Asiye TÜTÜNCÜ, PhD
atutuncu@kastamonu.edu.tr
Kastamonu University, Kastamonu, Türkiye

Şükran SIRKINTIOĞLU YILDIRIM, PhD (corresponding author)
sukransirkinti@gmail.com ssirkintioglu@kastamonu.edu.tr
Kastamonu University, Kastamonu, Türkiye

Omca ALTIN, PhD
oaltin@kastamonu.edu.tr
Kastamonu University, Kastamonu, Türkiye

Foreign Direct Investment and Environmental Impact: A Comparative Analysis of Türkiye, Bulgaria, and Romania

Abstract. *This study examines the impact of foreign investment inflows on pollution levels in Türkiye, a candidate for EU membership, and Bulgaria and Romania, the most recent members, using data from 1991 to 2019. It analyses the differences between these countries through a cointegration test with structural change and an FMOLS estimator. The findings reveal that while Bulgaria and Romania, as EU members, serve as pollution havens, foreign investments in Türkiye have no significant effect on pollution. This is attributed to Türkiye's predominantly brown investments and its lower ability to attract foreign capital. The research highlights the EU's emphasis on environmental policies when admitting members and the implications of foreign investments on pollution.*

Keywords: *carbon dioxide emission, foreign direct investment, EU countries, Türkiye, cointegration test.*

JEL Classification: C1, F18, Q56.

Received: 26 March 2025	Revised: 24 May 2025	Accepted: 12 June 2025

1. Introduction

Foreign direct investments (FDI) are considered to play a significant and decisive role in the economic development of host countries. According to the World Bank (2023) report, the average FDI rate (as a percentage of GDP) is 1.88 globally, 1.80 in developing countries, 2.38 in the European region, and 2.44 in European Union (EU) member countries. This rate is 4.38 on average in developed countries and 5.79 in developing countries in the European region (World Bank 2023).

The impact of FDIs on the environmental quality of host countries is explained by two hypotheses: the pollution haven and the pollution halo. The pollution haven hypothesis (PHH) suggests that due to its strict environmental policies, the source country transfers its dirty industries to less developed countries with more flexible

DOI: 10.24818/18423264/59.2.25.15

environmental regulations, thereby increasing pollution levels in the host countries (Apergis et al., 2023).

On the other hand, the pollution halo hypothesis (PHH) argues that developed countries use clean technological development due to their strict environmental policies and reduce environmental pollution in the host country through their investments (Apergis et al. 2023).

Each year, the EU refines its climate and environmental protection policies, ensuring that member countries adopt more stringent measures and lead in global climate policies. Furthermore, the EU mandates that every candidate country comply with the EU's Environmental Acquis[1]. However, Horobet et al. (2021) determined that FDIs played a crucial role in environmental degradation in EU member countries. According to the World Bank (2023), the average per capita CO_2 emission level is 4.27 globally and 7.52 in EU countries. Eurostat's (2023) data shows an increase in the EU's total greenhouse gas emissions, with CO_2 emissions accounting for 81% of this rise. This suggests that the environmental regulations implemented by the EU may not be reducing CO_2 emissions to the expected level.

Mert et al. (2019) attribute this situation to the fact that the environmental regulations of the newest EU members are at least 20 years behind those of older member countries. Additionally, Wang et al. (2023) support Mert et al. (2019) and emphasise that the latest members, in particular, contribute to heterogeneity within the Union. Therefore, this situation should be considered in efforts regarding environmental regulation. Bulgaria and Romania, considered developing countries when they became EU members, are evaluated differently from other countries. Lazăr et al. (2019) argued that these countries have shown less economic development than other EU countries. Romania and Bulgaria share similar economic and social structures and joint historical development as former communist countries.

Although Bulgaria and Romania have implemented some structural changes in their environmental standards to meet EU criteria, environmental regulations remain inadequate due to increased energy supplies, administrative failures, and poor air quality (Pavlović et al., 2021). Furthermore, the primary concern of these countries during the EU membership process was economic growth. Consequently, the primary goal became attracting investment from EU member states that made the most FDIs. However, the effects of FDIs on the environmental quality of these countries have been ignored (Christoforidis and Katrakilidis, 2022).

Taking into account Türkiye, a candidate country with a strong industry and a cheap skilled workforce, it is Europe's seventh most popular country in terms of FDIs as of 2019, according to the European Attractiveness Survey (Ernst and Young 2019). With the regulations introduced by the "Foreign Direct Investment Law" No. 4875 enacted in 2003 and the official launch of membership negotiations with the EU in 2005, Türkiye has achieved an upward momentum in FDI inflows. Although foreign capital inflow to Türkiye witnessed a sharp decline due to the impact of the 2008-2009 global crisis, it followed a fluctuating course as the effects of the crisis eased, ultimately reaching 19.26 billion dollars in 2015. In the following periods, FDIs declined due to tensions in the country's political environment and the impact of COVID-19, but continued to increase as of 2021 (World Bank 2023). However, Türkiye is not among the countries with the most significant responsibility for greenhouse gas emissions, but is rapidly increasing its emissions (International Energy Agency 2023). In fact, Türkiye, the 38th country in 1960 in the global CO_2 emission rankings, became the 16th country in 2019 and the 14th country in 2021 (Global Carbon Atlas 2021).

This study compares the EU candidate Türkiye and EU members Romania and Bulgaria regarding FDIs and their effects on pollution. Bulgaria and Romania, developing EU member countries, officially started their membership process in 2000 and became full members in 2007. On the other hand, Türkiye, which began negotiations in 2005, is still a candidate country. These countries have similar development levels and are geographically very close. For this reason, these two countries were selected for comparison with Türkiye in the study.

The main motivation of this study is to examine the environmental pollution of the European Union member countries and Turkey as a candidate country in the context of foreign investments. In this context, this study makes some significant contributions to the literature. Firstly, it examines FDIs with econometric methods regarding environmental regulations and informs policymakers about what policies Türkiye should follow in the negotiation process. Secondly, although there are studies on the relationship between variables, no studies compare the findings in this context. Finally, the relationship between the variables was examined with the cointegration test developed by Tsong et al. (2016), which considers structural change, representing another contribution to the literature. There are two reasons why structural changes are taken into account: first, if structural changes are not considered, the null hypothesis is likely to be rejected (Enders and Lee 2012); secondly, various policy regulations during the EU membership process of countries caused changes in many variables.

This study, which examines the relationship between carbon emissions and FDIs with a focus on Türkiye, Romania, and Bulgaria, discusses empirical studies in the first chapter under the title of the empirical literature. The second chapter presents the data, economic methods, and findings used in the study, and the conclusion chapter compares the study findings with the literature.

2. Literature review

The empirical literature has long discussed the relationship between FDIs and pollution, but there is no consensus on the outcome on a country-by-country basis. The reasons for this may include the selected countries, the research period, the length of data, the econometric methods used, and the environmental degradation indicators employed (e.g., CO_2, ecological footprint). The subject remains current in this sense.

Existing studies generally emphasise that a more significant number of FDIs enter developing countries, and therefore, they focus on these countries (Wang et al., 2023; Apergis et al., 2023). Table 1 presents the literature on the countries and/or groups of countries in question.

Table 1. Literature for developing countries

Author(s)	Period	Country(ies)	Methodology	Result(s)
Khan et al. (2020)	1995-2016	B&RI countries	GMM, FMOLS	Mixed Results
Awan et al. (2022)	1996-2015	Ten emerging countries	Method of Moments Quantile Regression	PHH
Li et al. (2022)	1995-2017	89 B&RI countries	Panel cointegration, PCSE, GLS estimator	Mixed Results
Apergis et al. (2023)	1993-2012	BRICS	GMM, Dumitrescu-Hurlin Panel Granger causality	Mixed Results
Khan et al. (2023)	2000-2016	108 developing countries	Panel cointegration, P-VECM, OLS	PHH
Wang and He (2023)	2000-2021	China	ARDL Bounds test	PHH

Source: Created by the authors.

Table 1 shows emerging country findings support the PHH. It can be contended that developing countries are prone to attract environmentally harmful investments. Among the studies in the literature that use panel data analysis for EU countries, Mert et al. (2019) and Li et al. (2022) could not detect a strong relationship between FDI and CO_2. However, while Wang et al. (2023) determined that FDI had an increasing effect on the pollution level of the countries in general, Horobeț et al. (2021) determined that FDI had a reducing effect on pollution levels. The results vary from country to country in studies conducted for Central and Eastern European Countries (CEECs). When the results for Bulgaria and Romania, the subjects of this study, are examined, Destek (2020), and Pavlović et al. (2021) supported the PHH, whereas Christoforidis and Katrakilidis (2022) found an inverted U-shaped relationship.

However, when the literature for Türkiye is examined, the studies in Table 2 generally support the PHH. Additionally, fewer studies have focused on Bulgaria or Romania than on Türkiye, and studies examining panel data in the context of the EU, CCEs, Soviet, and Balkan countries have reported similar results (Destek 2020; Pavlović et al., 2021).

Table 2. Empirical literature for Türkiye

Author(s)	Period	Methodology	Result(s)
Koçak and Şarkgüneşi (2018)	1974-2013	Maki cointegration, Hacker ve Hatemi-J bootstrap causality, DOLS	PHH
Haug and Ucal (2019)	1974-2014	ARDL Bounds test, NARDL	No relationship
Uğur (2022)	1974-2015	ARDL Bounds test, FMOLS, DOLS and CCR	PHH
Cil (2023)	1970-2020	FShin cointegariton, FADL cointegariton, FMOLS	PHH

Source: Created by the authors.

The literature has mostly addressed nation groupings using panel data analysis rather than time-series methods. However, changes over time and the number of nations considered may dramatically alter the results. This study compares non-EU Türkiye with growing Bulgaria and Romania, recent EU members. Due to the limitation, this comparison uses cointegration tests to account for structural changes in the same period instead of panel data analysis.

It has also been noted that studies conducted in Bulgaria and Romania have often overlooked structural changes despite these countries implementing various regulations in environmental policies and other areas during the EU harmonisation process (Christoforidis and Katrakilidis, 2022). Therefore, accounting for structural changes is likely to yield more robust results. Furthermore, although some studies focusing on Türkiye consider structural changes, no study has been found that examines these changes using Fourier functions, except for Cil (2023).

3. Econometric Methods

3.1 Ng-Perron Unit Root Test

Ng and Perron (2001) introduced the unit root test based on the trend-adjusted GLS method. In addition to providing effective results in small samples, it solves diagnostic problems that occur in variables using modified information criteria and the generalised ECM method. The Ng-Perron unit root test is widely used in the literature as it provides high-power, full-size performance. Moreover, this unit root test is based on four different test statistics: MZa, MZt, MZB, and MPT.

3.2 Fourier ADF Unit Root Test

Traditional unit root tests do not take structural changes into account. However, not addressing structural changes leads to the problem of misspecification. Moreover, especially in macroeconomic variables, the impact of structural changes is smooth (Enders and Lee, 2012). This smooth effect is investigated with Fourier functions that include trigonometric terms.

The Fourier ADF (FADF) unit root test, introduced by Enders and Lee (2012), is based on adding Fourier functions to the ADF unit root test. The test's null hypothesis states that there is a unit root, while the alternative hypothesis states that there is no unit root. Fourier functions are expressed by equation (1):

$$d(t) = a_0 + \sum_{k=1}^{n} a_k \, sin\left(\frac{2\pi kt}{T}\right) + \sum_{k=1}^{n} \beta_k \, cos\left(\frac{2\pi kt}{T}\right), n \leq T/2 \qquad (1)$$

In this equation, T, t, π, and k denote the sample size, trend, and 3.14416, a value between one and five that minimises the sum of residual squares, respectively. If$a_1 = \beta_1 = \cdots = a_n = \beta_n = 0$, the process is linear and traditional unit root tests must be used. But if this is not the case, there is a break or a non-linear slope, and at least one Fourier frequency must be present in the data generation process. Thus, the Fourier ADF unit root statistic developed by Enders and Lee (2012) can be used to test for the presence of a unit root using equation (2).

$$\Delta y_t = \rho y_{t-1} + c_1 + c_2 t + c_3 sin\left(\frac{2\pi kt}{T}\right) + c_3 cos\left(\frac{2\pi kt}{T}\right) + e_t \quad (2)$$

Equation 2 consists of adding Fourier terms to the ADF unit root test.

3.3 Fourier Shin Cointegration Test

Cointegration tests are essential to determine how the relationship between variables moves in the long run. These tests are divided into two categories: those that take structural change into account and those that do not. However, ignoring the structural change causes deviations in the results obtained (Cil 2023). To avoid these problems, Tsong et al. (2016) proposed a cointegration test based on the Fourier methodology. Thus, examining the long-run relationship between variables under structural change of unknown form is possible. In addition, this test has many advantages over other cointegration tests. One is that it allows studying structural changes under sharp and soft fractures. Moreover, Tsong et al. (2016) produce critical values to test the significance of Fourier functions. Finally, since this test is based on the Shin cointegration test, the null hypothesis states the existence of a cointegration relationship, unlike other cointegration tests. Tsong et al. (2016) consider the model in equation 3.

$$y_t = d_t + x_t'\beta + \eta_t \quad (3)$$

where, $\eta_t = \gamma_t + \upsilon_{1t}, \gamma_t = \gamma_{t-1} + u_t, x_t = x_{t-1} + \upsilon_{2t}$ ve $d_t = \sum_{i=0}^{m} \delta_i t^i + f_t, m = 0$ or $m = 1$.

Furthermore, it indicates the error term, random walk series with zero means, deterministic components, and Fourier functions. In addition, while υ_{1t} and υ_{2t} are stationary, y_t and x_t are stationary at first difference. The null hypothesis of the cointegration test is defined as equation 4.

$$H_0 : \sigma_u^2 = 0 \text{ versus } H_1 : \sigma_u^2 > 0 \quad (4)$$

The model based on equation (3) under the null hypothesis is as equation (5):

$$y_t = \sum_{i=0}^{m} \delta_i t^i + \alpha_k sin\left(\frac{2k\pi t}{T}\right) + \beta_k cos\left(\frac{2k\pi t}{T}\right) + x_t'\beta + \upsilon_{1t} \quad (5)$$

The cointegration test statistic calculated to test the alternative hypothesis that there is no cointegration relationship against the null hypothesis that there is a cointegration relationship with structural changes is given in equation (6).

$$CI_f^m = T^{-2}\widehat{\omega}_1^2 \sum_{t=1}^{T} S_t^2 , S_t = \sum_{t=1}^{T} \hat{\upsilon}_{1t} \quad (6)$$

Where, S_t is the sum of the error terms calculated by the Ordinary Least Squares (OLS) in equation (5); $\widehat{\omega}_1^2$ is the coefficient estimator of the long-run variance of υ_{1t}. Finally, the coefficients of the cointegration equation are estimated by Fully Modified OLS (FMOLS). This test removes endogeneity and autocorrelation problems and eliminates the effect of bias by using kernel estimators (Phillips and Hansen, 1990).

4. Data Set and Empirical Finding

4.1 Data set

This study aims to compare the impact of inward FDI on pollution levels in Türkiye, Bulgaria, and Romania with the help of control variables. Bulgaria and Romania are developing countries that have been accepted for EU membership. Based on the findings, the study aims to determine how Türkiye differs from these countries in the EU membership process and identify areas where it needs further improvement. For this purpose, data from 1991-2019 and the variables in Table 3 were used. Additionally, in the following sections of the study, the variables are referred to using the initials of the country they belong to.

Table 3. Information on variables

Abbreviation	Description	Source
CO_2	Carbon dioxide emissions (kt)	World Bank (2023)
FDI	Foreign direct investment net inflows (% of GDP)	
GDP	Real GDP per capita (2015 USD)	
URB	Urban population (% of total population)	
OPEN	Trade (% of GDP)	

Source: Created by the authors.

The control variables in the study were determined based on the study by Apergis et al. (2023). The logarithm of CO_2 and GDP values were used in the study. Additionally, the study used the period 1991–2019, for which the variables were calculated for the country group considered. The start of this period was determined as the date when the data for Bulgaria and Romania began to be calculated after the collapse of the Soviet Union, and the end was determined as the date when the CO_2 variable was last calculated. Diagnostic statistics for the variables in the study for the relevant period are given in Table 4.

Table 4. Diagnostic statistics

Variables	Mean	Median	Maximum	Minimum	SE	Skewness	Kurtosis	JB
BCO_2	17.65	17.66	17.96	17.32	0.20	-0.05	1.84	1.65
BFDI	6.38	3.64	31.23	0.37	7.22	2.02	6.71	36.27^{***}
BGDP	8.56	8.56	9.02	8.17	0.28	0.07	1.43	3.01
BURB	70.76	70.58	75.35	66.72	2.67	0.17	1.74	2.05
BOPEN	101.57	99.71	130.29	55.26	21.71	-0.10	1.81	1.76
RCO_2	11.44	11.46	11.87	11.18	0.20	0.39	2.18	1.54
RFDI	3.06	2.78	9.02	0.14	2.29	1.16	3.77	7.17
RGDP	8.76	8.75	9.33	8.31	0.33	0.13	1.56	2.59
RURB	53.61	53.77	54.23	52.78	0.42	-0.55	1.98	2.73
ROPEN	65.24	61.68	87.16	39.13	13.44	0.29	2.01	1.59
TCO_2	12.41	12.37	12.94	11.88	0.33	0.00	1.80	1.75
TFDI	1.23	1.26	3.62	0.31	0.89	1.01	3.46	5.18^{*}
TGDP	8.94	8.94	9.39	8.57	0.27	0.28	1.74	2.30
TURB	67.83	67.84	75.63	59.98	4.88	0.00	1.73	1.96
TOPEN	47.53	48.33	62.69	30.48	7.82	-0.38	3.17	0.74

Note: *, *** indicate 10%, 1% statistical significance level respectively.
Source: Calculated by the authors.

Among the statistics in Table 4, SE represents the standard error, and JB represents the Jarque-Bera statistic. As derived from the diagnostic statistics, Türkiye has the highest average GDP value, while Bulgaria has the highest average values for all other variables. In contrast, Türkiye has the lowest average FDI and OPEN values, Romania has the lowest URB value, and Bulgaria has the lowest GDP value. Judging by the skewness values, BCO_2, BOPEN, RURB, and TOPEN are skewed to the left, while the other variables are skewed to the right. Looking at the kurtosis values, the FDI values for each country and the TOPEN value have kurtosis more significant than three, indicating a leptokurtic distribution, which implies more volatility. Additionally, all variables except Bulgaria's and Türkiye's FDI show a normal distribution.

4.2 Empirical Findings

To examine the long-term impact of FDIs on the pollution levels of countries, this study used the cointegration test developed by Tsong et al. (2016), which takes into account structural changes. For this test to be applicable, the variables must be stationary at their first difference. Therefore, the unit root test was first applied to the variables. Tsong et al. (2016) utilised the Ng-Perron (2001) unit root test; therefore, this unit root test was first applied in the present study. The findings obtained are presented in Table 5.

Table 5. Results of unit root tests

	I(0)				I(1)			
Variables	MZa	MZt	MSB	MPT	MZa	MZt	MSB	MPT
BCO_2	-2.32	-0.79	0.34	8.84	-13.33**	-2.58***	0.19**	1.84**
BFDI	-5.27	-1.69	0.29	4.28	-28.27***	-3.76***	0.13***	0.87***
BGDP	1.74	1.73	0.99	78.77	-10.70**	-2.23**	0.21**	2.62**
BURB	2.16	15.54	7.19	4048.39	-5.71*	-1.63*	0.23*	4.35*
BOPEN	-4.45	-1.37	0.31	5.69	-12.41**	-2.47**	0.20***	2.06**
RCO_2	0.61	0.61	1.01	64.42	-9.54**	-2.16**	0.23**	2.66**
RFDI	-5.84	-1.7	0.29	4.21	-5.85*	-1.70*	0.27*	4.21*
RGDP	2.52	2.92	1.16	118.19	-7.70**	-1.89*	0.25*	3.43**
RURB	-3.85	-1.33	0.34	6.39	-8.21**	-2.03**	0.25*	2.99**
ROPEN	-1.6	-0.63	0.39	10.96	-6.16*	-1.72*	0.26*	3.58*
TCO_2	1.42	1.38	0.97	70.97	-13.49**	-2.48**	0.18***	2.26**
TFDI	-4.77	-1.54	0.32	5.14	-8.89**	-2.09**	0.23**	2.81**
TGDP	-4.77	-1.54	0.32	5.14	-11.38**	-2.36**	0.21**	2.23**
TURB	1.92	21.43	11.18	9371.37	-6.85*	-1.72*	0.25*	4.01**
TOPEN	0.47	0.22	0.45	18.46	-29.54***	-3.84***	0.13***	0.83***

Note: *, **, *** indicate 10%, %5, 1% statistical significance level respectively.
Source: Calculated by the authors.

As seen from the results in Table 5, all variables considered are stationary at the first difference, although their statistical significance levels differ. However, the Ng-Perron unit root test, one of the traditional tests, does not consider structural changes. These tests tend to reject the null hypothesis due to structural changes in the variables. For this reason, the FADF unit root test, which accounts for smooth structural breaks, was also applied to the variables. The results obtained are given in Table 6.

Table 6. Results of unit root tests

	FADF Unit Root Test				ADF Unit Root Test	
Variables	k	F Test Statistic	p	FADF Test Statistic	I(0)	I(1)
BCO_2	3	1.42	2	3.69	-1.95	-5.49***
BFDI	4	1.51	1	-2.27	-2.55	-4.16***
BGDP	2	6.9*	7	-1.19		
BURB	1	3.45	7	2.62	1.18	-1.955*
BOPEN	1	5.24	4	-3.08	-1.66	-7.35***
RCO_2	3	1.085	2	-1.79	-1.59	-4.19***
RFDI	3	5.58	7	-2.61	-2.3	-6.52***

	FADF Unit Root Test				ADF Unit Root Test	
RGDP	2	13.05***	5	3.49		
RURB	1	8.47	7	-3.38	-2.51	-1.67*
ROPEN	1	10.14**	6	-1.41		
TCO_2	3	6.42*	3	2.64	0.08	-4.85***
TFDI	1	3.97	1	-3.7	-2.1	-4.78***
TGDP	4	2.59	2	0.86	0.85	-4.63***
TURB	1	12.04***	7	1.24	-1.73	-1.66*
TOPEN	5	7.56*	6	1.45	1.578	-7.11***

Note: *, **, *** indicate statistical significance levels of 10%, 5%, and 1%, respectively.
Source: Calculated by the authors.

The applicability of the FADF unit root test depends on the significance of the F statistic. If the F statistic is significant, trigonometric terms are meaningful, and the unit root process under structural changes can be examined. However, if the F test statistic is not statistically significant, the traditional ADF unit root test is employed because the variables do not contain structural changes. According to the FADF unit root test results in Table 6, the F test statistics were statistically significant for BGDP, RGDP, ROPEN, TURB, and TOPEN but insignificant for the other variables. For this reason, the ADF unit root test was applied to the other variables, and all variables were found to be stationary at the first difference, as revealed by the Ng-Perron unit root test.

The Fourier-Shin cointegration test, used to investigate the relationship between variables, examines the structural change based on the Shin cointegration test. Therefore, the null hypothesis suggests that there is cointegration. The results of this cointegration test applied to Bulgaria, Romania, and Türkiye are shown in Table 7.

Table 7. Results of Fourier Shin Cointegration test

CO_2 = f(FDI, GDP, URB, OPEN)

	k	p	Test Statistic	F Test Statistic
Bulgaria	3	4	0.17	5.12**
Romania	3	4	0.15	7.51***
Türkiye	3	4	0.12	6.91***

Note: ** and *** indicate statistical significance levels of 5% and 1%, respectively. Critical values of the test statistic and F statistic are included in the study of Tsong et al. (2016: 1091).
Source: Calculated by the authors.

According to the findings in Table 7, the cointegration relationship is valid in the established model for the three countries. Additionally, the F statistics of the models are statistically significant, indicating a structural change in the models. However, this cointegration test does not explain how the independent variables affect the dependent variable. Therefore, the coefficients of the country models were examined using the FMOLS coefficient estimator developed by Phillips and Hansen (1990). The FMOLS estimator overcomes bias caused by missing variables, produces consistent estimates in small samples, and addresses the endogeneity problem between variables (Cil, 2023). The results obtained from the FMOLS estimator are presented in Table 8.

Table 8. Results of FMOLS Coefficient estimator

Variables	Bulgaria	Romania	Türkiye
FDI	0.002***	0.034**	0.012
GDP	-0.203***	-0.453**	0.367**
URB	0.094***	0.325*	0.043***
OPEN	0.001	0.008***	0.002
Sin	-0.005*	-0.055***	-0.011***
Cos	-0.006***	-0.016**	-0.059**
Constant	11.03***	-6.28**	6.10***
Jarque-Bera (p-value)	1.687 (0.431)	0.805 (0.668)	0.816 (0.665)

Note: *, **, and *** indicate statistical significance levels of 10%, 5%, and 1%, respectively.
Source: Calculated by the authors.

According to the results in Table 8, the FDIs in Bulgaria and Romania positively impact pollution, indicating that these countries serve as pollution havens (PH). However, no statistically significant effect of FDIs on pollution was detected in the context of Türkiye. When examining the control variables, it was observed that improvements in GDP led to decreased pollution in Bulgaria and Romania. However, no statistically significant effect was found for Türkiye. Additionally, urbanisation was found to affect pollution in all three countries positively. Furthermore, it was determined that openness positively affected pollution only in Romania. Lastly, the models exhibited a normal distribution.

5. Discussion of the Empirical Results

The paper compares FDIs and pollution in the EU candidate Türkiye, Bulgaria, and Romania. The study used the Fourier-Shin cointegration test by Tsong et al. (2016), which accommodates structural changes, together with the FMOLS coefficient estimator. The findings demonstrate that the models analysed for each nation exhibit cointegration. EU nations Bulgaria and Romania have a PH effect, not expected, according to FMOLS. Simultaneously, foreign direct investments exhibit no statistically significant impact on pollution levels in Turkey.

Although EU member countries are expected to have stricter environmental regulations and, therefore, not exhibit a Pollution Haven (PH) effect (Mert et al. 2019), the results reported in the literature show the opposite, as observed in the current study. The findings of this study are corroborated by Destek (2020), Pavlović et al. (2021), Christoforidis and Katrakilidis (2022) and Wang et al. (2023). Moreover, Lazăr et al. (2019) find a U-curve shape for Bulgaria. These results indicate that, despite the standard environmental policies among EU countries, their policies may vary based on their interests. Studies conducted for the countries in question and EU member countries support this finding (Lazăr et al. 2019; Mert et al. 2019).

The results obtained for Türkiye also vary considerably. Although studies in the context of Türkiye generally identify the country as PH (Cil 2023), the current study could not identify a statistically significant impact of FDI on pollution. Nevertheless, this result aligns with Haug and Ucal (2019) study. This result may be because most investments entering Türkiye are brownfield investments (United Nations Conference on Trade and Development [UNCTAD], 2023). According to the UNCTAD (2023) report, brownfield investments in Türkiye are approximately five times greater than green investments, including investing in the host country from scratch and establishing new facilities. Moreover, compared to other EU member countries, as well as Bulgaria and Romania, total FDI inflows to Türkiye are pretty low (World Bank, World Development Indicator (WDI) 2023).

On the other hand, considering the CO_2 values reported by the World Bank's WDI (2023), Türkiye is a more polluted country than Bulgaria and Romania. Furthermore, while environmental taxes (GDP%) have been increasing in Bulgaria and Romania over the years, they have been on a downward trend in Türkiye, especially after 2010 (OECD 2023). This situation shows that Bulgaria and Romania have tightened their environmental regulations recently, but Türkiye has loosened them. This situation is not only one of the reasons for pollution in Türkiye, but also stems from the activities of its dirty industries classified under NACE.Rev.2 (Eurostat 2023). In Türkiye, these activities are generally carried out with domestic resources, not through FDI (UNCTAD 2023).

Considering the control variables, developments in national income reduced pollution in EU member countries but increased it in Türkiye. In this case, Bulgaria and Romania prioritised growth and ignored environmental regulations in the early EU membership process, as determined by Christoforidis and Katrakilidis (2022). However, this situation tended to change in these countries in the following years, and economic development led to decreased pollution. This result parallels that of Lazăr et al. (2019). In the Turkish context, on the other hand, economic development led to increased pollution as Türkiye ignored the environment to grow. Urbanisation positively affects pollution in all three countries, similar to Awan et al.'s study (2022). The main reason for this result is that uncontrolled human activities in urban areas caused by uncontrolled migrations spread pollutants into the atmosphere, which pose a serious warning for human well-being and the natural ecosystem (Apergis et al., 2023). Finally, trade openness, which is statistically significant for Romania, shows that the country's exports and imports increase pollution in parallel with FDI, consistent with the study of Apergis et al. (2023).

6. Conclusions

The effects of FDI on countries have been frequently discussed in the literature in different ways. Increasing concerns about global environmental pollution, parallel to globalisation, have created the need to examine the effects of FDI on the environment. Developing countries Bulgaria and Romania, which became members of the EU in 2007, and Türkiye, which is a candidate country, are attractive countries for FDIs due to their qualified and cheap workforce. Due to their proximity to developed countries, these countries contribute to reducing logistics costs for FDIs.

Accordingly, this study examines the relationship between FDIs and pollution in Bulgaria, Romania, and Türkiye. For this purpose, the relationship between the variables for the period 1991-2019 was examined through the Fourier Shin cointegration test and FMOLS estimator. Thus, the gap in the literature was filled by investigating the differences between EU member countries Bulgaria and Romania and the candidate country Türkiye. In addition, it has been observed that many structural reforms carried out by Bulgaria and Romania during the membership process (Christoforidis and Katrakilidis 2022) are not taken into account by studies focusing on these countries. Therefore, this study filled this gap in the literature by considering structural changes. As a result of the cointegration test, it was determined that the models of all three countries were cointegrated. As a result of the coefficient estimator, it was determined that Bulgaria and Romania were PHs, while there was no statistically significant relationship in Türkiye.

EU membership is essential for Türkiye, which currently has the candidate country status. Based on the findings, Türkiye is not a PH, but has a higher pollution rate than Romania and looser environmental regulations than the EU member states (World Bank 2023; OECD 2023). At this point, some policy suggestions can be put forward for Türkiye. Complying with the acquis during the candidature process and aligning environmental pollution control plans with Union law are legal coordination requirements. Türkiye successfully implements legal regulations in this process, but the actual issue is applying the laws, harmonising environmental pollution policies, and developing its institutional ability. To successfully harmonise with EU legislation in practice, Türkiye must adopt policies that fit its internal structure within EU general policies.

On the other hand, strict environmental regulations in EU member states are insufficient, and stricter regulations should be introduced for FDIs. Spendzharova and Vachudova (2012) emphasises that Romania and Bulgaria are not among the weakest countries of the EU and that their admission to the union was a wrong decision. Although these countries did not meet many EU conditions, political policies were effective in their admission to the Union[1].

Türkiye has a great potential for FDIs due to its location and youthful, qualified workforce, but fewer FDIs enter than the countries in the research. Therefore, open policies, reasonable taxes, and investor trust and stability should accelerate green investment. This will result in the country's accession to EU membership and ultimately facilitate technical and sustainable economic development. Conversely, the European Commission's Türkiye Report (2023) indicates that Türkiye lacks a long-term decarbonisation strategy, which is a goal of the EU. A contributing factor to this predicament is the exceedingly low level of substantial investments. Consequently, Türkiye had to establish more specific objectives and attract clean

[1] For detailed information see: Andreev (2009).

foreign direct investment. The report further advises that Türkiye acceded to the Espoo Convention and the Aarhus Convention, thereby formulating policies aligned with EIA protocols.

This study is limited. This study's duration was based on projected varying publication dates. This is the study's biggest drawback. CO_2 is the most polluting emission in EU countries; hence this analysis included it. Future studies can compare emissions. Finally, this study chose nations with similar development levels to Türkiye to compare. Further research may classify candidate and member countries by development.

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