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Effectiveness of Environmental Regulation in E7 and G7 Countries: Revisiting the Pollution Halo and Pollution Haven Hypothesis

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Abstract

This study examines the environmental impact of foreign direct investment (FDI) in E7 and G7 countries from 2005 to 2020 using the ecological footprint as a comprehensive indicator. Employing both linear and nonlinear dynamic panel models, the findings reveal that the environmental effects of FDI depend on the stringency and type of environmental regulation. In E7 countries, FDI tends to worsen environmental degradation under weak regulatory frameworks, providing partial support for the pollution haven hypothesis (PHV). In contrast, in G7 countries, FDI contributes to environmental improvement when market-based and technology-oriented policies surpass certain thresholds, aligning with the pollution halo hypothesis (PHL). The study disaggregates the OECD Environmental Policy Stringency Index (EPS) and identifies regime-dependent effects of FDI across different policy types. It is asserted that while non-market-based policies are more effective in E7 countries, market-based instruments have a larger influence on the environment in G7 economies. Our paper also acknowledges theoretical limitations of the PHV and the PHL, including assumptions of industry mobility, and suggests alternative mechanisms such as technology spillovers. Overall, the results emphasize the importance of context-sensitive policy design to ensure that FDI supports environmental sustainability goals.

Keywords: Foreign direct investment, environmental regulation, pollution haven hypothesis, pollution halo hypothesis, ecological footprint, dynamic panel threshold model

JEL Classification: Q58, F18, Q56, C23

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1. Introduction

Currently, the apparent conflict between economic interests and environmental preservation is undergoing a reassessment worldwide. While local and national economies often emphasize fossil fuel extraction and energy production for growth and employment, there are increasing debates about the merits of banning shale gas extraction (fracking) and transitioning to renewable energy sources. This division is underscored by surging global temperatures, as evidenced by a peak temperature of 49.6 °C in North America in 2022 (NASA/GISS, 2023), alongside an increase in ocean temperatures, which have risen by between 0.1 °C and 0.6 °C over the last fifty years (Wagner and Timmins, 2009). Such environmental degradation, including plastic pollution and industrial waste compromising water resources, underscores the urgency of prioritizing environmental protection for sustainability and human health.

In the 21st century, capital flows have evolved to focus on environmental, social and governance (ESG) sustainability, supporting Sustainable Development Goals (Akbulut and Yereli, 2023). Foreign direct investment (FDI), while fostering economic growth in host countries, has significant impacts on their natural resources and environments (Cole *et al*., 2006; Shahbaz *et al*., 2015; Wagner and Timmins, 2009). The environmental dynamics of FDI differ notably between greenfield investments, which involve developing new areas with specific environmental challenges, and brownfield investments, which integrate sustainable practices in previously industrialized areas (Bulus and Koc, 2021; Mwilima, 2003).

Environmental impacts of FDI are examined under the framework of two prominent theories in environmental economics: the pollution haven hypothesis (PHV) and the pollution halo hypothesis (PHL). The PHV indicates that countries with less stringent environmental rules tend to draw industries that are heavy polluters (Gyamfi *et al*., 2021; Sarkodie and Strezov, 2019; Wang *et al.*, 2021). Conversely, the PHL asserts that multinational enterprises (MNEs) elevate environmental standards in the host countries by introducing advanced, cleaner technologies and production practices, in accordance with local regulations (Ali and Wang, 2024; Balsalobre-Lorente, 2022; Kisswani and Zaitouni, 2023). This hypothesis argues that MNEs can help local firms enhance their environmental performance by transferring environmental knowledge and technologies. These perspectives provide essential guidance for shaping investment decisions and environmental policy design.

FDI significantly influences environmental conditions, especially in the E7 developing countries and the G7 industrialized economies. Analysing the environmental impacts of these investments reveals both differences and similarities in the international execution of environmental policies, highlighting the balance between economic growth and environmental protection across these diverse economic blocks. However, empirical evidence on how environmental policy stringency shapes this relationship across different country groups remains fragmented. The OECD Environmental Policy Stringency Index (EPS), created by Botta and Koźluk in 2014, has enabled a thorough assessment of these regulations, addressing a significant deficiency in the literature (Botta and Koźluk, 2014). The EPS measures the effects of environmental policies through three lenses: market-based, non-market-based and technology support policies. Market-based policies, such as the CO_2 trading scheme and various pollution taxes, aim to mitigate negative externalities through pricing mechanisms. Non-market-based policies, including emission limits for various pollutants, directly control environmental impacts. The third component, technology support policies, includes public research and development expenditures and incentives for renewable energy sectors such as solar and wind (Kruse *et al*., 2022).

Within this framework, the primary objective of our study is to empirically examine the environmental effects of FDI, with a particular focus on its impact on the ecological footprint, and to comparatively analyse the role of environmental regulatory stringency in shaping this relationship within the country groups E7 (China, Indonesia, Turkey, Brazil, Russia, India and Mexico) and G7 (Italy, Japan, the United Kingdom, the United States of America, Canada, France and Germany). To the best of our knowledge, this is the first study to simultaneously compare E7 and G7 countries while disaggregating environmental policies by type to examine their conditioning effects on the FDI–environment relationship. In this context, we aim to contribute to the existing literature by advancing both the methodological and conceptual understanding of the FDI–environment nexus in several novel ways. Firstly, while most prior studies have primarily focused on the relationship between FDI and CO_2 emissions, we adopt the ecological footprint as a more comprehensive and multidimensional indicator of environmental degradation. Secondly, we incorporate the OECD's updated EPS indices and categorize them into market-based, non-market-based and technology-based policy types, allowing a more nuanced examination of how different regulatory approaches condition the environmental impact of FDI. Thirdly, we employ a dynamic panel threshold model, enabling the identification of nonlinear effects and country-specific regime shifts and methodological improvement over conventional linear estimations commonly used in previous research.

More briefly, the direction and magnitude of the environmental impact of FDI inflows are first analysed using a linear approach, namely the system generalized method of moments (system GMM). Subsequently, in order to account for the nonlinear nature of the FDI–environment relationship and the heterogeneity of environmental policy across countries, the dynamic panel threshold model developed by Kremer *et al*. (2013) is employed. This method enables the identification of potential regime shifts between the pollution haven hypothesis and the pollution halo hypothesis, depending on the stringency of environmental regulation. Furthermore, by disaggregating the OECD Environmental Policy Stringency Index into market-based, non-market-based and technology-supportive components, our study provides a detailed evaluation of how different regulatory approaches condition the environmental consequences of FDI. The originality of this research lies in its simultaneous consideration of both linear and nonlinear dynamics of the FDI–environment nexus and in being among the first empirical studies to offer a comparative analysis for E7 and G7 countries using disaggregated EPS data by policy type. The comparative framework applied to both E7 and G7 countries provides novel insights into how the effectiveness of environmental policies varies across country groups with different levels of institutional development and economic maturity. In doing so, we intend to deliver actionable insights for policymakers from a sustainable development perspective.

The remainder of our paper is structured as follows. Initially, a thorough literature review is provided in Section 2. Section 3 delineates the data and methodological approach. Section 4 examines the empirical findings. Section 5 concludes and proposes policy recommendations.

2. Literature Review

The literature on the environmental consequences of FDI is particularly based on the PHV and PHL hypotheses. The theoretical approach of the PHV was first articulated by Pethig (1976) and further extended by Walter and Ugelow (1979) and Copeland and Taylor (1994), who conceptualized the environment as a production factor and highlighted the displacement of pollution-intensive industries due to uneven regulatory standards. Despite the theoretical coherence of the PHV framework, early empirical research yielded mixed and context-dependent results, partly due to methodological differences and country-specific variations. Among these studies, Hoffmann *et al*. (2005), using data from 112 countries, found income-level dependent causality between FDI and CO_2 emissions. Similarly, Aliyu (2005) observed pollution-intensive FDI from OECD countries gravitating towards countries with tax regulations, supporting the PHV, but found no significant link in developing economies. These findings underscore a lack of consensus and highlight the importance of incorporating institutional and policy heterogeneity in FDI–environment analyses.

Subsequent research has expanded the analytical framework to include more environmental indicators and more advanced econometric approaches. For example, Sarkodie and Strezov (2019) empirically supported the pollution haven hypothesis (PHV) by finding a strong relationship between energy consumption and greenhouse gas emissions in developing countries. Similarly, Rana and Sharma (2019) and Nathaniel *et al*. (2020) found that the environmental impacts of foreign direct investment (FDI) differ depending on contextual factors such as trade intensity, the composition of energy resources and the nature of regulatory institutions, and these results showed that context sensitivity is high. Kaur *et al*. (2023) emphasized the role of FDI in green energy and sustainability. More recent studies go beyond CO_2 emissions and consider more comprehensive ecological indicators and advance the literature in this field by using nonlinear modelling techniques. Indeed, Sun *et al*. (2017) found that FDI accelerates environmental degradation in China under conditions of inadequate environmental regulations, while Liu *et al*. (2019) identified U- and N-shaped curves in the environmental impacts of FDI, emphasising that this effect varies significantly depending on the stringency level of the regulatory framework and that threshold effects and nonlinear policy dynamics should be taken into account in empirical models.

On the other hand, studies using indicators that measure environmental pressure in a more holistic manner, such as the ecological footprint, provide more detailed findings on these dynamics. For example, Balsalobre-Lorente *et al*. (2019), in their analysis of MINT countries, found that FDI inflows initially increase ecological degradation; however, with the continuation of economic development and strengthening of the institutional structure, these negative effects decrease, which is consistent with the PHL hypothesis. Similarly, Akbulut and Yereli (2023) supported the PHL approach by emphasising the regulatory role of strict environmental policies in limiting the negative effects of FDI on the environment. On the other hand, Özkan *et al*. (2023) confirmed the PHV hypothesis in their study on China and also drew attention to the positive effects of energy efficiency and trade openness. Sadik-Zada and Ferrari (2020) addressed the carbon leakage phenomenon in the context of OECD countries and argued that strict domestic environmental regulations may lead to a shift of emissions to countries with more lenient standards. Singhania and Saini (2021) argued that both PHV and PHL dynamics depend on the institutional and economic characteristics of countries. Adebayo (2022), in his study on E7 economies, stated that the environmental effects of financial globalization are not homogeneous; it leads to an increase in emissions in some countries and a decrease in others, and this situation is shaped depending on the quality of governance and policy design. Moreover, comparative assessments have been made between developed and developing country groups not only in terms of environmental impacts but also in terms of financial integration[1].

In conclusion, the environmental impacts of FDI are inherently context-sensitive and multidimensional, shaped not only by income levels and industrial development but also by the type of environmental policy (market-based, command-and-control or technology-oriented) and the strength of institutional capacity. This diversity highlights the limitations of one-size-fits-all approaches such as the PHV or PHL. By integrating a comprehensive indicator – the ecological footprint – and disaggregating environmental policy types using updated OECD indices, this study contributes a more nuanced and policy-relevant understanding of the FDI–environment nexus, particularly across diverse country groups such as the E7 and G7.

3. Empirical Methodology and Data

The dataset employed in this study covers the period from 2005 to 2020 and is based on a sample comprising E7 countries (China, Indonesia, Turkey, Brazil, Russia, India and Mexico) and G7 countries (Italy, Japan, the United Kingdom, the United States of America, Canada, France and Germany). The study, grounded in theoretical foundations, aims to investigate the conditions under which the PHV – which posits that *FDI* deteriorates environmental quality – holds true, in contrast to the PHL, which suggests that *FDI* improves environmental outcomes. In this context, the research proceeds in two directions. Firstly, it examines the environmental effects of *FDI*, particularly its impact on the ecological footprint, which is considered a comprehensive and integrative indicator of environmental degradation. Secondly, based on the assumption that the environmental effects of *FDI* may not follow a linear and unidirectional pattern, our study explores whether this relationship varies depending on the stringency of environmental policies implemented by countries. Given the heterogeneity in environmental regulatory frameworks across countries, it is anticipated that the *FDI*–ecological footprint relationship may exhibit nonlinear dynamics. This approach not only allows a comparative assessment between different country groups but also enables a more in-depth analysis within regimes defined by the stringency of environmental policies. In doing so, the findings of this study are expected to provide valuable insights for policymakers within the framework of sustainable development.

In line with the first objective of the study, the direction and magnitude of the environmental impact of *FDI* inflows will be empirically tested within a linear framework using

1 For detailed information, see Kaur *et al*. (2025) and Aggarwal and Khurana (2018).

the system generalized method of moments (system GMM), a dynamic panel data estimation technique widely utilized in empirical research for its ability to control endogeneity, autocorrelation and unobserved fixed effects. Developed by Arellano and Bover (1995) and Blundell and Bond (1998), system GMM addresses the weak instrument problem associated with the difference GMM approach by jointly employing moment conditions from both level and first-difference equations. In this method, lagged levels of the variables are used as instruments for differenced equations, while lagged differences are used as instruments for level equations, thereby yielding more consistent and less biased estimates. The method is commonly implemented using the *xtabond2* command in Stata, developed by Roodman (2009) and instrument validity is assessed using the Arellano-Bond autocorrelation test and the Hansen test for over-identifying restrictions. To prevent instrument proliferation, which can weaken the power of diagnostic tests, the number of instruments is kept below the number of observations. The Hansen's *J*-test is preferred over the Sargan test due to its robustness under heteroscedasticity, and Windmeijer's (2005) correction is applied to adjust standard errors in two-step estimations, thereby enhancing the reliability of inference. These features make system GMM a strong and widely preferred approach in linear dynamic panel data analysis.

Accordingly, the model to be estimated for the first objective of the study is presented below in Equation (1).

$$\ln eco_{it} = \gamma \ln eco_{i,t-1} + \varphi_1 FDI_{it} + \varphi_2 X_{it} + \partial_i + \theta_t + \varepsilon_{it} \tag{1}$$

In Equation (1), ln *eco* represents the dependent variable. The coefficient γ captures the effect of the lagged value of the dependent variable, while φ_1 denotes the direction and magnitude of the impact of the explanatory variable *FDI* on the dependent variable. The coefficient φ_2 corresponds to the control variables, ∂ reflects unobserved unit-specific effects, θ_t captures unobserved time-specific effects and ε represents the error term.

On the other hand, due to the inability of linear models to adequately capture potential structural breaks, a nonlinear analytical approach is required to address the second objective of the study. At this point, the dynamic panel threshold model developed by Kremer *et al*. (2013) is employed. This method assumes that the relationship between variables may differ depending on whether the value of the Environmental Policy Stringency Index falls below or above a certain threshold, thereby allowing the analysis of nonlinear effects across regimes. In this way, the study aims to reveal whether the impact of *FDI* on environmental performance varies in a positive or negative direction depending on the degree of environmental policy stringency.

At this juncture, our choice to employ the dynamic panel threshold analysis method developed by Kremer *et al*. (2013) highlights the methodological superiority of our research. Indeed, threshold models, which reveal structural relationships and breakpoints defined in terms of threshold levels, are crucial as they facilitate a more straightforward capture of economic phenomena. More specifically, the dynamic panel threshold method with endogenous regressors by Kremer *et al*. (2013) used in the case of heterogeneity in panel data cannot be adequately resolved with linear models, as structural relationships can significantly vary across units. In the context of our study, the endogenous regressor-inclusive dynamic panel threshold model addresses this issue by evaluating the impact of *FDI* inflows on the ecological footprint according to EPS indices under different regimes. This model captures the nonlinear effects of *FDI* inflows under various conditions and alleviates concerns about endogeneity.

In the dynamic panel threshold analysis, we employ the forward orthogonal deviation transformation as proposed by Arellano and Bover (1995). This method is combined with the instrumental variable estimate of the cross-sectional threshold model, first proposed by Caner and Hansen (2004), and is further integrated with Hansen's (1999) panel threshold model. The dynamic model framework alleviates the problem of endogeneity among essential control variables. Essentially, this approach effectively tackles the problems of endogeneity while considering the dynamic aspects of the dataset, which may be overlooked by Hansen's model. Drawing from these methodologies, the dynamic panel threshold model is structured as follows, facilitating the estimation of threshold effects in panel data, even when dealing with endogenous regressors:

$$y_{it} = \mu_i + \beta_1' \boldsymbol{z_{it}} I(q_{it} \leq \gamma) + \beta_2' \boldsymbol{z_{it}} I(q_{it} > \gamma) + \varepsilon_{it} \tag{2}$$

The subscripts $t = 1, ..., T$ indicate time, while $i = 1, ..., N$ represents unit and country-specific fixed effects. The error term is $\varepsilon_{it} \sim \text{iid}(0, \sigma^2)$. $I(.)$ denotes the indicator function that signifies the regime determined by the threshold variable q_{it} and the threshold level γ. $\boldsymbol{z_{it}}$ is an m-dimensional vector of explanatory regressors that may encompass lagged values of y and other endogenous variables. The vector of explanatory variables is divided into a subset z_{1it} of exogenous variables that are uncorrelated with ε_{it} and a subset z_{2it} of endogenous variables that are correlated with ε_{it}. Alongside structural Equation (1), the model necessitates an appropriate set of $k \geq m$ instrumental variables x_{it}, which includes z_{1it}.

Building on the approach of Kremer *et al*. (2013), we adopt the forward orthogonal deviation transformation technique from Arellano and Bover (1995) to mitigate fixed effects during the initial phase of our estimation. This method is beneficial as it prevents serial correlation in the transformed error terms, thus maintaining the distributional properties outlined by Hansen (1999) and further developed by Caner and Hansen (2004). Consequently, rather than resorting to first differences – which may introduce serial correlation – or employing mean subtraction as described in Hansen (1999), this technique utilizes the mean of all subsequent observations of a variable for transformation. This ensures that, with the application of the forward orthogonal deviation method, the error terms are appropriately adjusted as specified in Equation (3).

$$\varepsilon_{it} = \sqrt{\frac{T-t}{T-t+1}}\left[\varepsilon_{it} - \frac{1}{T-t}(\varepsilon_{it}(t+1)+\ldots+\varepsilon_{iT})\right] \tag{3}$$

Consequently, the forward orthogonal deviation transformation maintains the independence of the error terms; thus:

$$Var(\varepsilon_i) = \sigma^2 I_T \Rightarrow Var\,(\varepsilon_i^*) = \sigma^2 I_{T-1} \tag{4}$$

In accordance with Hansen (2000), this enables the application of Caner and Hansen's (2004) estimation approach for the cross-sectional model to the dynamic panel Equation (1). Utilizing the dynamic panel threshold model to examine the influence of *FDI* inflows on ecological footprints in E7 and G7 countries, we establish the threshold models for the relationship between *FDI* inflows and ecological footprints as follows.

Table 1: The model specifications

Model 1	$y_{it} = \mu_i + \beta_1' FDI_{it} I(totalenv \le \gamma) + \delta_1 I(totalenv_{it} \le \gamma) + \beta_2' FDI_{it} I(totalenv_{it} > \gamma) + \theta z_{it} + \varepsilon_{it}$
Model 2	$y_{it} = \mu_i + \beta_1' FDI_{it} I(marketenv \le \gamma) + \delta_1 I(marketenv_{it} \le \gamma) + \beta_2' FDI_{it} I(marketenv_{it} > \gamma) + \theta z_{it} + \varepsilon_{it}$
Model 3	$y_{it} = \mu_i + \beta_1' FDI_{it} I(nonmarketenv \le \gamma) + \delta_1 I(nonmarketenv_{it} \le \gamma) + \beta_2' FDI_{it} I(nonmarketenv_{it} > \gamma) + \theta z_{it} + \varepsilon_{it}$
Model 4	$y_{it} = \mu_i + \beta_1' FDI_{it} I(technoenv \le \gamma) + \delta_1 I(technoenv_{it} \le \gamma) + \beta_2' FDI_{it} I(technoenv_{it} > \gamma) + \theta z_{it} + \varepsilon_{it}$

Source: Authors' own compilation

In the models in Table 1, y_{it} denotes the ecological footprint of the country *i* in the period *t*, which is the dependent variable of our model. μ_i represents the country-specific fixed effect removed by forward linear transformation as specified by Arellano and Bover (1995).

In this regard, the serial correlation of converted errors is avoided. In the analyses, *FDI* is the explanatory variable and a different Environmental Policy Stringency Index (*totalenv* or *marketenv* or *nonmarketenv* or *technoenv*) is the threshold variable that separates regimes. $I(.)$ also has an indicator function that refers to the regimes defined by the threshold variable (*totalenv* or *marketenv* or *nonmarketenv* or *technoenv*). It splits the threshold variable into two regimes, above and below the level of the unspecified threshold parameter (γ). After determining the threshold value that minimizes the sum of squared error terms, the slope coefficients are estimated using the GMM approach for the predefined instruments and the estimated threshold value. β_1 and β_2 are regime-dependent slope coefficients. δ_1 represents the constant regime coefficient common to all cross-sections. ε_{it} is the independent and identically distributed error term.

Explanations on the data sources and definitions of variables used within the framework of this methodology are given in Table 2 below.

The variables utilized in the analyses are selected considering the theoretical framework and empirical literature. As an indicator of environmental quality, ecological footprint measures the impact of factors such as fossil fuel combustion, deforestation and industrial processes, as well as the consumption habits of individuals, communities, businesses and countries on natural resources. Although it has some certain limitations in terms of data calculation, availability and comparability, providing a more comprehensive measure of environmental degradation, it is preferred to be used as a dependent variable over alternatives, such as CO_2 emissions. Unlike indicators focusing on a single pollutant, the ecological footprint reflects the cumulative pressure on ecosystems, including carbon emissions, land use change and biological capacity overshoot. Therefore, its exclusive use in the model enables a broader and more integrated understanding of environmental stress.

Considering the significant effect of *FDI* inflows on the ecological footprint in terms of theory, literature and practice, the ratio of *FDI* inflows to GDP is determined as the regime-dependent variable of the model. In addition, the variables ln *prim*, ln *gdpper*, *reguqua*, *law*, *urban* and *renew* are utilized as control variables. In order to capture the potential effects of major economic shocks within the scope of this study, a dummy variable (*crisis_dummy*) is specified. The variable takes the value of 1 for the years 2008 and 2009, which are marked by the global financial crisis, and for the year 2020, which reflects the economic impact of the COVID-19 pandemic that emerged at the end of 2019. For all other years, the variable is coded as 0.

Table 2: Data specification

Variables and abbreviations	Description	Source
	Dependent variable	
ln *eco*	Ecological footprint (global hectares per capita) in natural logarithmic transformation	Global Footprint Network (2024)
	Regime-dependent variable	
FDI	Foreign direct investment, net inflows (% of GDP)	WB, WDI (2024)
	Control variables	
ln *prim*	Primary energy consumption per capita (kWh/person) in natural logarithmic transformation	Our World in Data (2024)
ln *gdpper*	GDP per capita (constant 2015 USD) in natural logarithmic transformation	WB, WDI (2024)
reguqua	Regulatory quality, ranges from –2.5 (weak) to 2.5 (strong)	WB, WGI (2024)
law	Rule of law, ranges from –2.5 (weak) to 2.5 (strong)	WB, WGI (2024)
urban	Population in the largest city (% of urban population)	WB, WDI (2024)
renew	Renewable energy consumption (% of total final energy consumption)	WB, WDI (2024)
crisis_dummy	Dummy variable equal to 1 for the years characterized by major economic shocks (2008, 2009 and 2020) and 0 otherwise	Created by the authors (2025)
	Threshold variables	
totalenv	EPS index	OECD (2024)
marketenv	EPS index (market-based policies)	OECD (2024)
nonmarketenv	EPS index (non-market-based policies)	OECD (2024)
technoenv	EPS index (technology support policies)	OECD (2024)

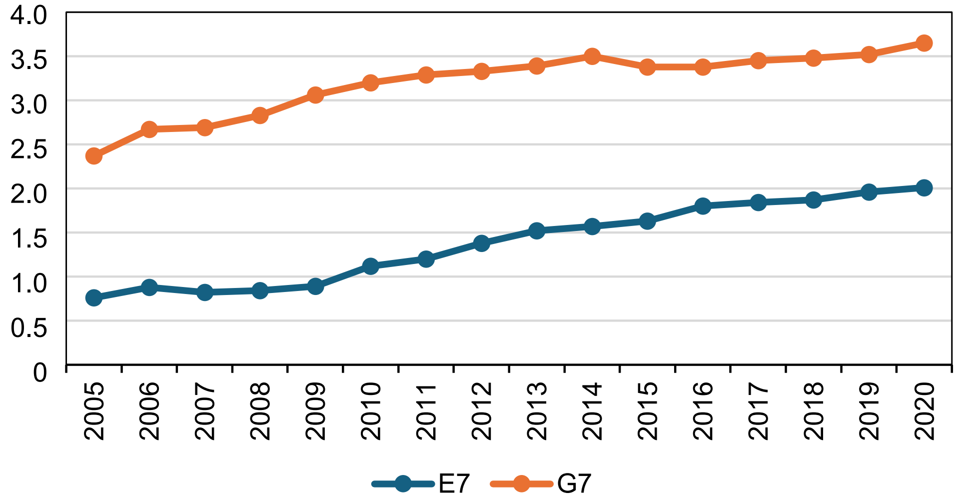
Source: Authors' own elaboration

The influence of *FDI* on the environment within the context of environmental legislation is examined by utilizing the OECD EPS index as a threshold variable. The OECD EPS has been widely employed in empirical studies to evaluate the cross-country effects of stricter environmental policies on environmental and economic outcomes, supporting a better understanding of these impacts (Botta and Koźluk, 2014). Stringency refers to the extent to which environmental policies impose explicit or implicit costs on pollution or environmentally harmful behaviour. The rating is founded on the rigour of 13 environmental policy measures primarily pertaining to climate and air pollution. The index ranges from 0 (least strict) to 6 (most stringent).

The index analyses environmental policies from three different perspectives: market-based policies, non-market-based policies and technology support policies. While the initial version of the EPS included market-based and non-market-based policies, technology support policies were also included afterwards. Market-based policies such as the carbon dioxide (CO_2) trading scheme, renewable energy trading scheme, carbon dioxide tax (CO_2), nitrogen oxide tax (NO_X), sulphur oxide tax (SO_X) or diesel tax aim to eliminate negative externalities through price mechanism. On the other hand, emission limit values for NO_X, SO_X, particulate matter and sulphur are among the non-market-based policies, which attempt to minimize negative externalities by imposing direct controls on pollutants; they appear to be the most basic indicators of direct controls. The last component of EPS index is technology support policies. These comprise public research and development expenditures and support for renewable energy, specifically in the solar and wind sectors (Kruse *et al*., 2022). In this framework, the variables *totalenv*, *marketenv*, *nonmarketenv* and *technoenv* are used as thresholds to analyse the nonlinear impact of *FDI* on ln *ecofo*.

In general terms, it is possible to assert that the total EPS index, which aims to minimize the environmental impact of potential negative externalities, has been continuously increasing and becoming stricter. Figure 1 below shows the course of the EPS index in E7 and G7 countries in 2005–2020.

Figure 1: EPS index in E7 and G7 countries (country averages)

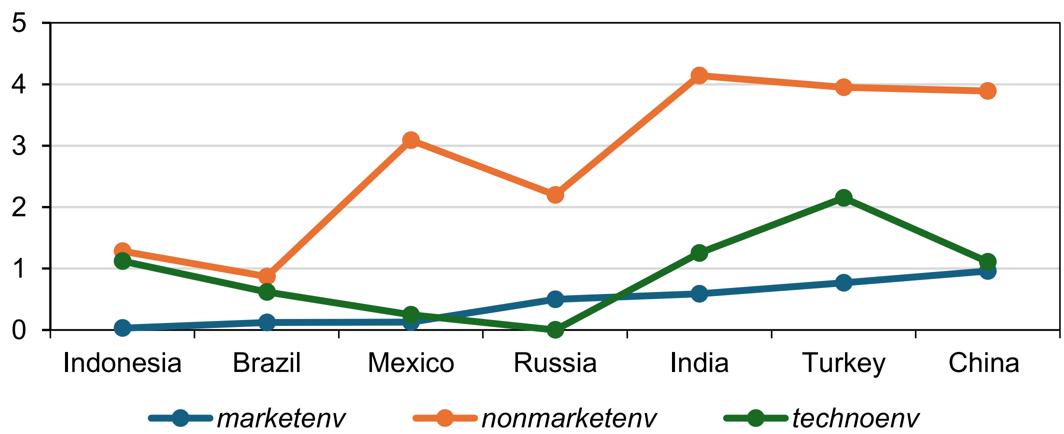


Source: Authors' own elaboration, using data from OECD (2024)

Following Figure 1, it is observed that the EPS index is in a continuous upward trend between 2005 and 2020. This indicates that these countries are tightening their environmental controls more and more. On the other hand, another piece of evidence from Figure 1 is that the high level of the EPS index is more evident in G7 countries than in E7 countries. In light of this general impression, it would be more enlightening to analyse the subcomponents of the Environmental Policy Stringency Index separately for country groups.

In this framework, Figure 2 below plots the 2005–2020 averages of *marketenv*, *nonmarketenv* and *technoenv* indices in E7 countries.

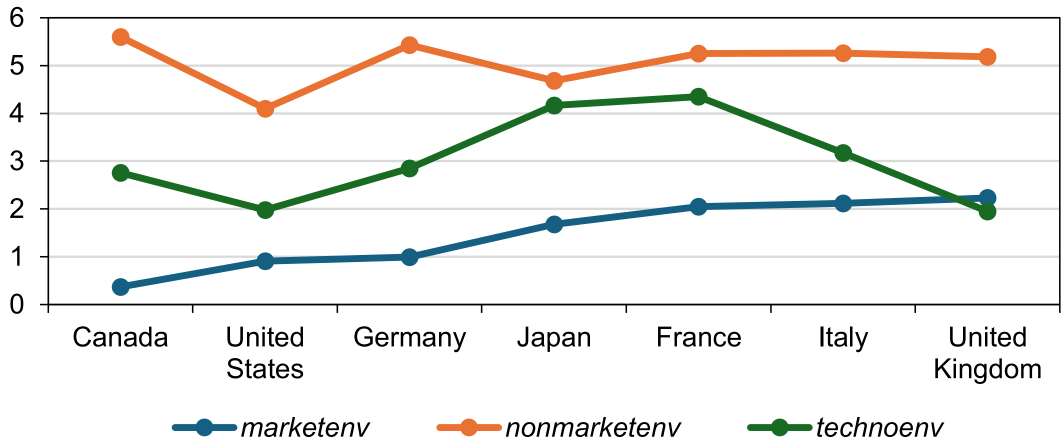
Figure 2: Trends of different EPS indices in E7 countries (2005–2020 averages)



Source: Authors' own elaboration, using data from OECD (2024)

Figure 2 points out that non-market-based policies are more common in each of the E7 countries. In other words, it is observed that E7 countries have stricter controls based on non-market policies that have a direct impact on the direction of investments. On the other hand, compared to technology-based policies, market-based policies are tighter in six countries with the exception of Russia.

Figure 3: Trends of different EPS indices in G7 countries (2005–2020 averages)



Source: Authors' own elaboration, using data from OECD (2024)

Figure 3 indicates 2005–2020 averages of market-based, non-market-based and technology-based indices in G7 countries. Like E7 countries, G7 countries exhibit a greater prevalence of non-market-based environmental policies. In G7 countries, market-based rules are more rigorous than technology-based policies in six countries except the United Kingdom.

4. Empirical Findings and Discussion

In this study, the initial analysis examines the impact of *FDI* on the ecological footprint using a linear approach, with a focus on different country groups. Table 3 below presents the empirical findings derived from the system GMM estimation method.

Table 3: Dynamic panel data regression results – system GMM approach

	All countries	**E7 countries**	**G7 countries**
Coefficient estimates			
ln *eco*	−0.372*** (−4.72)	−0.152** (−2.07)	−0.051*** (−3.48)
FDI	−0.015* (−1.72)	0.433*** (7.28)	−0.293* (−1.78)
totalenv	−0.337** (−1.96)	−0.050** (−2.38)	−0.062*** (−3.55)
marketenv	−0.056* (−1.78)	0.299* (1.76)	−0.628** (−2.05)
nonmarketenv	−0.606*** (−2.62)	−1.109*** (−3.78)	−0.588*** (−2.56)
technoenv	−0.133* (−1.87)	0.243 (0.73)	0.074 (1.56)
ln *prim*	9.252** (2.32)	4.822* (1.77)	0.343** (2.19)
ln *gdpperca*	−0.014 (−0.85)	−1.450 (−1.25)	−0.645*** (−8.54)
reguqua	−0.043** (−2.13)	−0.052** (−2.15)	−0.026** (−2.41)
law	−0.123 (−1.115)	−0.220** (−2.11)	−0.014 (−0.68)
urban	0.031 (1.38)	2.000*** (6.86)	0.016 (1.35)
renew	−0.052*** (−3.40)	−0.389*** (−2.85)	−0.026 (−1.34)
Crisis_dummy	−0.032*** (−4.25)	−0.848*** (−2.70)	−0.017* (−1.70)
Constant	9.657*** (2.36)	12.230*** (2.74)	12.885*** (3.23)
Hansen *J*-test	0.268	0.210	0.345
AR(2)	0.317	0.243	0.276
N	14	7	7
Obs.	210	105	105

Notes: *, **, *** denote statistical significance at the 10%, 5% and 1% levels, respectively. The *p*-values of A-Bond AR(2) and Hansen *J*-test statistics are reported.
Source: Authors' own calculations

An analysis of Table 3 reveals that *FDI* has a statistically significant impact on the ecological footprint across all three panels. However, the direction of this effect varies by country group: while *FDI* exerts a negative effect on the ecological footprint in all the countries and G7 panels, indicating an improvement in environmental quality, its effect is positive in the E7 panel, suggesting a deterioration. These findings support the PHL for the overall sample and the developed countries, implying that *FDI* contributes positively to environmental performance in these contexts, while they lend empirical backing to the PHV for the developing countries, where *FDI* appears to exacerbate environmental degradation. Regarding the control variables, per capita income is found to have a negative and statistically significant effect only in the E7 panel, indicating that economic growth in these countries may help alleviate environmental pressure. The share of renewable energy consumption is negative and significant across all the panels, confirming that energy transition policies play an effective role in reducing ecological footprints. The industrial value-added variable is significantly positive only in the overall sample, highlighting that industrialization contributes to environmental degradation; the variation in this effect across country groups may be attributed to differences in technological advancement.

Urbanization, on the other hand, is positive and significant only in the E7 group, suggesting that unplanned urban expansion intensifies environmental degradation in developing countries. It has been identified that institutional quality – measured in terms of regulatory quality and rule of law – generally exerts a mitigating effect on environmental degradation. These findings reveal that the environmental impact of *FDI* is shaped not only by its volume but also by the host country's institutional capacity, the stringency of environmental regulations and the level of economic development. This underscores the necessity of designing environmentally responsible investment strategies tailored to the specific contexts of country groups. Furthermore, the results indicate that during periods of economic crisis, environmental degradation declines significantly across all three panels.

The second part of this study seeks to explore whether the observed effects vary depending on the stringency of environmental policies. To address this question, the analysis proceeds to a nonlinear approach in the second stage, as linear methods are deemed insufficient to fully capture the complexity of the relationship under varying environmental policy regimes. To make a comparative assessment, our study intends to explain the impact of *FDI* inflows on the ecological footprint through policies implemented to protect the environment and reduce negative externalities by using three different panels (all countries, E7 countries and G7 countries) and the models specified in Table 1. It is important to emphasize that the robust variance-covariance estimator was employed in the analysis to produce standard errors that are consistent in the presence of heteroscedasticity and to mitigate potential biases arising from serial correlation in the idiosyncratic error term. Table 4 exhibits the results of the analysis for all the sample countries.

Table 4: Dynamic panel threshold regression results (all countries)

Dependent variable: (ln *ecofo*), Regime dependent variable: (*FDI*)				
	Model 1 (*totalenv*)	**Model 2 (*marketenv*)**	**Model 3 (*nonmarketenv*)**	**Model 4 (*technoenv*)**
Threshold estimate (%)	1.97	1.93	4.50	2.00
Regime 1: *FDI* ($\hat{\beta}_1$)	**3.180*** (4.47)**	**0.996* (1.76)**	**0.292 (0.39)**	**0.675 (1.30)**
Regime 2: *FDI* ($\hat{\beta}_2$)	**−0.218 (−0.21)**	**0.120 (0.39)**	**−1.371*** (−6.74)**	**0.021 (0.06)**
Impact of covariates				
ln *ecofo*	−0.578 ** (−2.84)	−0.363*** (−9.13)	−1.853** (−2.28)	−0.400 (−1.26)
ln *prim*	13.718** (2.67)	13.198* (1.67)	10.940** (1.93)	28.940** (2.61)
ln *gdpperca*	−19.583* (−1.65)	−11.263** (−1.89)	−12.386** (−2.07)	−14.150* (−1.75)
reguqua	−0.259** (−2.06)	−2.104* (−2.52)	−0.965 (−0.88)	−5.432* (−1.84)
law	0.616 (1.41)	3.104 (0.76)	4.663 (1.01)	−0.124 (−0.05)
urban	0.841** (2.17)	0.588* (1.84)	1.762* (1.72)	3.473* (1.65)
renew	−0.348*** (−8.34)	−0.144* (1.81)	−0.189 (−1.07)	−0.657 (−1.29)
Crisis_dummy	−0.037* (−1.66)	−0.412 (1.56)	−0.724* (1.79)	−0.180 (−0.59)
Constant	8.852** (2.14)	7.283*** (2.46)	−9.524 (−1.32)	−9.67*** (−2.67)
Observations	210	210	210	210
Wald χ^2 (Prob. > χ^2)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Notes: *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Every regime account for a minimum of 5% of the total observations, as stipulated by Hansen (1999). Parentheses enclose *t*-statistics. For definitions of variables, refer to the main text.

Source: Authors' own calculations

Table 4 displays the analytical outcomes of Models 1, 2, 3 and 4 for the entire sample, encompassing E7 and G7 countries. Within this approach, Table 4 examines the influence of *FDI* inflows on the ecological footprint across several regimes based on EPS metrics. In the first column of the results of Model 1, it is analysed whether there is a differentiation according to the *totalenv* effect. Below the threshold value (1.97), which indicates that environmental policy stringency is lower, *FDI* inflows have a significant and positive effect on ln *ecofo*. Above the threshold value (1.97), *FDI* inflows have a negative effect on economic growth, but this effect is insignificant. In the column containing the findings of Model 2, the effect of marketing is investigated. Here, the effect is found to be significant and positive below the estimated threshold value (1.93). Above the threshold value (1.93), no significant effect was found. In Model 3, the threshold value was determined to be 4.50. According to the findings of Model 3, when *nonmarketenv* is above the threshold value (4.50), *FDI* inflows have a significant and negative effect on ln *ecofo*. Below the threshold (4.50), no significant effect is detected. Finally, in Model 4, the threshold value for technology is determined as (2.00). Nonetheless, no substantial influence is identified, either at or over the technological barrier. The estimation results for all the countries indicate that when environmental policy stringency and market-based environmental policies fall below the estimated threshold values, *FDI* inflows will augment the ecological footprint of *FDI*. Conversely, when non-market-based environmental policies exceed the threshold, indicating greater stringency, *FDI* inflows will diminish the ecological footprint of *FDI*.

On the other hand, control variables such as per capita income, regulatory quality and renewable energy use are generally found to reduce the ecological footprint, whereas variables such as primary energy consumption per capita and urbanization are associated with increased environmental degradation. However, the statistical significance of these variables varies across models. Although the crisis dummy exhibits a negative coefficient in all the models, this effect is statistically significant only in Model 1 and Model 3.

Table 5: Dynamic panel threshold regression results (E7 countries)

Dependent variable: (ln *ecofo*), Regime dependent variable: (*FDI*)				
	Model 1 (*totalenv*)	**Model 2 (*marketenv*)**	**Model 3 (*nonmarketenv*)**	**Model 4 (*technoenv*)**
Threshold estimate (%)	1.62	0.77	4.00	1.50
Regime 1: *FDI* ($\hat{\beta}_1$)	**0.456*** (4.71)**	**0.552*** (3.55)**	**1.656*** (2.56)**	**0.127 (0.76)**
Regime 2: *FDI* ($\hat{\beta}_2$)	**−0.432 (−0.39)**	**−0.144 (0.67)**	**−0.044*** (−2.97)**	**−0.450 (−1.42)**
Impact of covariates				
ln *ecofo*	−0.343 *** (−3.44)	−0.163 (−0.58)	−0.168*** (−3.07)	−0.103* (−1.82)
ln *prim*	5.305 (0.81)	6.532*** (4.45)	6.070*** (7.78)	7.951** (2.42)
ln *gdpperca*	−9.051** (−2.17)	−14.738* (−1.83)	−7.230** (−2.04)	−9.099* (−1.70)
reguqua	−1.544 * (−1.79)	−1.232* (−1.76)	−0.767 (−0.77)	−1.980 (−0.89)
law	0.667 (0.58)	−0.829** (−2.18)	−0.357 (−0.94)	−0.911** (−2.12)
urban	0.433 ** (2.74)	0.762* (1.82)	0.127*** (3.76)	0.589 (1.43)
renew	−0.133 * (−1.72)	−0.071** (−2.32)	−0.314** (−2.26)	−0.297 (−1.09)
Crisis_dummy	−0.600* (−2.01)	−0.646* (−1.75)	−0.341 (−1.31)	−0.675** (−2.11)
Constant	1.654 (0.52)	2.937 (1.53)	2.882* (1.66)	3.534*** (5.33)
Observations	105	105	105	105
Wald χ^2 (Prob. > χ^2)	(0.0000)	(0.0003)	(0.0021)	(0.0000)

Notes: *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Every regime account for a minimum of 5% of the total observations, as stipulated by Hansen (1999). Parentheses enclose *t*-statistics. For definitions of variables, refer to the main text.

Source: Authors' own calculations

Table 5 presents the analysis results of Models 1, 2, 3 and 4 for the sample of E7 countries. In this framework, Table 5 discusses the impact of *FDI* inflows on the ecological footprint under different regimes depending on EPS indices. In the first column, containing the findings of Model 1, it is examined whether there is a differentiation according to the *totalenv* effect. It is found that *FDI* inflows have a significant and positive effect on ln *ecofo* in cases below the threshold value (1.62), which indicates that *totalenv* is lower. Above the threshold value (1.62), *FDI* inflows have a negative effect on economic growth, but this effect is insignificant. In the column containing the findings of Model 2, the effect of *marketenv* is investigated. Here, the effect is found to be significant and positive below the calculated threshold value (0.77). Above the threshold value (0.77), no significant effect was found.

In Model 3, the threshold value was determined as 4.00. According to the findings of Model 3, *FDI* inflows have a significant and negative effect on ln *ecofo* when *nonmarketenv* is above the threshold (4.00) and a significant and positive effect when it is below the threshold (4.00). In other words, the determinant threshold effect of non-market-based environmental policies comes to the fore in E7 countries. As a matter of fact, it is seen that E7 countries can be evaluated under different regimes according to nonmarket-based environmental policies. If the rigour of non-market-based measures is low, *FDI* inflows will augment the ecological footprint; conversely, if it surpasses the threshold and is substantially more severe, it will diminish the ecological footprint. No significant influence was observed for the threshold value of technology-based environmental policy as delineated by Model 4.

Control variables such as per capita income, regulatory quality, rule of law and renewable energy consumption are generally associated with a reduction in the ecological footprint, whereas primary energy consumption per capita and urbanization tend to increase environmental degradation. The crisis dummy exhibits a negative effect across all the models; however, this effect is not statistically significant in Model 3.

Table 6: Dynamic panel threshold regression results (G7 countries)

Dependent variable: (ln *ecofo*), Regime dependent variable: (*FDI*)				
	Model 1 (*totalenv*)	**Model 2 (*marketenv*)**	**Model 3 (*nonmarketenv*)**	**Model 4 (*technoenv*)**
Threshold estimate (%)	2.77	1.66	5.00	2.50
Regime 1: *FDI* ($\hat{\beta}_1$)	**0.203 (0.46)**	**0.440*** (5.03)**	**0.254 (0.65)**	**0.054 (0.88)**
Regime 2: *FDI* ($\hat{\beta}_2$)	**−1.853** (−2.27)**	**−0.348*** (−7.40)**	**−0.844** (−2.11)**	**−0.865** (−2.24)**
Impact of covariates				
ln *ecofo*	−0.338*** (−6.89)	−0.325** (−2.84)	−0.293*** (−3.55)	−0.552*** (−5.65)
ln *prim*	5.365** (2.01)	2.443** (2.07)	3.007 (0.95)	4.193 (1.55)
ln *gdpperca*	−13.946* (−1.80)	−17.450** (−2.46)	−14.738*** (−3.56)	−20.305* (−1.78)
reguqua	−0.443* (−1.82)	−2.211*** (−2.99)	−1.544 (−0.59)	−1.912** (−2.31)
law	− 2.821** (−2.30)	−1.711 (−0.67)	−2.580 (−0.98)	−2.995 (−1.05)
urban	1.191** (2.36)	2.852*** (5.83)	3.180*** (5.88)	3.375*** (4.77)
renew	−0.505*** (−4.53)	−0.779** (−2.43)	−0.770** (−2.13)	−0.600** (−1.97)
Crisis_dummy	−0.916** (−2.41)	−1.102** (−2.07)	−2.330** (−2.04)	−1.188** (−2.26)
Constant	−4.771** (−2.03)	−2.651*** (−6.17)	−5.595** (−2.38)	−6.051* (−1.66)
Observations	105	105	105	105
Wald χ^2 (Prob. > χ^2)	(0.0000)	(0.0000)	(0.0005)	(0.0000)

Notes: *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Every regime account for a minimum of 5% of the total observations, as stipulated by Hansen (1999). Parentheses enclose *t*-statistics. For definitions of variables, refer to the main text.

Source: Authors' own calculations

Table 6 presents the analysis results of Models 1, 2, 3 and 4 for the sample of G7 countries. In this framework, Table 6 discusses the impact of *FDI* inflows on the ecological footprint under different regimes depending on EPS indices. In the first column, containing the findings of Model 1, it is examined whether there is a differentiation according to the *totalenv* effect. It is evident that *FDI* inflows have a significant and negative effect on ln *ecofo* in cases above the threshold value (2.77), which indicates that *totalenvis is* higher. Below the threshold value (2.77), although *FDI* inflows have a positive effect on economic growth, this effect is insignificant. In the column containing the findings of Model 2, the effect of *marketenv* is investigated. We find that the effect is significant and positive below the estimated threshold value (1.66), while it is significant and negative above the estimated threshold (1.66). In other words, the determinant threshold effect of market-based environmental policies comes to the fore in G7 countries. As a matter of fact, it can be asserted that G7 countries can be evaluated under different regimes according to *marketenv*. In other words, if the stringency of market-based policies is low, *FDI* inflows would increase the ecological footprint, while if it is above the threshold, *i.e.*, relatively more stringent, it will decrease the ecological footprint. In the column containing the findings of Model 3, the effect of *nonmarketenv* is examined. Here, the effect is found to be significant and negative above the calculated threshold value (5.00). Below the threshold value (5.00), no significant effect is found. Similar to Tables 4 and 5, we find no evidence supporting a significant effect on the threshold value of technology-based environmental policies characterized by Model 4.

Per capita income, regulatory quality, rule of law and the share of renewable energy consumption are generally associated with reductions in the ecological footprint, underlining the role of institutional strength and cleaner energy sources in promoting environmental sustainability. Conversely, higher levels of primary energy consumption and urbanization are linked to increased ecological pressure. Although the positive effect of primary energy consumption on environmental degradation is not consistently significant across all the model specifications, it is in line with theoretical expectations. On the other hand, the increasing share of renewable energy has a statistically significant negative impact on the ecological footprint, emphasizing its mitigating role. Moreover, the crisis dummy variable shows a consistently negative and significant effect, suggesting that periods of economic contraction may temporarily alleviate environmental stress due to reduced industrial activity and consumption.

A key finding for all the panels is that the transition to alternative and renewable energy sources is critical for achieving long-term environmental goals. These findings are consistent with previous empirical studies by Bae *et al*. (2017), Liu *et al.* (2019), Balsalobre-Lorente *et al*. (2022), Akbulut and Yereli (2023) and Ali and Wang (2024).

In the following Table 7, the findings obtained from Tables 4, 5 and 6 are summarized within the framework of the PHV and PHL hypotheses.

Table 7: Summary table for all panels

Panel types	Effect of *FDI* on ln *eco* according to different thresholds							
	Model 1 (*totalenv*)		Model 2 (*marketenv*)		Model 3 (*nonmarketenv*)		Model 4 (*technoenv*)	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
E7 and G7	PHV	–	PHV	–	–	PHL	–	–
E7	PHV	–	PHV	–	PHV	PHL	–	–
G7	–	PHL	PHV	PHL	–	PHL	–	PHL

Notes: (1) First regime falls below the threshold value; (2) second regime exceeds the threshold value; (–) denotes a lack of significant effect.

Source: Authors' own elaboration

Following Table 7, it can be observed that the PHV hypothesis, which predicts that the ecological footprint will increase together with *FDI* inflows, is valid in all the countries, including E7 and G7, in Regime 1, which expresses that the stringency of environmental policies is low (below the threshold value) in Models 1 and 2, whereas the PHL hypothesis is valid in Regime 2, which implies that the stringency of environmental policies is relatively high (above the threshold value) in Model 3. In E7 countries, the PHV hypothesis is generally observed. However, it is observed that the PHL hypothesis emerges only in cases where *nonmarketenv* policies are stricter and the threshold effect is more pronounced. This indicates that, to confirm the PHL hypothesis in E7 countries, the tightening of *nonmarket* policies, including direct practices such as emission reductions, is more decisive.

In G7 countries, although the PHL hypothesis is generally observed, it is observed that the PHV hypothesis emerges only in cases where the tightness of *market* policies, where the threshold effect is more pronounced, is lower. This situation points to the importance of *marketenv* policies for indirect practices such as tax regulations in order to avoid the confirmation of the PHV hypothesis in G7 countries. These findings align well with Shahbaz's (2015) study, which is seminal in the literature regarding *FDI*–emission relationships. Previous research has indicated that this link differs among country groups (*e.g.*, low-, middle- and high-income countries). Shahbaz (2015) demonstrated that the PHV is more robustly supported in low- and middle-income countries, whereas the PHL is more applicable in high-income countries. Moreover, numerous studies in the literature corroborate these findings (Abid and Sekrafi, 2021; Álvarez-Herránz *et al*., 2017; Balsalobre *et al*., 2018; Balsalobre-Lorente *et al*., 2022; Bekun *et al*., 2023; Bulut, Uçler and Inglesi-Lotz, 2021; Karimov, 2020; Murshed, 2023; Sabir *et al*., 2022; Shahbaz *et al*., 2019; 2020; Wang *et al*., 2022; Wen *et al*., 2022).

Furthermore, the findings of this study are broadly consistent with more recent research focusing on the interactions between renewable energy, institutional quality and policy design in shaping environmental outcomes. For instance, Adebayo (2025) and Adebayo and Olanrewaju (2025) emphasized the role of green production processes, renewable energy use and green finance in enhancing environmental quality. Similarly, our results show that the impact of *FDI* varies significantly depending on the stringency of environmental policy. Özkan and Adebayo (2024) highlighted the importance of adaptive policy tools in response to market volatility, while our study identifies clear threshold effects based on the type and level of environmental policy. Likewise, Adebayo and Özkan (2024) demonstrated the multi-dimensional determinants of CO_2 emissions, whereas we offer a broader assessment using the ecological footprint as the dependent variable. Finally, Özkan *et al.* (2023) underscored the importance of energy efficiency and renewable energy intensity in reducing greenhouse gas emissions, while our findings show that the environmental impact of *FDI* is shaped by cross-country structural differences. Taken together, the overlapping and divergent findings across these studies underline the decisive role of context-sensitive and policy-driven designs in achieving environmental sustainability.

5. Conclusion

This study intended to provide a comprehensive reassessment of the environmental consequences of FDI through the lens of the ecological footprint, with a particular focus on the moderating role of environmental policy stringency. By employing a dynamic panel threshold model and disaggregated policy indicators across E7 and G7 countries, the analysis uncovers significant nonlinearities in the FDI–environment nexus and offers new empirical evidence to reconcile the conflicting predictions of the pollution haven and pollution halo hypotheses.

Our findings indicate that the environmental impact of FDI is far from uniform and is decisively shaped by the institutional and regulatory contexts of host countries. In E7 countries, where regulatory enforcement tends to be weaker, FDI inflows are found to exacerbate ecological degradation unless stringent non-market-based environmental measures are in place. Conversely, in G7 economies, the effectiveness of FDI in reducing ecological pressure is contingent upon surpassing critical thresholds in market-based and technology-oriented policies. These results underscore the importance of context-sensitive environmental governance and demonstrate the limitations of generic policy prescriptions.

Furthermore, building on our findings regarding the threshold effects of environmental policy stringency in shaping the FDI–environment nexus, more targeted policy recommendations can be proposed for E7 and G7 countries. For E7 economies, where non-market-based policies (*e.g.*, direct regulatory measures such as emission caps and command-and-control rules) were found to be more effective, policymakers should prioritize strengthening regulatory enforcement mechanisms and expanding compliance-based environmental monitoring frameworks. Introducing stricter emission performance standards and enhancing transparency requirements for foreign-invested industries could reduce the ecological burden. In contrast, for G7 countries, market-based environmental policies (*e.g.*, carbon pricing, emissions trading systems, green taxes) appear more decisive in improving environmental outcomes. These countries should focus on refining carbon pricing instruments, closing tax loopholes that favour high-emission sectors and increasing the allocation of revenues from environmental taxes to fund clean technology innovation. At the sectoral level, both country groups should tailor their policy mixes according to the specific environmental risks and investment dynamics of key sectors such as energy, manufacturing and transportation. While E7 countries may benefit from sector-specific subsidies for clean energy transition and eco-certification programmes in manufacturing, G7 countries should prioritize incentivizing innovation in green finance and sustainable infrastructure. These differentiated, context-sensitive approaches can enhance policy effectiveness in both groups and ensure that FDI contributes positively to long-term environmental sustainability.

Moreover, the inclusion of the ecological footprint as a multidimensional indicator – beyond traditional CO_2-based metrics – offers a more nuanced understanding of the cumulative environmental pressures associated with international capital flows. The disaggregation of the OECD's Environmental Policy Stringency Index into policy typologies allows a more targeted evaluation of policy design, revealing that the transition from the PHV to the PHL dynamics is neither automatic nor universal, but conditional upon the nature and strength of environmental regulation.

To sum up, this study not only advances the theoretical discourse on FDI and environmental quality but also provides actionable insights for policymakers. Strengthening non-market-based regulatory regimes in developing countries and reinforcing market-based instruments in advanced economies appear crucial for aligning FDI with sustainability objectives. Future research should further explore the dynamic interplay between institutional quality, green investment strategies and transnational environmental outcomes, particularly in emerging economies. Furthermore, it will also be striking to benefit from explicitly distinguishing between “dirty” and “clean” forms of FDI – such as those directed towards manufacturing versus service sectors – to better capture the sector-specific environmental implications of foreign direct investment.

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