Sectoral Foreign Direct Investment, Institutional Quality, and Environmental Sustainability: Evidence from CEE countries

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Abstract

This paper examines the relationship between sectoral foreign direct investment (FDI), institutional quality, and environmental sustainability in Central and Eastern European countries. The analysis is based on a balanced panel dataset covering Bulgaria, the Czech Republic, Croatia, Poland, Romania, Slovakia, and Slovenia over the period 2010-2023. Environmental sustainability is measured using two indicators: ecological footprint and CO_2 emissions. The study considers both total FDI and sectoral FDI in mining and quarrying, manufacturing, electricity and gas, construction, and services. Institutional quality is captured through a composite index constructed from control of corruption, government effectiveness, political stability, regulatory quality, rule of law, and voice and accountability. Using fixed-effects panel models with country and year effects, the paper investigates whether institutional quality moderates the environmental impact of FDI. The results suggest that the relationship between FDI and environmental sustainability differs across environmental indicators and sectors. Total FDI is negatively associated with CO_2 emissions in the baseline model, while its relationship with ecological footprint is not statistically significant. The moderation results indicate that institutional quality plays a sector-specific role, particularly in the CO_2 models, where stronger institutions reduce the environmental impact of total FDI, manufacturing FDI, and services FDI. These findings highlight the importance of considering both the sectoral composition of FDI and institutional conditions when assessing the environmental implications of foreign investment in CEE economies.

Keywords: Foreign direct investment (FDI); sectoral FDI; institutional quality; environmental sustainability; ecological footprint.

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1. Introduction

Foreign direct investment (FDI) continues to play a central role in the economic development of Central and Eastern European (CEE) countries. Since the transition from centrally planned economies and the subsequent integration into the European Union, these countries have experienced substantial economic restructuring, increasing market integration, and growing exposure to international capital flows. Earlier studies emphasize the importance of macroeconomic dynamics, financial development, and convergence processes in shaping the development trajectory of CEE economies (Rapacki & Próchniak, 2009; Dobrinsky & Havlik, 2014; Szakálné Kanó et al., 2025). At the same time, institutional quality has been identified as a key factor supporting economic growth and development in post-transition economies (Peev & Mueller, 2012; Osińska et al., 2025).

Foreign direct investment has played a major role in this transformation process. The literature identifies institutional quality among the most important determinants of FDI attractiveness in transition economies (Kinoshita & Campos, 2003; Bevan & Estrin, 2004; Busse & Hefeker, 2007). More recent evidence confirms that governance quality, corruption control, and broader institutional conditions continue to influence the ability of CEE countries to attract foreign investment (Dorożyński et al., 2020; Popovici et al., 2021; Mance et al., 2026).

At the same time, the environmental consequences of FDI remain the subject of considerable debate. The Pollution Haven Hypothesis suggests that multinational firms may relocate pollution-intensive activities to countries characterized by weaker environmental regulations, thereby increasing environmental degradation (Jorgenson, 2007; Acharyya, 2009). In contrast, the Pollution Halo Hypothesis argues that foreign investment may improve environmental performance through technology transfer, managerial know-how, and higher production standards (Gray, 2002; Albornoz et al., 2009; Nippa et al., 2021). Recent studies further suggest that institutional quality may play an important role in shaping the environmental effects of foreign investment (Singhania & Saini, 2021).

Despite the growing literature on FDI and environmental sustainability, several important gaps remain. First, most empirical studies focus on aggregate FDI measures, although the environmental effects of foreign investment may differ substantially across sectors. Second, institutional quality is often examined as a direct determinant of environmental outcomes rather than as a moderating factor influencing the environmental impact of FDI. Third, evidence for Central and Eastern European countries remains comparatively limited despite the region's importance as a major recipient of foreign investment and its continuing process of institutional transformation.

Against this background, the present study investigates whether the environmental effects of FDI in CEE countries depend on both the sectoral destination of investment and the quality of domestic institutions. The analysis focuses on Bulgaria, the Czech Republic, Croatia, Poland, Romania, Slovakia, and Slovenia over the period 2010–2023. Environmental sustainability is measured using two complementary indicators, namely ecological footprint and CO_2 emissions, while institutional quality is captured through a composite governance index.

The study contributes to the literature in several ways. First, it moves beyond the conventional aggregate treatment of FDI by distinguishing between total FDI and sector-specific FDI in mining and quarrying, manufacturing, electricity and gas, construction, and services. Second, it examines institutional quality as a moderating factor in the FDI–environment relationship.

Third, the use of both ecological footprint and CO_2 emissions allows the analysis to capture different dimensions of environmental sustainability. Finally, the paper provides new evidence from CEE economies, a region characterized by substantial foreign investment inflows, ongoing institutional development, and increasing environmental policy commitments.

The remainder of the paper is structured as follows. Section 2 reviews the relevant literature and develops the research framework. Section 3 presents the data and methodology. Section 4 reports and discusses the empirical results. Section 5 concludes and outlines the main theoretical and policy implications.

2. Literature review

The literature reviewed above highlights three key dimensions that are particularly relevant for the present analysis: (i) the importance of institutional quality for economic performance and development in CEE countries, (ii) the role of institutional and governance factors in attracting foreign direct investment, and (iii) the relationship between FDI and environmental sustainability. While these research streams have developed largely in parallel, relatively few studies examine them jointly. In particular, limited attention has been paid to the possibility that institutional quality may moderate the environmental effects of sector-specific FDI. Addressing this gap represents the main objective of the present study.

2.1. Economic transformation, institutional quality, and development in CEE countries

Central and Eastern European (CEE) countries have undergone substantial economic transformation over the last decades, characterized by market liberalization, institutional reforms, increasing financial integration, and convergence towards European Union standards. Earlier studies emphasized the importance of macroeconomic dynamics, financial development, and market integration in shaping regional economic trajectories. Albu et al. (2014) examined the long-term relationship between market capitalization and GDP per capita in Eastern EU countries, while Albu et al. (2015) analyzed asymmetric volatility and macroeconomic dynamics in Central and Eastern European stock markets. Earlier, Barbić and Čondić-Jurkić (2011) investigated the relationship between stock market indices and macroeconomic variables, while Lupu and Călin (2014) explored the connections between macroeconomic variables and financial markets using a mixed-frequency approach. Kubinschi and Barnea (2016) further analyzed the effects of systemic risk on macroeconomic developments in selected CEE economies. More recently, Szakálné Kanó et al. (2025) documented significant structural changes across CEE regions, highlighting the evolution of gross value added and employment across economic sectors over the integration period.

These profound transformations contributed to what Kornai (2006) described as a successful transition process. Several studies report evidence of economic convergence following EU accession (Rapacki & Próchniak, 2009; Dobrinsky & Havlik, 2014), although important differences remain regarding growth patterns and development trajectories across countries. Within this context, institutional quality has emerged as a key determinant of economic performance. Peev and Mueller (2012) showed that democratic institutions and economic freedom contributed positively to economic growth in post-communist economies, while Osińska et al. (2025) confirmed the importance of institutional quality for long-term economic development in transition countries.

2.2. Foreign direct investment and institutional quality

A substantial body of literature investigates the determinants of foreign direct investment in transition economies. Early contributions emphasize the specific characteristics of CEE countries as host locations for foreign investment (Carstensen & Toubal, 2004). Beyond traditional determinants such as market size, labor costs, and trade openness, institutional quality has increasingly been recognized as a key factor shaping FDI attractiveness (Kinoshita & Campos, 2003; Bevan & Estrin, 2004).

Busse and Hefeker (2007) provide evidence that political and institutional conditions significantly influence FDI inflows in developing economies. Focusing specifically on CEE countries, Popovici and Călin (2012a) analyze the attractiveness of public policies for foreign investors, while Popovici and Călin (2012b) and Popovici and Călin (2015) emphasize competitiveness as an important determinant of foreign investment. Subsequent studies further highlight the relevance of corruption, governance quality, and institutional effectiveness in attracting foreign capital (Zurawicki & Habib, 2010). In particular, Popovici and Călin (2013a) argue that reducing corruption may improve the attractiveness of CEE countries for foreign investors, while Cuervo-Cazurra (2008) shows that different forms of corruption influence investors' confidence and location decisions. Similarly, Popovici and Călin (2013b) emphasize that improving institutional quality represents an important channel for attracting FDI in both Western and Eastern European economies, while Popovici and Călin (2014) underline the importance of location-specific factors in the distribution of foreign investment.

More recent contributions continue this line of research by emphasizing governance, ethics, and broader institutional determinants of foreign investment. Dorożyński et al. (2020) confirm the importance of institutional quality for attracting FDI in CEE transition countries, while Popovici and Călin (2019) discuss the role of governance ethics in explaining FDI motivations. Revisiting FDI determinants using broader empirical evidence, Popovici et al. (2021) reach similar conclusions regarding the importance of institutional and governance-related factors, results that are further supported by Mance et al. (2026). Taken together, these studies suggest that foreign investment is influenced not only by economic fundamentals but also by the quality of domestic institutions and governance frameworks.

2.3. FDI, environmental sustainability, and the moderating role of institutions

The environmental consequences of foreign direct investment remain the subject of extensive academic debate. Much of the literature is framed around the Pollution Haven and Pollution Halo hypotheses (Benzerrouk et al., 2021). In the first case, countries with weaker regulations are more attractive for foreign investors which further contribute to environmental degradation (Jorgenson, 2007; Acharyya, 2009). In the second case, the technology and managerial know-how transfers, innovation, and cleaner production processes that the foreign investment activity develop (Gray, 2002; Albornoz et al., 2009; Nippa et al., 2021) improve the environmental performance.

Alongside this debate, a growing literature examines broader determinants of environmental sustainability, including energy performance, environmental regulation, and sustainable development policies. Ding et al. (2020) propose a constrained performance index measure for evaluating energy and carbon emission performance. Duan et al. (2022) analyze the transformation of Pakistan's energy sector and emphasize the importance of infrastructure and energy-sector modernization for sustainable development. Khurshid et al. (2022) investigate the role of pricing strategies, ecological regulation, and clean technologies in supporting the objectives of the UN 2030 Agenda, while Liu et al. (2024) examine how green strategies and policies influence production-based emissions, industrial development, and sustainable

development goals. In a European context, Zhou et al. (2025) analyze whether financial policy alignment can accelerate sustainable transport transitions.

Recent studies also emphasize the importance of institutional quality in shaping environmental outcomes. Stronger institutions may improve regulatory enforcement, increase monitoring capacity, and facilitate the adoption of environmentally friendly technologies. Singhania and Saini (2021) provide evidence that institutional quality influences the environmental consequences of FDI, suggesting that governance conditions may determine whether foreign investment generates positive or negative environmental effects.

Climate-related challenges are particularly relevant for European regions undergoing structural transformation. Rodríguez-Pose and Bartalucci (2023) argue that regions already exposed to climate risks may experience increasing development disparities if adequate policy responses are not implemented. Diemer et al. (2022) warn about the emergence of regional development traps associated with declining competitiveness, while Sala et al. (2025) confirm the importance of European climate strategies in reducing CO_2 emissions across EU member states.

2.4. Research gap and research framework

Although previous studies provide important insights into the relationships between foreign direct investment, institutional quality, and environmental sustainability, several limitations remain.

First, most empirical studies focus on aggregate FDI measures, while the environmental implications of sector-specific FDI remain comparatively underexplored. Investments directed toward manufacturing, mining and quarrying, construction, services, or energy-related activities may generate substantially different environmental outcomes due to differences in production technologies and resource intensity.

Second, while institutional quality is frequently examined as a determinant of FDI attractiveness or environmental performance, its role as a moderating factor influencing the environmental effects of foreign investment has received less attention. Existing evidence suggests that governance quality may shape the direction and magnitude of environmental outcomes associated with FDI, but empirical findings remain inconclusive.

Third, despite the importance of Central and Eastern European countries as major recipients of foreign investment and their continuing process of institutional transformation, empirical evidence for this region remains relatively limited compared with studies focusing on larger emerging economies.

To address these gaps, the present study investigates whether the environmental effects of FDI depend on both the sectoral destination of investment and the quality of domestic institutions. The analysis focuses on seven CEE countries and employs two complementary measures of environmental sustainability—ecological footprint and CO_2 emissions—while examining both aggregate and sector-specific FDI flows. By combining sectoral FDI, institutional quality, and environmental sustainability within a unified empirical framework, the study contributes to a more nuanced understanding of the mechanisms through which foreign investment affects environmental outcomes in transition economies.

3. Data and methodology

This study examines the relationship between foreign direct investment, institutional quality, and environmental sustainability in Central and Eastern European countries. The empirical analysis is based on a balanced panel dataset covering seven CEE countries over the period 2010-2023, due to data availability. The countries included in the sample are Bulgaria, the Czech Republic, Croatia, Poland, Romania, Slovakia, and Slovenia, which are aligned with the objectives of analyzing the CEE countries and with data availability. The final dataset contains 98 country-year observations.

Environmental sustainability is measured using two dependent variables: ecological footprint (EFP) and CO_2 emissions (CO_2). These indicators capture different dimensions of environmental pressure. Ecological footprint reflects broader resource use and environmental demand, while CO_2 emissions capture air pollution and climate-related environmental pressure.

The main explanatory variable is foreign direct investment. The study considers both total FDI (FDI) and sectoral FDI, including FDI in mining and quarrying (MQFDI), manufacturing (MFDI), electricity, gas, steam, and air conditioning supply (EFDI), construction (CFDI), and services (SFDI). Since FDI values differ substantially across countries and sectors, the FDI variables are transformed into natural logarithms before estimation.

Institutional quality is included as a moderating variable. A composite institutional quality index (INST_INDEX) is constructed from six institutional indicators: control of corruption (COR), government effectiveness (GOV), political stability (POL), regulatory quality (RGQ), rule of law (RLW), and voice and accountability (VOC). Each institutional variable is standardized, and the institutional index is computed as the average of the standardized indicators. This approach reduces multicollinearity and captures the common institutional component across governance dimensions.

The model also includes several control variables that may influence environmental outcomes: energy use (ENG), urbanization (URB), population (POP), GDP growth (GDPG), GDP per capita (GDPC), and trade openness (TO). Energy use, population, and GDP per capita are log-transformed in the empirical models.

Data sources are Eurostat for total and sectoral FDI, as well as for GDPG, GDPC, and TO. We used the World Bank database for CO2 emissions, energy use, and total and urban population, while National Ecological Footprint and Biocapacity Accounts, 2025 Edition, was used for the ecological footprint. Finally, Worldwide Governance Indicators database was the source for the six institutional indicators. The variables are presented in Table 1.

Table 1. The variables used in the study

Variable	Abbreviation	Definition	Unit of measurement	Source
Independent variables				
Total FDI inflows	TFDI	Total foreign direct investment, net inflows	Mil. euro	Eurostat
FDI inflows in *Mining and quarrying*	MQFDI	Foreign direct investment Mining and quarrying, net inflows	Mil. euro	Eurostat
FDI inflows in *Manufacturing*	MFDI	Foreign direct investment Manufacturing, net inflows	Mil. euro	Eurostat

Variable	Abbreviation	Definition	Unit of measurement	Source
FDI inflows in *Electricity, gas, steam, and air conditioning supply*	EFDI	Foreign direct investment Electricity, gas, steam and air conditioning supply, net inflows	Mil. euro	Eurostat
FDI inflows in *Construction*	CFDI	Foreign direct investment Construction, net inflows	Mil. euro	Eurostat
FDI inflows in *Services*	SFDI	Foreign direct investment Services, net inflows	Mil. euro	Eurostat
Dependent variables				
Ecological Footprint	EFP	Ecological Footprint of production (in global hectares) divided by the population of the country	Global hectares/population	National Ecological Footprint and Biocapacity Accounts, 2025 Edition
CO_2 Emissions	CO_2	Annual CO_2 emissions (per capita) - Annual total emissions of carbon dioxide (CO_2), excluding land-use change, measured in tonnes per person.	Tonnes per person	World Bank
Control variables				
GDP growth	GDPG	GDP (Chain linked volumes, percentage change on previous period, per capita)	%	Eurostat
Market development	GDPC	GDP per capita (Chain linked volumes, 2020)	euro per capita	Eurostat
Trade openness	TO	Sum of exports and imports of goods and service as % of GDP	%	Eurostat
Urban population	URB	People living in urban areas as defined by national statistical offices	% of total population	World Bank
Population	POP	All residents regardless of legal status or citizenship	Persons	World Bank
Energy use	ENG	The use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport.	Kg of oil equivalent per capita	World Bank
Institutional variables				
Control of Corruption	COR	Measures the extent to which public power is used for private gain.	Governance score (0-100)	WGI database
Government Effectiveness	GOV	Measures the quality of public services, policymaking, and policy implementation.	Governance score (0-100)	WGI database
Political Stability	POL	Measures the likelihood of political instability or changes in government through violent or unconstitutional means.	Governance score (0-100)	WGI database
Regulatory Quality	RGQ	Measures the government's ability to formulate and implement policies	Governance score (0-100)	WGI database

Variable	Abbreviation	Definition	Unit of measurement	Source
		that support private sector development.		
Rule of Law	RLW	Measures the extent to which individuals and institutions respect and abide by the rule of law.	Governance score (0-100)	WGI database
Voice and Accountability	VOC	Measures citizens' ability to participate in selecting their government and hold it accountable.	Governance score (0-100)	WGI database

Notes: The table presents the variables used in the empirical analysis together with their definitions, units of measurement, and data sources. EFP denotes ecological footprint per capita, while CO_2 denotes carbon dioxide emissions per capita. The institutional quality index employed in the empirical analysis is constructed from the six World Governance Indicators (WGI) dimensions reported in the table: control of corruption, government effectiveness, political stability, regulatory quality, rule of law, and voice and accountability.

Source: Authors own work.

The selection of Bulgaria, the Czech Republic, Croatia, Poland, Romania, Slovakia, and Slovenia was guided by data availability and comparability considerations. These countries represent relatively homogeneous EU transition economies that experienced significant FDI inflows, institutional transformation, and increasing environmental policy commitments during the analyzed period. Other CEE countries were excluded due to incomplete sectoral FDI or environmental data, which would have prevented the construction of a balanced panel. The period 2010–2023 was selected to maximize data coverage while ensuring consistency across all variables included in the empirical analysis.

The baseline empirical model is specified as follows:

Model 1: Baseline model

$$\text{Environmental Sustainability}_{it} = \beta_0 + \beta_1 \ln\_FDI_{it} + \beta_2 INST\_INDEX_{it} + \beta_3 Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

where $\text{Environmental Sustainability}_{it}$ represents either ecological footprint (EFP) or CO_2 emissions (CO_2) for country i in year t, $\ln\_FDI_{it}$ is the natural logarithm of total FDI, $INST\_INDEX_{it}$ is the institutional quality index, $Controls_{it}$ represents the vector of control variables, μ_i denotes country fixed effects, λ_t denotes year fixed effects, and ε_{it} is the error term.

To examine whether institutional quality moderates the relationship between FDI and environmental sustainability, the following interaction model is estimated:

Model 2: Moderation model

$$\text{Environmental Sustainability}_{it} = \beta_0 + \beta_1 \ln\_FDI_{it} + \beta_2 INST\_INDEX_{it} + \beta_3 (\ln\_FDI_{it} \times INST\_INDEX_{it}) + \beta_4 Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

The coefficient of the interaction term, β_3, is central to the analysis. A negative and statistically significant β_3 indicates that stronger institutional quality reduces the pollution-related effect of FDI. This would support the idea that better institutions can help transform FDI into a cleaner and more environmentally sustainable form of investment. Conversely, a positive and statistically significant β_3 would suggest that institutional quality does not mitigate, and may even amplify, the environmental pressure associated with FDI.

In addition to the total FDI model, separate sectoral models are estimated for each FDI sector. This approach avoids excessive multicollinearity between sectoral FDI variables and allows the analysis to identify whether the moderating role of institutional quality differs across sectors.

Model 3: Sectoral moderation model

$$\text{Environmental Sustainability}_{it} = \beta_0 + \beta_1 \ln\_SECTOR\_FDI_{it} + \beta_2 INST\_INDEX_{it} + \beta_3 (\ln\_SECTOR\_FDI_{it} \times INST\_INDEX_{it}) + \beta_4 Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

where $\ln\_SECTOR\_FDI_{it}$ refers, in turn, to the natural logarithm of FDI in mining and quarrying (ln_MQFDI), manufacturing (ln_MFDI), electricity, gas, steam and air conditioning supply (ln_EFDI), construction (ln_CFDI), and services (ln_SFDI).

The control vector is defined as:

$$Controls_{it} = \ln\_ENG_{it} + URB_{it} + \ln\_POP_{it} + GDPG_{it} + \ln\_GDPC_{it} + TO_{it}$$

The models are estimated using fixed-effects panel regression with both country and year fixed effects. Country fixed effects control for time-invariant characteristics of each country, such as geography, historical industrial structure, and long-term institutional background. Year fixed effects control for shocks common to all countries, such as EU-level policy changes, economic crises, and broader regional trends. Standard errors are clustered at the country level to account for within-country correlation over time.

4. Results

4.1. Descriptive statistics

Table 2 presents the descriptive statistics for the variables included in the empirical analysis. The dataset contains 98 observations, corresponding to a balanced panel of seven CEE countries over the period 2010-2023.

The two environmental indicators show noticeable variation across countries and years. The ecological footprint has a mean value of 4.319, with values ranging from 2.950 to 6.550. CO_2 emissions also vary substantially, with a mean of 6.599 and a range between 3.569 and 11.227. This variation supports the use of both indicators in the analysis, as they capture different dimensions of environmental pressure.

The FDI variables display high dispersion, especially total FDI and services FDI. Total FDI has a mean of 77,148.565, but ranges from 8,897 to 308,773.5, indicating large differences in the scale of foreign investment across countries and over time. Services FDI records the highest average among the sectoral FDI variables, followed by manufacturing FDI, while mining and quarrying FDI has the lowest mean value. This suggests that foreign investment in the CEE sample is concentrated mainly in services and manufacturing rather than in extractive activities.

The institutional quality index has a mean of zero because it was constructed from standardized institutional indicators. Its values range from -1.580 to 1.599, showing meaningful differences in institutional performance across the countries and years included in the sample.

The control variables also show substantial variation. GDP per capita ranges from 7,060 to 25,120, while trade openness ranges from 53.168 to 181.338. GDP growth also varies considerably, from -8.3 to 12.6, reflecting different macroeconomic conditions during the period analyzed. Overall, the descriptive statistics indicate sufficient cross-country and over-time variation to justify the use of panel-data methods.

Table 2. Descriptive statistics of the variables included in the analysis (N = 98): mean values, standard deviations, and observed ranges (minimum–maximum)

Variable	N	Mean	Std. Dev.	Minimum	Maximum
EFP	98	4.319	0.921	2.95	6.55
CO_2	98	6.599	1.979	3.569	11.227
FDI	98	77148.565	67608.866	8897	308773.5
MQFDI	98	826.797	1090.292	19	4697.5
MFDI	98	22836.077	21191.544	2429	94769.3
EFDI	98	3349.402	2490.972	29.2	11792.6
CFDI	98	3003.427	3959.684	85.6	18285.1
SFDI	98	45701.645	40206.816	5123	181372.9
INST_INDEX	98	0	0.903	-1.58	1.599
ENG	98	2794.991	735.61	1579.407	4308.571
URB	98	60.365	8.438	49.762	73.732
POP	98	12341971.54	11723330.7	2048583	38063255
GDPG	98	2.409	3.113	-8.3	12.6
GDPC	98	14725.102	4791.968	7060	25120
TO	98	114.76	32.964	53.168	181.338

Notes: The table reports descriptive statistics for the variables included in the empirical analysis over the period 2010–2023 (N = 98 country-year observations). Mean values, standard deviations, and observed ranges (minimum–maximum) are presented. Variable definitions and data sources are reported in Table 1. INST_INDEX denotes the composite institutional quality indicator constructed from the six World Governance Indicators (WGI) dimensions.

Source: Authors own work.

Table 3 presents the country coverage of the sample for the period 2010-2023. The dataset is balanced, as each of the seven CEE countries has 14 yearly observations. This confirms that the empirical analysis is based on a complete panel, which is appropriate for fixed-effects panel estimation.

The table shows substantial cross-country differences in both environmental indicators and FDI inflows. The Czech Republic records the highest average ecological footprint and CO_2 emissions, with mean values of 6.037 and 9.824, respectively. Poland also shows relatively high CO_2 emissions, with a mean of 8.383, while Romania and Croatia report lower average CO_2 levels.

In terms of foreign direct investment, Poland has the highest average FDI inflows, followed by the Czech Republic and Romania. By contrast, Slovenia and Croatia record the lowest average FDI values in the sample. These differences suggest that the scale of foreign investment varies considerably across CEE countries.

The institutional quality index also differs across countries. The Czech Republic, Slovenia, Poland, and Slovakia have positive average institutional scores, while Bulgaria, Romania, and Croatia have negative values. This variation is important for the analysis, as it allows the study to examine whether institutional quality moderates the relationship between FDI and environmental outcomes.

Overall, Table 3 confirms that the sample includes meaningful variation across countries in environmental performance, FDI inflows, and institutional quality. This supports the use of panel-data models to investigate how FDI and institutions interact in shaping environmental sustainability.

Table 3. Country coverage of the sample (2010–2023)

Country	Start year	End year	Observations	Mean EFP	Mean CO_2	Mean FDI	Mean institutional index
BG	2010	2023	14	4.532	6.294	42780.029	-1.338
CZ	2010	2023	14	6.037	9.824	129602.386	1.128
HR	2010	2023	14	3.226	4.464	22676.607	-0.479
PL	2010	2023	14	4.643	8.383	205362.457	0.496
RO	2010	2023	14	3.248	3.998	77679.607	-0.940
SI	2010	2023	14	4.190	6.841	14383.964	0.875
SK	2010	2023	14	4.358	6.391	47554.907	0.259

Notes: The table summarizes the country coverage of the balanced panel dataset used in the analysis. Mean values are reported for the main variables of interest over the period 2010–2023. EFP denotes ecological footprint per capita, CO_2 denotes carbon dioxide emissions per capita, FDI denotes total foreign direct investment inflows, and the institutional index represents the composite governance indicator employed in the empirical analysis.

Source: Authors own work.

4.2. Sectoral structure of FDI

Table 4 presents the sectoral distribution of FDI across the countries included in the sample. The results show that services represent the dominant destination of foreign investment in all seven CEE countries. The share of services FDI ranges from 49.81% in Romania to 71.19% in Croatia, indicating that the largest part of foreign investment is concentrated in less directly industrial sectors.

Manufacturing is the second most important sector for FDI in the sample. Its share is particularly high in Slovakia, Slovenia, Poland, Romania, and the Czech Republic, where it accounts for around 30% or more of sectoral FDI. This confirms the importance of manufacturing as a major recipient of foreign investment in CEE economies.

By contrast, mining and quarrying FDI represents a relatively small share of total sectoral FDI in most countries. The highest value is observed in Romania, at 4.22%, while the remaining countries record values close to or below 1.5%. Construction FDI also accounts for a limited share, although it is somewhat higher in Romania and Poland. Electricity, gas, steam, and air conditioning supply has a moderate but still relatively small share compared with services and manufacturing.

Overall, Table 4 shows that the sectoral structure of FDI in CEE countries is dominated by services and manufacturing, while mining, construction, and electricity-related sectors play a smaller role. This sectoral composition is important for the empirical analysis, as the environmental effects of FDI may differ depending on the type of economic activity receiving foreign investment.

Table 4. Sectoral FDI share across countries

Country	MQFDI share (%)	MFDI share (%)	EFDI share (%)	CFDI share (%)	SFDI share (%)
BG	1.44	19.03	6.95	3.83	68.74
CZ	1.05	30.63	3.82	1.66	62.85
HR	0.65	25.59	0.42	2.15	71.19
PL	0.30	31.76	3.15	5.38	59.41
RO	4.22	31.64	7.68	6.64	49.81
SI	0.35	32.05	2.83	1.27	63.51
SK	0.49	32.90	8.56	1.19	56.86

Notes: The table reports the average sectoral composition of foreign direct investment inflows by country over the period 2010–2023. Shares are expressed as percentages of total FDI inflows and may not sum exactly to 100 due to rounding. MQFDI denotes FDI in mining and quarrying, MFDI denotes FDI in manufacturing, EFDI denotes FDI in electricity, gas, steam, and air conditioning supply, CFDI denotes FDI in construction, and SFDI denotes FDI in services. Variable definitions and data sources are reported in Table 1.

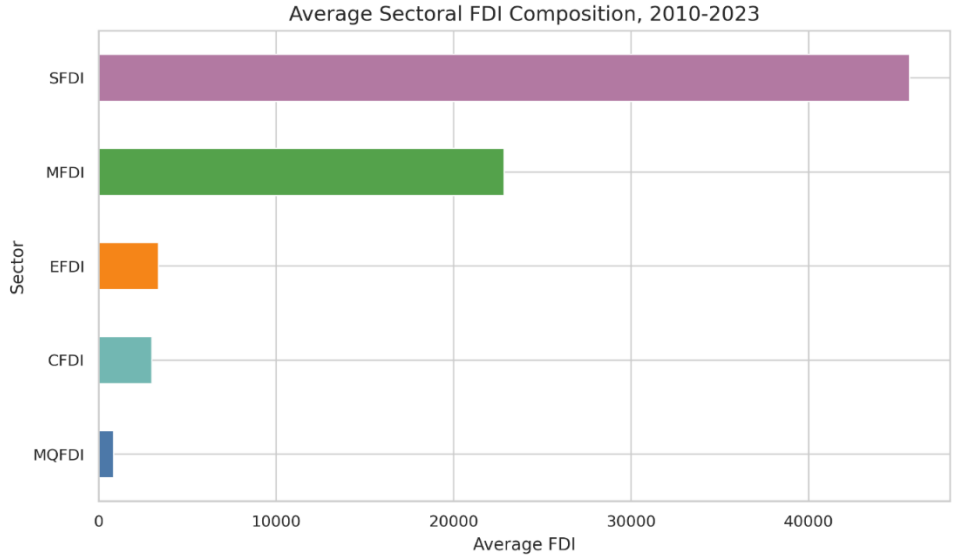
Source: Authors own work.

Figure 1 illustrates the average sectoral composition of FDI in the CEE sample over the period 2010-2023. The figure shows a clear dominance of services FDI, which records the highest average value among all sectors. Manufacturing FDI is the second largest category, but its average level is considerably lower than that of services.

The remaining sectors account for much smaller average FDI values. Electricity, gas, steam, and air conditioning supply, construction, and mining and quarrying attract substantially lower levels of foreign investment compared with services and manufacturing. Mining and quarrying records the lowest average value, confirming that extractive-sector FDI represents only a limited part of the sectoral FDI structure in the sample.

Overall, Figure 1 confirms that foreign investment in the analyzed CEE countries is concentrated mainly in services and manufacturing. This sectoral distribution is important for the empirical analysis, because the environmental effects of FDI may differ depending on whether investment is directed toward service activities, industrial production, energy-related activities, construction, or extractive sectors.

Figure 1. Average sectoral FDI composition



Source: Authors own work.

4.3. Environmental trends

Figure 2 presents the evolution of the two environmental sustainability indicators, ecological footprint and CO_2 emissions, across the CEE countries during 2010-2023. The figure shows clear cross-country differences in environmental pressure over time.

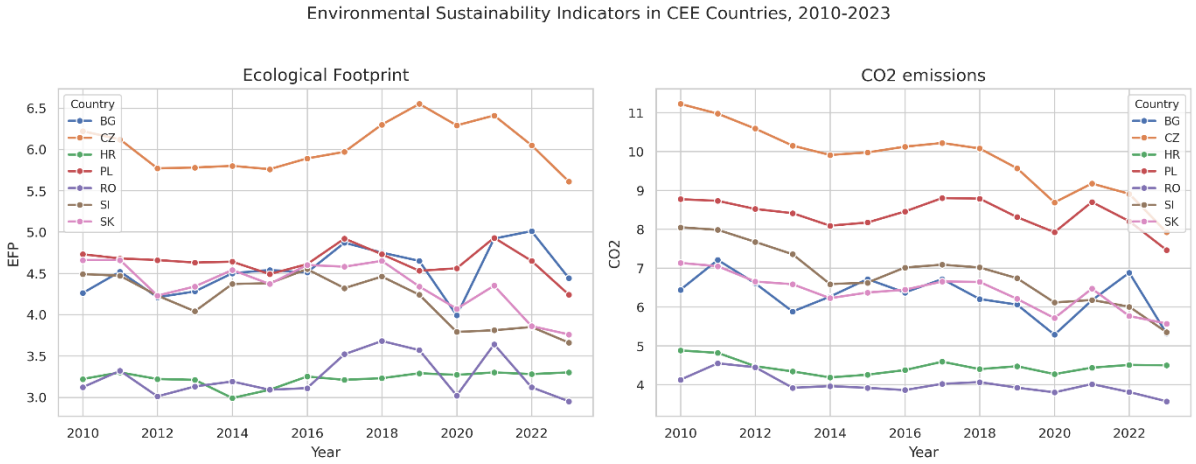
In the ecological footprint panel, the Czech Republic records the highest values throughout most of the period, indicating a higher level of resource use and environmental pressure compared with the other countries in the sample. Poland, Bulgaria, Slovakia, and Slovenia show intermediate values, while Croatia and Romania generally record lower ecological footprint

levels. The trends are not uniform across countries, suggesting that environmental performance evolved differently within the CEE region.

The CO_2 emissions panel also shows substantial differences across countries. The Czech Republic and Poland display the highest levels of CO_2 emissions for most of the period, while Croatia and Romania record lower values. In several countries, CO_2 emissions appear to decline after 2018-2019, although the pattern differs across the sample. This variation may reflect differences in economic structure, energy use, industrial activity, and environmental policy.

Overall, Figure 2 confirms that the environmental indicators vary both across countries and over time. This supports the use of panel-data methods, as the empirical analysis needs to account for country-specific characteristics and common time effects when estimating the relationship between FDI, institutions, and environmental sustainability.

Figure 2. Environmental trends



Source: Authors own work.

4.4. Institutional quality patterns

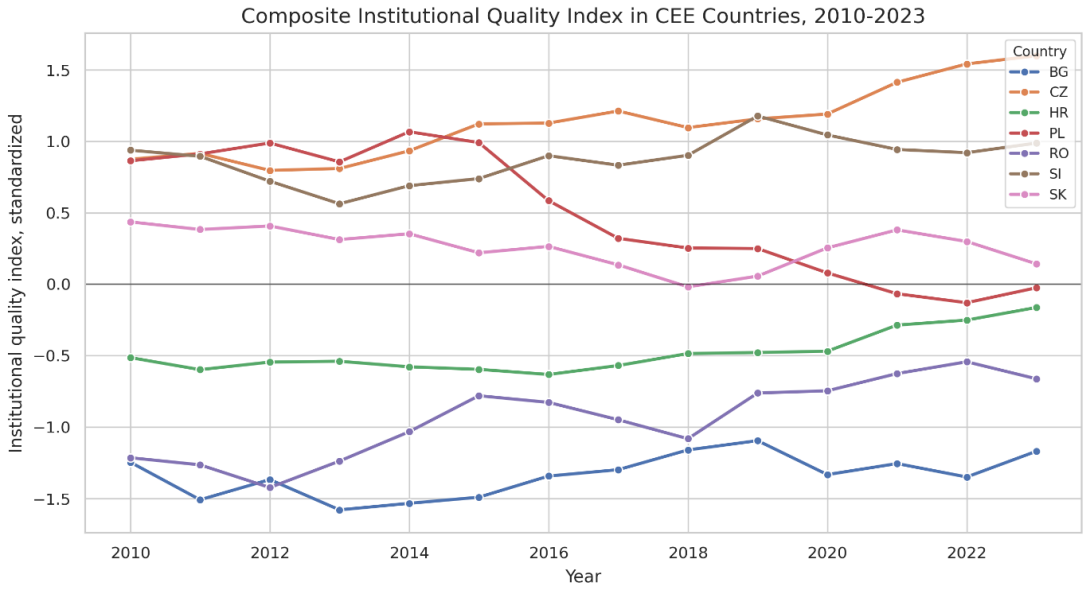
Figure 3 shows the evolution of the composite institutional quality index across the CEE countries between 2010 and 2023. The index is standardized, meaning that values above zero indicate institutional quality above the sample average, while values below zero indicate institutional quality below the sample average.

The figure reveals clear differences in institutional performance across countries. The Czech Republic and Slovenia consistently record positive institutional quality values, indicating stronger institutional environments compared with the sample average. Slovakia also remains mostly above zero, although at a lower level. Poland records relatively high institutional quality values in the first part of the period, but its institutional index declines after 2015 and moves close to or below the sample average in the later years.

By contrast, Bulgaria, Romania, and Croatia display negative institutional quality values for most of the period. Bulgaria records the lowest institutional scores in the sample, although there are some signs of improvement over time. Romania also remains below the sample average, despite a gradual improvement after 2018. Croatia is closer to the sample average than Bulgaria and Romania, but it remains mostly negative throughout the period.

Overall, Figure 3 highlights substantial institutional heterogeneity within the CEE region. This variation is important for the empirical analysis, as it supports the use of institutional quality as a moderating variable in the relationship between FDI and environmental sustainability.

Figure 3. Institutional quality trends



Source: Authors own work.

Table 5 reports the correlation coefficients between the institutional indicators used to construct the composite institutional quality index. The results show that all institutional variables are positively correlated, with relatively high correlation coefficients across most pairs of indicators.

The strongest correlations are observed between control of corruption and government effectiveness, as well as between control of corruption and rule of law. Government effectiveness is also strongly correlated with rule of law and voice and accountability. These relationships indicate that the institutional dimensions tend to move together: countries with stronger governance performance in one dimension also tend to perform better in the others.

The positive and relatively high correlations support the construction of a composite institutional quality index. Using a single index helps summarize the common institutional component captured by the six indicators and reduces the risk of multicollinearity that could arise if all institutional variables were included separately in the same regression model.

Table 5. Institutional correlations

	COR	GOV	POL	RGQ	RLW	VOC
COR	1	0.887172	0.725933	0.708293	0.859471	0.767987
GOV	0.887172	1	0.766474	0.683673	0.841135	0.792484
POL	0.725933	0.766474	1	0.690244	0.721508	0.808487
RGQ	0.708293	0.683673	0.690244	1	0.710593	0.738132
RLW	0.859471	0.841135	0.721508	0.710593	1	0.820298
VOC	0.767987	0.792484	0.808487	0.738132	0.820298	1

Notes: The table reports Pearson correlation coefficients among the six governance dimensions used to construct the institutional quality index. COR denotes Control of Corruption, GOV denotes Government Effectiveness, POL denotes Political Stability, RGQ denotes Regulatory Quality, RLW denotes Rule of Law, and VOC denotes Voice and Accountability. The consistently positive and relatively high correlations provide support for combining these

indicators into a composite institutional quality measure. Variable definitions and data sources are reported in Table 1.

Source: Authors own work.

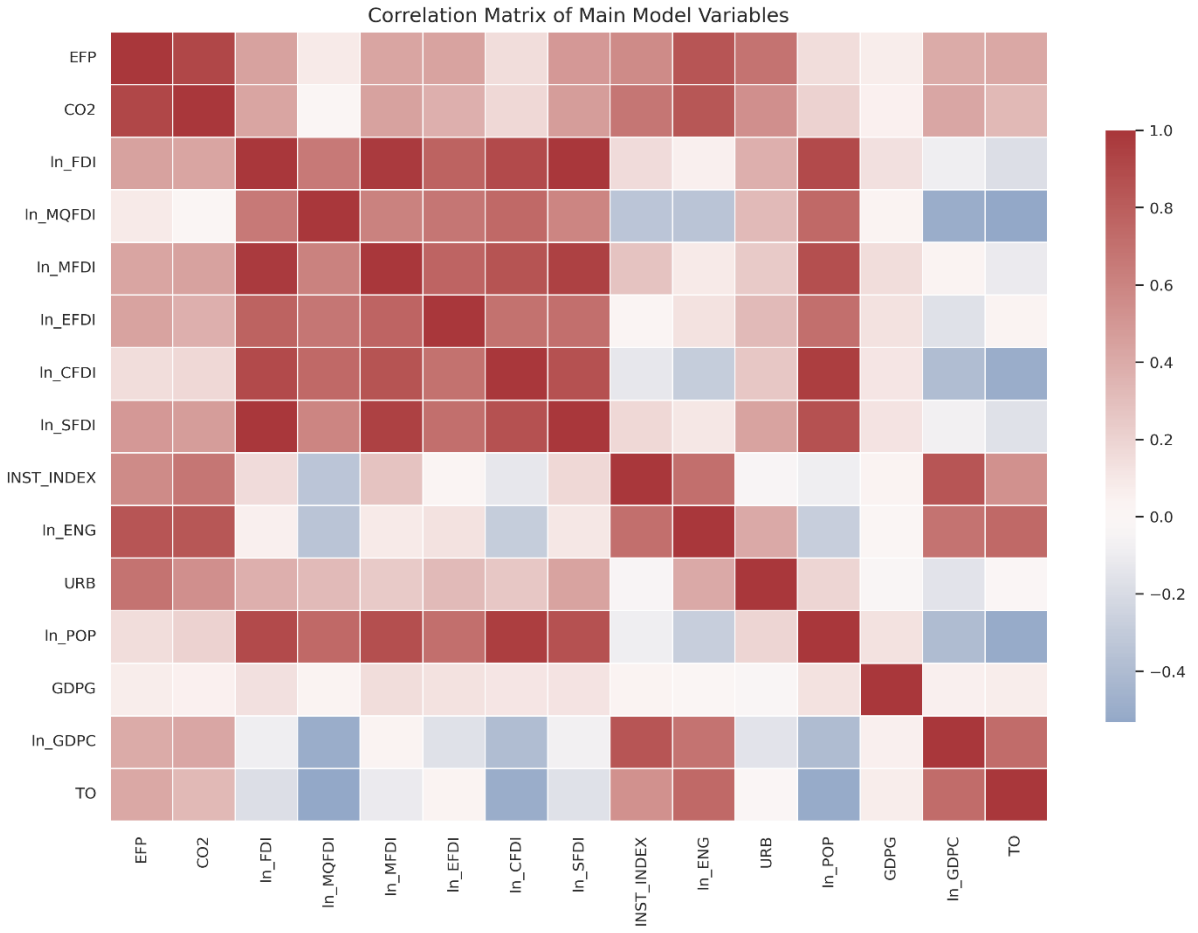
4.5. Correlation analysis

Figure 4 presents the correlation matrix of the main variables included in the empirical models. The figure provides an initial overview of the relationships between the environmental indicators, FDI variables, institutional quality, and control variables.

The two environmental indicators, EFP and CO_2, are strongly positively correlated. This suggests that ecological footprint and CO_2 emissions capture related dimensions of environmental pressure, although they are not identical measures. The positive correlation supports the use of both indicators in the empirical analysis as complementary measures of environmental sustainability.

The FDI variables are also generally positively correlated with each other, especially total FDI, manufacturing FDI, construction FDI, and services FDI. This indicates that countries and years with higher total FDI also tend to have higher levels of sectoral FDI. However, the correlations are not identical across sectors, which supports the decision to estimate sectoral models separately rather than including all FDI sectors simultaneously in the same specification.

Figure 4. Correlation Matrix of Main Model Variables



Source: Authors own work.

The institutional quality index is positively associated with several macroeconomic variables, including GDP per capita and trade openness. This suggests that countries with stronger institutions also tend to display higher levels of economic development and external openness. At the same time, the figure shows that several explanatory variables are correlated with each other, which justifies the use of fixed-effects panel models and control variables in the regression analysis.

Overall, Figure 4 should be interpreted as descriptive evidence rather than causal evidence. The correlation matrix helps identify basic patterns in the data, but it does not control for country-specific characteristics or common time effects. For this reason, the fixed-effects panel regressions provide the main empirical evidence in the following sections.

4.6. Baseline regression results

Table 6 presents the baseline fixed-effects results for the relationship between total FDI, institutional quality, and environmental sustainability. The models include country and year fixed effects, allowing the analysis to control for unobserved country-specific characteristics and common time shocks.

Table 6. Baseline fixed-effects results

Variables	EFP	CO_2
ln_FDI	0.6442	-1.2312**
	(0.5502)	(0.4677)
Institutional quality index	0.1622	0.1757*
	(0.1242)	(0.0974)
Country fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Observations	98	98
R-squared within	0.1087	-0.5660

Notes: Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The dependent variables are Ecological Footprint (EFP) and CO_2 emissions (CO_2). The models include control variables and country and year fixed effects.

Source: Authors own work.

For the ecological footprint model, the coefficient of ln_FDI is positive, but statistically insignificant. This suggests that total FDI is not significantly associated with ecological footprint in the baseline specification. Similarly, the institutional quality index is positive but not statistically significant in the EFP model.

For the CO_2 model, the coefficient of ln_FDI is negative and statistically significant at the 5% level. This indicates that higher total FDI is associated with lower CO_2 emissions, which is more consistent with the Pollution Halo Hypothesis than with the Pollution Haven Hypothesis. The institutional quality index is positive and weakly significant at the 10% level, suggesting that institutional quality is associated with CO_2 emissions in the baseline model, although this result should be interpreted cautiously.

Overall, Table 6 shows that the baseline relationship between FDI and environmental sustainability depends on the environmental indicator used. While the results do not show a significant effect of total FDI on ecological footprint, they suggest a significant negative association between total FDI and CO_2 emissions. The negative association between total FDI and CO_2 emissions is more consistent with the Pollution Halo Hypothesis than with the Pollution Haven Hypothesis. This finding suggests that foreign investment may contribute to environmental improvements through technological upgrading, greater production efficiency,

and the diffusion of higher environmental standards. In the context of CEE economies, multinational firms may bring cleaner technologies and managerial practices that help reduce carbon intensity, particularly in sectors integrated into European production networks. Consequently, the results provide preliminary evidence that foreign investment may support environmental improvements rather than merely relocate pollution-intensive activities across borders.

4.7. Moderation results

Table 7 reports the moderating effect of institutional quality on the relationship between FDI and environmental sustainability. The interaction term shows whether stronger institutions change the effect of FDI on environmental outcomes.

Table 7. Moderating effect of institutional quality

Interaction term	EFP	CO_2
ln_FDI x INST_INDEX	0.3846*	-0.3733**
	(0.2303)	(0.1683)
ln_MQFDI x INST_INDEX	-0.0487	0.2113**
	(0.0476)	(0.0961)
ln_MFDI x INST_INDEX	0.3355	-0.2690**
	(0.2147)	(0.1214)
ln_EFDI x INST_INDEX	-0.0685**	-0.0657
	(0.0296)	(0.1101)
ln_CFDI x INST_INDEX	0.0727	-0.1176
	(0.1058)	(0.0921)
ln_SFDI x INST_INDEX	0.3697**	-0.3290***
	(0.1682)	(0.0968)
Country fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Observations	98	98

Notes: Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. All models include control variables, country fixed effects, and year fixed effects.

Source: Authors own work.

For EFP, the interaction between total FDI and institutional quality is positive and weakly significant at the 10% level. This suggests that institutional quality does moderate the FDI-ecological footprint relationship, although the effect is not very strong statistically. Among sectoral FDI variables, the interaction for electricity, gas, steam, and air conditioning supply is negative and statistically significant, indicating that stronger institutions may reduce the ecological footprint effect of FDI in this sector. However, the interaction for services FDI is positive and significant, suggesting that the moderating effect differs across sectors.

For CO_2, the results are clearer. The interaction between total FDI and institutional quality is negative and statistically significant, meaning that stronger institutions reduce the CO_2-related impact of total FDI. This supports the idea that better institutions can weaken the pollution effect of FDI, which is consistent with the Pollution Halo mechanism. Similar negative and significant effects are found for manufacturing FDI and services FDI. By contrast, the interaction for mining and quarrying FDI is positive and significant, suggesting that in this sector stronger institutions do not reduce the CO_2 effect in the same way.

Table 7 shows that institutional quality plays an important moderating role, especially for CO_2 emissions. The negative and significant interaction terms for total FDI, manufacturing FDI, and services FDI suggest that stronger institutions can help reduce the environmental pressure

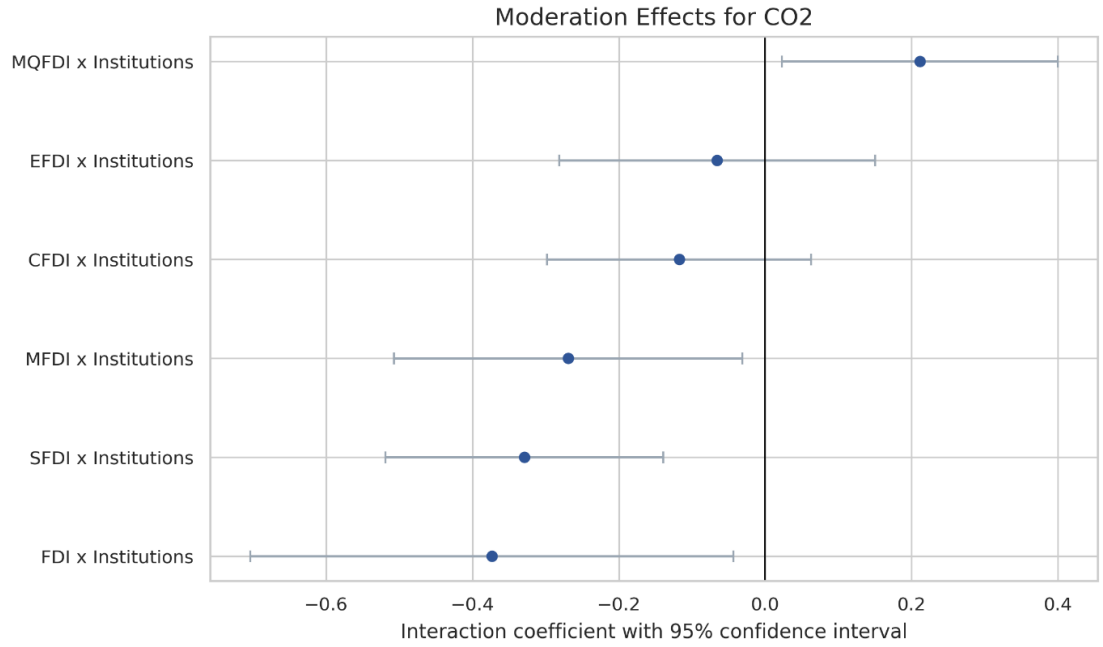
associated with FDI. However, the mixed results across sectors indicate that the moderating role of institutions is sector-specific rather than uniform across all types of FDI. An important finding is that the moderating role of institutional quality appears substantially stronger for CO_2 emissions than for ecological footprint. A possible explanation is that carbon emissions are more directly affected by regulatory enforcement, environmental standards, energy efficiency requirements, and technological upgrading, all of which are closely related to institutional effectiveness. By contrast, ecological footprint captures a broader set of environmental pressures, including resource consumption and land-use impacts, which may be less responsive to institutional improvements in the short run. Consequently, stronger institutions may exert a more immediate influence on emissions-related outcomes than on broader measures of environmental sustainability.

Figure 5 presents the estimated moderation effects of institutional quality on the relationship between FDI and CO_2 emissions. The vertical line at zero indicates whether the interaction effect is positive or negative, while the horizontal confidence intervals show the precision of the estimates.

The results indicate that institutional quality moderates the relationship between FDI and CO_2 emissions in a sector-specific way. The interaction between total FDI and institutional quality is negative, suggesting that stronger institutions reduce the CO_2-related impact of FDI. Similar negative effects are observed for manufacturing FDI and services FDI, indicating that better institutional quality may help mitigate the environmental pressure associated with investment in these sectors.

By contrast, the interaction between mining and quarrying FDI and institutional quality is positive. This suggests that, in this sector, stronger institutions do not appear to reduce the CO_2-related impact of FDI. A possible explanation is that mining and quarrying are structurally pollution-intensive activities, where institutional improvements alone may not be sufficient to offset environmental pressure.

Figure 5. Moderation coefficients CO_2



Source: Authors own work.

The interaction effects for electricity-related FDI and construction FDI are not statistically clear, as their confidence intervals cross the zero line. Therefore, the results do not provide strong evidence that institutional quality significantly moderates the CO_2 impact of FDI in these sectors.

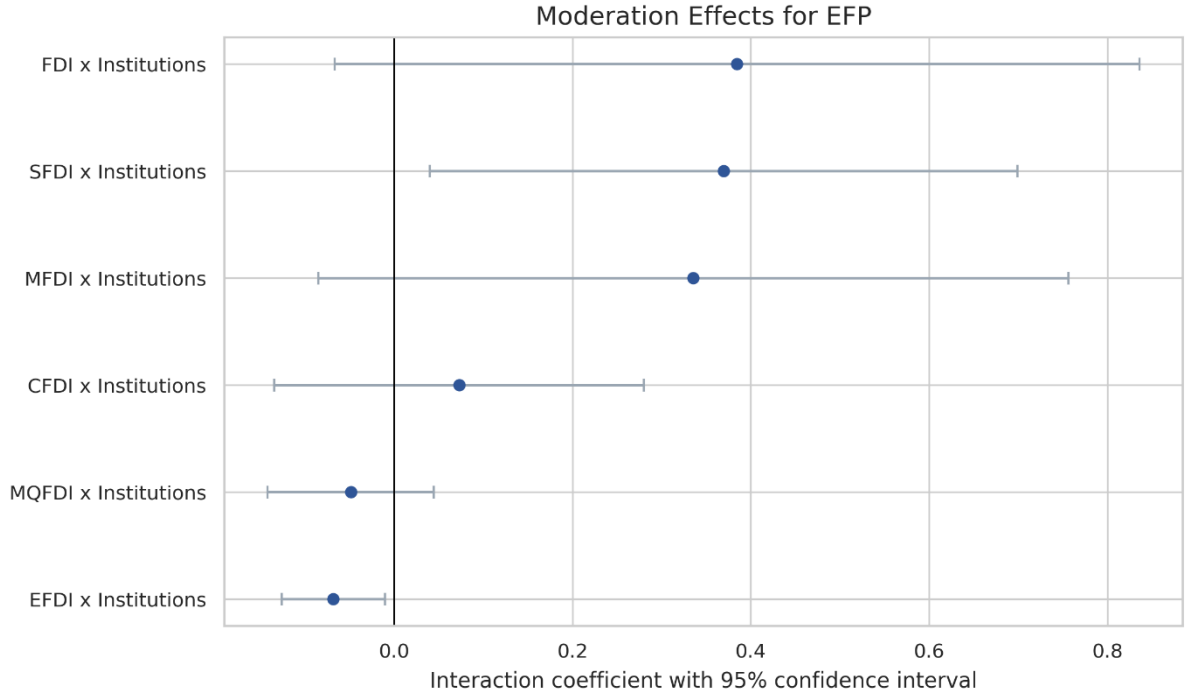
Overall, Figure 5 suggests that institutional quality plays an important role in shaping the environmental impact of FDI, but this role is not uniform across sectors. The strongest evidence of a mitigating institutional effect is found for total FDI, manufacturing FDI, and services FDI.

Figure 6 presents the estimated moderation effects of institutional quality on the relationship between FDI and ecological footprint. The results show that the moderating role of institutional quality is less uniform for EFP than for CO_2 emissions.

The interaction between total FDI and institutional quality is positive, but its confidence interval is wide, indicating that the effect should be interpreted with caution. This suggests that the moderating role of institutions in the relationship between total FDI and ecological footprint is not as clear as in the CO_2 model.

At the sectoral level, the interaction between electricity-related FDI and institutional quality is negative and statistically significant, as its confidence interval remains below zero. This indicates that stronger institutions may reduce the ecological footprint associated with FDI in electricity, gas, steam, and air conditioning supply. This result is consistent with the idea that better institutional quality can help limit environmental pressure in sectors where regulation and technological standards are particularly important.

Figure 6. Moderation coefficients EFP



Source: Authors own work.

For services FDI, the interaction effect is positive and statistically significant, suggesting that stronger institutions do not reduce the ecological footprint effect of FDI in this sector. This result may reflect the broader and more indirect nature of ecological footprint as an environmental indicator, which captures more dimensions of resource use than CO_2 emissions alone.

The interaction effects for mining and quarrying, manufacturing, and construction FDI are not statistically clear, as their confidence intervals cross the zero line. Therefore, the results do not provide strong evidence that institutional quality significantly moderates the ecological footprint impact of FDI in these sectors.

Overall, Figure 6 suggests that the moderating effect of institutional quality on ecological footprint is sector-specific and weaker than in the CO_2 model. The clearest evidence of a mitigating institutional effect appears in electricity-related FDI, while the positive interaction for services FDI indicates that the role of institutions may differ depending on the sector and the environmental indicator considered.

4.8. Sectoral FDI results

The sectoral results indicate that the environmental impact of FDI is not uniform across sectors. This confirms the importance of moving beyond total FDI and examining the sectoral composition of foreign investment. The results show that the role of institutional quality differs depending on both the sector receiving FDI and the environmental indicator considered.

For CO_2 emissions, the findings provide stronger evidence of a moderating institutional effect. The interaction terms for total FDI, manufacturing FDI, and services FDI are negative and statistically significant, suggesting that stronger institutions reduce the CO_2-related impact of FDI in these cases. This result is consistent with the Pollution Halo Hypothesis, according to which better institutional environments may facilitate cleaner technologies, stronger environmental standards, and better monitoring of foreign investment.

However, the interaction between mining and quarrying FDI and institutional quality is positive and statistically significant. This suggests that institutional quality does not mitigate the CO_2-related impact of FDI in this sector. One possible explanation is that mining and quarrying are structurally pollution-intensive activities, where institutional improvements alone may not be sufficient to offset the environmental pressure generated by foreign investment. This result also suggests that general improvements in institutional quality may not be sufficient to offset the environmental pressures associated with extractive industries. Even under stronger governance conditions, mining activities often remain characterized by intensive resource extraction, significant energy consumption, and substantial environmental externalities. As a result, sector-specific environmental regulations and monitoring mechanisms may be required in addition to broader institutional reforms.

For ecological footprint, the results are more mixed. The clearest negative and statistically significant interaction is found for electricity, gas, steam, and air conditioning supply, suggesting that stronger institutions may reduce the ecological footprint associated with FDI in this sector. By contrast, the interaction for services FDI is positive and statistically significant, indicating that institutional quality does not necessarily reduce the ecological footprint effect of FDI in all sectors. The remaining sectoral interactions are not statistically clear, as their confidence intervals cross zero. The findings for services FDI may reflect the distinct characteristics of service-sector investments compared with traditional industrial activities. Foreign investment in services is often associated with knowledge transfer, digitalization, managerial innovation, and the adoption of international operational standards. These channels

may help explain why stronger institutions appear to reinforce the environmental benefits of services-related FDI in the CO_2 models. At the same time, the more mixed results obtained for ecological footprint suggest that the environmental effects of services extend beyond emissions alone and may involve broader patterns of resource consumption.

Overall, the sectoral analysis shows that the moderating role of institutional quality is sector-specific rather than uniform. Institutional quality appears to play a stronger mitigating role for CO_2 emissions than for ecological footprint. These findings suggest that the environmental consequences of FDI depend not only on the total volume of foreign investment, but also on the sectoral destination of investment and the institutional conditions under which it takes place.

5. Conclusion

The findings indicate that the environmental effects of foreign direct investment in CEE countries are not uniform, but depend on both the sectoral destination of investment and the institutional environment in which investment takes place. While total FDI is not significantly associated with ecological footprint, it is negatively associated with CO_2 emissions, providing evidence that is more consistent with the Pollution Halo Hypothesis than with the Pollution Haven Hypothesis. The results therefore suggest that foreign investment may contribute to environmental improvements through cleaner technologies, higher production standards, and greater production efficiency.

Institutional quality emerges as an important moderating factor, particularly in the CO_2 models. Stronger institutions appear to enhance the environmental benefits associated with foreign investment, especially in manufacturing and services, while their influence is less pronounced for ecological footprint. At the same time, the sectoral results indicate that institutional improvements alone may not be sufficient to offset the environmental pressures associated with structurally pollution-intensive activities such as mining and quarrying. Overall, the findings highlight the importance of considering both the sectoral composition of FDI and institutional quality when assessing the environmental consequences of foreign investment.

Beyond the empirical results, the study contributes to the broader debate surrounding the Pollution Haven and Pollution Halo hypotheses. The findings indicate that the environmental consequences of foreign investment depend not only on the volume of FDI but also on the institutional environment in which investment takes place. In this respect, the study contributes to the emerging literature that views institutional quality as a moderating factor capable of influencing the environmental outcomes associated with foreign investment. The results further suggest that institutional conditions represent an important mechanism through which the environmental benefits associated with FDI may materialize in CEE economies.

The findings also carry several policy implications for both national governments and European policymakers. First, attracting foreign investment alone may not be sufficient to achieve environmental sustainability objectives. The quality of domestic institutions plays an important role in shaping the environmental consequences of FDI and should therefore be considered an integral component of sustainable investment strategies. Efforts aimed at strengthening regulatory quality, government effectiveness, and environmental enforcement may increase the likelihood that foreign investment contributes to cleaner production processes and lower environmental pressures.

Second, the sectoral differences identified in the analysis suggest that a uniform policy approach may not be appropriate. While stronger institutions appear to enhance the environmental benefits of manufacturing and services FDI, more targeted regulatory frameworks may be required for environmentally sensitive sectors such as mining and quarrying. In these sectors, stricter environmental standards, enhanced monitoring mechanisms, and more rigorous compliance requirements may be necessary to mitigate the environmental risks associated with foreign investment.

Third, the findings support ongoing European efforts aimed at strengthening governance quality, environmental standards, and sustainable investment frameworks across CEE economies. In this respect, institutional reforms and environmental policies should be viewed as complementary instruments for achieving both economic convergence and sustainability objectives. More broadly, the results are consistent with the objectives of EU cohesion, climate, and industrial policies, which increasingly emphasize the need to combine investment attraction with environmental sustainability and institutional development.

Several limitations should be acknowledged. First, the analysis is restricted to seven CEE countries and is conditioned by the availability of comparable sectoral FDI, institutional, and environmental data. Second, the study relies on ecological footprint and CO_2 emissions as proxies for environmental sustainability and therefore may not capture all environmental dimensions. Third, the empirical framework identifies statistical associations rather than fully causal relationships between FDI, institutions, and environmental outcomes.

Future research could extend the analysis to a broader set of countries, alternative environmental indicators, and additional dimensions of institutional quality. Further work may also explore nonlinear effects, sector-specific transmission mechanisms, differences across stages of economic development, and causal identification strategies capable of providing deeper insights into the relationship between foreign investment, institutions, and environmental sustainability.

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