can be concluded that this situation creates an attraction for foreign direct investments. Considering the one-way causality relationship from trade openness to carbon emissions, it turns out that non-environmentally friendly products are traded as a result of legal flexibility in emerging economies. Based on these, it can be said that it is appropriate to take measures to reduce carbon emissions in emerging economies, and also to consider the carbon emission problem in the promotion of FDI and especially trade.

The limitation of this study is that the study is based on emerging economies only. For future studies on EMEs, it may be recommended to analyze by separating pollution-intensive industries and other industries, or by grouping countries with similar FDI and TO increases.

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