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The impact of value added for US multinationals in European countries on climate activities using the Driscoll and Kraay estimator

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Abstract

This study examines the impact of U.S. multinational corporations (MNCs) on the climate actions of European countries, with a focus on SDG 13 (climate action). Using panel data from 2009 to 2021, the analysis investigates whether the value added generated by these companies influences host countries' climate performance. The empirical results reveal a significant negative relationship between US MNCs' value added and the SDG 13 score of host countries. These findings support the Pollution Haven hypothesis, which suggests that MNCs may relocate pollution-intensive operations to countries, thereby increasing environmental risks. Conversely, the Pollution Halo hypothesis posits that MNCs can transfer green technologies and best practices to host countries, potentially improving environmental outcomes; however, this effect was not observed in the current study. Overall, the research contributes to the limited literature quantitatively assessing the macro-level impact of MNCs on sustainable development and climate action, highlighting the tension between economic contributions and environmental responsibilities.

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1. Introduction

Multinational corporations (MNCs) can be described as mechanisms that combine mobile assets (technology, capital, skills, management, knowledge) with spatially fixed factors (labor, markets, raw materials) to reshape the international political and economic landscape (Buckley, 2016; Cohen, 2007). Within this scope, MNCs are also referred to as successful firms that have evolved over many years into large international corporations in terms of their operations, vision, and strategies (Aggarwal et al., 2011). MNCs have brought about a qualitative change in our economic world, both in terms of numbers and power (Chandler & Mazlish, 2005). As a result, MNCs are recognized as major actors in the global political economy (Irogbe, 2013). MNCs are therefore the global giants of modern times. Collectively, these organizations are responsible for a large share of world production, employment, investment, international trade, research, and innovation (Foley et al., 2021). Moreover, MNCs and their foreign subsidiaries account for one-third of world production and GDP and two-thirds of international trade (Backer et al., 2019). While the gross product of foreign subsidiaries of MNCs has grown faster than global GDP over the last three decades, according to the United Nations, foreign subsidiary sales have grown faster than global exports (Epstein, 2019).

MNCs' decisions, directly and indirectly, affect not only themselves, their employees, customers, suppliers, and competitors, but also the communities, countries, and billions of people in which they operate (Foley et al., 2021; Martinuzzi & Schönherr, 2019). MNCs are therefore a major force to be reckoned with in the economic, political, environmental, and cultural spheres (Nye Jr., 1974; Roach, 2005). From environmental policies to international security, from issues of personal identity to social issues, from the future of work to the future of regional development, MNCs have an impact on almost every aspect of life (Chandler & Mazlish, 2005). Although the majority of MNC activities are considered beneficial, MNCs are not always uncontroversial institutions (Dörrenbächer & Geppert, 2017). While MNC activities have positive impacts on countries, they also have some negative impacts on the economy, income distribution, other social issues, and the environment (Chen, 2004). The negative situations in the regions where MNCs operate have led international organizations, media, human rights groups, social investors, and consumers, as well as some corporate executives, to discuss the responsibility of MNCs (Bennett, 2002). One of the most important of these debates is the impact of MNCs on Sustainable Development Goals (SDG) efforts in the countries where they operate.

One can argue that there is a need for further research on institutions with international influence, especially MNCs, in achieving the SDGs (Teekasap & Frutos-Bencze, 2022). From another perspective, the realization of the SDGs requires contributions from

governments, businesses, civil society, and academic researchers alike (Rygh et al., 2022). Research on MNCs and SDGs in the same framework is therefore important (Teekasap & Frutos-Bencze, 2022). However, in international business research, the role that MNCs can play in achieving the SDGs has not yet received due attention from researchers (Ghauri, 2022; van Zanten & van Tulder, 2018). It therefore remains unclear to what extent companies are contributing to solving the challenges related to the SDGs (van der Waal et al., 2021). The most important of these uncertainties is the impact of MNCs on environmental degradation and climate change (Irogbe, 2013). The environmental responsibility of MNCs has recently attracted considerable attention from academia (Peng et al., 2023) and the critical role played by MNCs in combating climate change is considered among the top research priorities by academics (Leonidou et al., 2024; Roth & Kostova, 2003). The climate change issue is a fertile area where theories of international business can be tested and new theoretical insights into the dynamics of the interaction between MNCs and their environments can be uncovered (Kolk & Pinkse, 2022). Nevertheless, studies in this field are quite limited in the literature. Climate change is an under-researched topic in the international business (IB) literature because it is an inherently challenging area and there is a lack of systematic country-specific data on MNCs (Kanagaretnam et al., 2022; Kolk & Jonatan, 2012).

Multinational corporations, which drive a large portion of global economic activity, are seen as key actors in the sustainable development processes of host countries through capital and technology transfer. However, the expanding operational footprints of these companies can weaken efforts to combat climate change by increasing carbon emissions. This creates a significant dilemma for policymakers. The dilemma is this: “Does the economic value provided by multinational corporations support host countries' climate commitments, or does it undermine them?” There is an ongoing tension in the academic literature regarding this question. On one side, proponents of the “Pollution Paradise Hypothesis” argue that multinational corporations transform countries with weak environmental regulations into pollution havens by relocating their pollution-intensive production processes there. On the other hand, proponents of the “Pollution Halo Hypothesis” argue that the green technology and management practices brought by these companies improve the environmental performance of local firms.

Existing studies in the literature generally focus on corporate-level environmental reporting or direct foreign investment flows, and empirical evidence examining the macro-level relationship between the value added created by multinational companies and countries' objective climate action performance is limited. While the existing empirical literature is replete with theoretical discussions on the impact

of MNCs on climate action, a critical gap exists in the form of a lack of large-scale quantitative studies containing numerous observations that isolate the net effect of the activities of US-based multinational corporations in highly integrated European economies on the host country's climate action scores.

This study addresses this specific gap by analyzing the impact of the value added provided by US-based multinational corporations to selected European countries on these countries' climate action scores during the period 2009–2022. Thus, by empirically testing opposing theoretical approaches in the literature, such as Pollution Paradise and Pollution Halo, it aims to contribute to the debate on the role of MNCs in climate change from a new quantitative, macroeconomic perspective. The study first examines theoretical discussions in the literature addressing the economic, social, and environmental impacts of MNCs and their contributions to the SDGs. The second section discusses existing theoretical approaches and hypotheses (Pollution Paradise and Pollution Halo) regarding the effects of MNC activities on host countries' climate actions. The third section explains the data sources, criteria, and empirical model. The fourth section analyzes the relationships between the added value provided by US MNCs to European countries and the SDG 13 scores of the respective countries and presents the findings. These findings support the Pollution Haven hypothesis, which suggests that MNCs may increase environmental risks by shifting their pollution-intensive activities to countries. Finally, the fifth section summarizes the results and discusses implications for MNCs and policymakers.

2. Climate change, sustainable development goals, and multinationals

Climate change is one of the long-term global environmental challenges that increasingly attracted the attention of the business community in the 1990s (Kolk & Pinkse, 2005; Montiel et al., 2021; Tol, 2009). Climate change is transnational in nature, not local (Schotter & Goodsite, 2013) and is linked to the fate of the planet more broadly, with implications beyond purely environmental dimensions (Kolk & Pinkse, 2022). Climate change is global in its origin and impacts, which necessitates that an effective fight against it must be organized at the global level and involve international understanding and cooperation (Stern, 2008). Governments, politicians, and scientists feature prominently in the popular discourse on climate change, while business organizations are less prominent. The contemporary economic order, however, is dominated by MNCs, which exert significant influence on governments, public policies, and communities (Wright & Nyberg, 2015). Companies, and MNCs in particular, are therefore at the center of this challenge (Wright & Nyberg, 2017). Business is a major contributor to the rising greenhouse gas emissions that drive climate change. Meanwhile, businesses are contributing to climate change

mitigation and adaptation by using renewable energy and developing and implementing new low-carbon technologies. No one business is solely responsible for climate change, but ultimately all businesses are affected (Martinuzzi & Schönherr, 2019). Increasingly unfavorable climatic conditions are creating systemic risks for companies in the global economy (Huang et al., 2018). This picture begs the question, what is the role of businesses in worsening climate conditions? This question has also led to the emergence of the "double materiality" approach, which has become increasingly important in recent years and has been integrated into international sustainability regulations.

Sustainable development is a central concept today. It is both a way of understanding the world and a way of solving global problems (Sachs, 2015). The United Nations SDGs were adopted by all UN member states in 2015 and adopted by many MNCs and international non-governmental organizations (van Tulder et al., 2021). The Goals are a universally applicable framework for business that can guide companies (Martinuzzi & Schönherr, 2019). Coordinated and collective efforts of governments, society, and MNCs are required to achieve these goals (Ghauri, 2022; Yiu & Saner, 2017). The United Nations 2030 Agenda for Sustainable Development also emphasizes the central role of the private sector in implementing the SDGs (McIntyre et al., 2022). However, the role of MNCs in sustainable development is one of the most controversial issues among scholars (Abdul-Gafaru, 2009).

In terms of MNCs, these companies have realized that they have an important role to play in protecting the environment in the 21st century and that they live in an increasingly fragile global environment (Ewing-Chow & Soh, 2009). Besides, this realization has raised several questions. In particular, the recent transformation of climate change into a climate crisis has increased the interest in the international business literature to the question: Can MNCs save sustainable development, to what extent, and under what conditions (van Tulder et al., 2023)? Some of the other questions on the agenda are: Can MNCs make a significant contribution to solving climate change (Kolk & Pinkse, 2022)? Do MNCs contribute to development and poverty reduction in the countries where they operate (Ghauri & Wang, 2017)? How MNCs do or do not contribute to global prosperity (Foley et al., 2021)? How a multinational company is addressing the SDGs (Hauska, 2019)? Are MNCs a force for good in promoting environmental sustainability in developing countries? Does increased multinational investment necessarily lead to environmental sustainability (Abdul-Gafaru, 2009)? What impact MNCs are already having on climate change, both through their operations and through emissions from their supply chains (Steenbergen & Saurav, 2023)? When those and similar questions are simultaneously considered from an SDG and climate perspective, the following picture emerges. While international business (IB) researchers are currently debating whether it is the responsibility of

MNCs to contribute to the SDGs (Ghauri, 2022), there is a growing sentiment that MNCs should increasingly take responsibility for finding solutions to this problem (Anjanappa, 2023). It is undeniable that MNCs have a significant impact on climate change (Comyns, 2018). Reflecting this, SDG 13, summarized under the label "Take urgent action to tackle climate change and its impacts", pushes businesses to set ambitious emission reduction targets and decarbonize their operations (Findler, 2019).

3. Literature and Hypothesis development

Although interest in the social and environmental impacts of MNCs is not new, it seems to have increased again due to climate change. MNCs are increasingly being asked to play a positive role in this regard and thus contribute to sustainable development (Kolk & van Tulder, 2010). However, MNCs can play a positive or negative role in promoting sustainability and finding solutions to climate change (Afriyie & Zahoor, 2023). MNCs can provide an important contribution to efforts to tackle global climate change (Donoher, 2017). This contribution suggests that MNCs may be the most important catalysts for sustainable development. Neoliberal theorists also argue that MNCs are the key to achieving sustainable development through the transfer of modern technologies, financial resources, and management skills (Abdul-Gafaru, 2009; Randaccio, 2012).

MNCs need to be part of the solution in the fight against climate change as articulated by investors and consumers, reducing emissions within their operations and supply chains (López et al., 2019). This is because the first of the roles that MNCs play concerning climate change is as producers of greenhouse gas emissions (Wright & Nyberg, 2015). There is a consensus that MNCs can play an important role by investing in reducing greenhouse gas emissions, which are critical to the climate crisis (Stadelmann & Gangneux, 2022).

The pace of climate change can be slowed if MNCs, as major economic actors, succeed in reducing their greenhouse gas emission levels (Chakrabarty & Wang, 2013). A recent report by World Bank Invesment Environment Unit indicates that climate change mitigation efforts could be fundamentally jeopardized if MNCs fail to significantly accelerate decarbonization actions (Haddad et al., 2023). It is indisputable that MNCs should be involved in finding solutions, not only because they are major contributors to greenhouse gas emissions, but also because of the nature of the climate change problem as a global common challenge that requires international cooperation of multiple actors, including MNCs (Oyson, 2015). This is why the international community needs to harness the power of MNCs to tackle climate change (Patchell & Hayter, 2013).

In practice, many MNCs are taking steps to adapt their operations to climate change (Abara et al., 2023). The majority of MNCs include

these steps in their sustainability reports within the framework of SDGs. Besides, the quality of these reports is currently poor and not adequately assured (Hauska, 2019). However, most MNCs continue to contribute to worsening environmental and social outcomes (Sachs & Sachs, 2021). This situation highlights the importance of policy tools such as green taxes, financial development, and foreign direct investment, along with the rigidity of environmental taxes and the advancement of green technologies. Green taxes can contribute to reducing greenhouse gas emissions by limiting the shift of MNCs' pollution-intensive activities to countries with low regulations (Rasoulinezhad, 2025; Wang & Pang, 2025). Financial development can strengthen climate action by creating an economic infrastructure that interacts with technological innovation capacity and regulatory frameworks, enabling MNCs to manage their environmental impacts and support sustainable investments (Estrada et al., 2010; Ketchoua et al., 2024). Similarly, in economies with strong financial and environmental regulations and advanced financial instruments and green finance, promoting green growth through foreign direct investment can play a critical role in aligning the activities of MNCs with SDG 13 targets (Phung et al., 2023; Shi & Shi, 2025). Recent studies also suggest that MNCs' investments in green technologies can improve their environmental performance and limit the effects of the pollution halo and pollution haven hypotheses in contexts with high carbon emissions or intense state ownership (Dogan Basar et al., 2025; Tunçel et al., 2025).

There are limited studies in the literature that address the concepts of MNCs and SDGs together and reveal how MNCs strive to achieve the SDGs (Anjanappa, 2023; DasGupta et al., 2022; Kolk et al., 2017). Considering both the limited literature on the role of MNCs in achieving the SDGs and the content of corporate websites and the opinions of academics, it is seen that the most frequently examined SDGs are "responsible consumption and production", "end poverty", "peace, justice and strong institutions" and "climate action" (Leonidou et al., 2024).

In one of the limited number of studies that quantitatively examine the impact of MNCs (especially US MNCs) on the SDGs (Neme Castillo & Chiatchoua, 2022), US MNCs operating in developing countries have a positive impact on poverty reduction. Similarly, DasGupta et al. (2022) argue that the degree of internationalization of MNCs has a positive impact on the adoption of SDGs. Furthermore, they state that country-specific SDG scores positively affect the relationship between MNCs' internationalization and their SDG participation. Abdul-Gafaru (2009), examining the impact of MNCs on the climate action goal, found that despite their ability to implement higher environmental standards, their actual contribution to environmental sustainability in developing countries remains minimal. In parallel to this study, Chakrabarty & Wang (2013) conclude that the

impact of MNCs' actions to combat climate change on return on equity is positive but not statistically significant. Considering the results of the limited studies, it is possible to say that the impact of MNCs on the SDGs in the countries where they operate is complex. In support of these complex effects, Dörrenbächer et al. (2024) note that the limited number of studies on the subject is evenly distributed across studies investigating the positive and negative contributions of MNCs to the SDGs.

The positive or negative contributions of MNCs to the SDGs can be explained by two different theories: the Pollution Paradise Hypothesis and the Pollution Halo Hypothesis. The Pollution Paradise Hypothesis states that firms with pollution-intensive processes move from high-income countries with strict environmental regulations to countries with weaker environmental regulations. As a result, the countries of destination are considered to have become "pollution havens" where rich countries relocate environmentally harmful industries. The Pollution Halo Hypothesis, by contrast, argues that firms in high-income countries can reduce pollution in the host country because their production relies on greener technologies. Thus, the diffusion of environmentally friendly practices improves the environmental performance of domestic firms (Steenbergen & Saurav, 2023). However, despite the richness of these theoretical discussions, the existing literature generally examines the contribution of MNCs to SDGs through company-level case studies, discourse analysis, or corporate reporting. Therefore, quantitative, large-scale empirical studies linking the impact of MNCs' activities on host countries' SDG performance to macroeconomic indicators such as value added are limited. In light of all this information, our study fills this quantitative empirical gap and presents the hypothesis formulated below to test the two opposing approaches mentioned above at the macro level.

H_1: The value added created by US MNCs in the countries where they operate affects their climate action performance.

4. Data and Methodology

To test the hypothesis formulated for the study, the value-added data of the countries in which US MNCs have the most investments in Europe (Austria, Belgium, Czech RepublicDenmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Russia, Spain, Sweeden, Switzerland, Türkiye and United Kingdom) and the SDG 13 scores of the relevant countries are considered. The value-added figures for MNCs are taken from the Activities of U.S. Multinational Enterprises (MNEs) section of the Bureau of Economic Analysis database. The data on the value added created by U.S. MNEs in 22 European countries between 2009 and 2021 were used in this study. Therefore, 286 observations

consisting of 13 years of data from 22 European countries are included in the analysis. Baltagi (2013) stated that similar cases where the unit size (N) is larger than the time dimension are called micro panels. However, it is possible to come across studies that perform panel data analysis with micro panel sets in the literature (Wasara & Ganda, 2019; Partalidou et al., 2020). The SDG 13 information of the European countries considered in the study was obtained from the Sustainable Development Report in the SDG Transformation Center. The mathematical model created based on the organized data is presented Equation (1).

$$sdg_{i,t} = \beta_0 + \beta_1 logva_{i,t-1} + \beta_2 logrde_{i,t-1} + \beta_3 gdp_{i,t-1} \quad (1)$$

where $sdg_{i,t}$ is the SDG 13 score of country *i* in period *i*, $logva_{i,t-1}$ is the logarithm of the value added of US MNCs in country *i* in period *t-1*, $logrde_{i,t-1}$ is the logarithm of research and development (R&D) expenditures of US MNCs in country *i* in period *t-1*, and $gdp_{i,t-1}$ is the gross domestic product (GDP) growth rate of country *i* in period *t-1* (annual %). Since value-added and R&D consist of amounts, it was decided to take their logarithms. Hence, a semi-logarithmic model is constructed.

5. Empirical results

Table 1 shows the descriptive information of the variables before the analysis of the model in Equation (1), which was created for the study. There are differences in the number of observations of the variables. This is because the value added for Luxembourg for 2018 and 2019 is negative (excluded from the analysis due to the inability to perform logarithms) and the R&D expenditures for Luxembourg in 2009, 2010, 2011, and 2013 and for Türkiye in 2012 and 2013 are missing. It is possible to say that all variables are not distributed in a large range, especially when the minimum and maximum values are analyzed in Table 1. This also shows that the natural logarithmic transformation of the value-added variable (va) and the R&D expenditure variable (rde) is appropriate. Table 2 shows the correlation and variance inflation factor (VIF) values between the variables.

Table 1. Descriptive statistics

	Obs	Mean	Min	Max
SDG	286	63.938	17.575	87.436
va	284	9.586	7.074	12.172
logrde	280	6.163	2.89	9.12
GDP	286	1.436	-11.167	24.475

Table 2 shows that all of the correlation values are significant. Accordingly, it can be said that there is a negative correlation between SDG and va and rde variables and a positive correlation between pop. In addition, it was found that there were positive correlations between va and rde and pop as well as between rde and pop. In particular, the 85.17% correlation between va and rde indicates a multicollinearity problem. However, when the VIF values are examined, the average VIF is 2.77 and all VIF values are less than 5, indicating that there is no dichotomy problem.

Table 2. Correlation and VIF values

	SDG	**logva**	**logrde**	**GDP**	**VIF**
SDG	1.0000				
logva	-0.2151*	1.0000			3.64
logrde	-0.2755*	0.8517*	1.0000		3.65
GDP	0.5718*	0.1210*	0.1294*	1.0000	1.02
Mean VIF					2.77

* $P < 0.05$

The structure of the model in Equation (1) is a panel data structure. Therefore, first, model selection was performed with both Hausman and Hausman-Resistant tests. The test values obtained as a result of the tests were 0.6712 and 0.9357, respectively. According to these values, it is determined that the random effects model is appropriate. The results of the assumption tests (normality, heteroskedasticity, autocorrelation, and cross-section dependence) calculated with the random effects model are calculated as in Table 3.

Table 3. Assumption tests

		Test value	***P* value**
Normality	Units	2.46	0.2919
	Residuals	1.71	0.4256
Heteroskedasticity	W0	11.8794924	0.00000000
	W50	3.8104656	0.00000016
	W10	10.4294225	0.00000000
Autocorrelation		0.45891704	
		0.72686607	
Cross section dependence		16.638	0.0000

Table 3 shows that according to the D'Agostino, Belanger, and D'Agostino (1990) normality test, normality is ensured for both units and residuals. Levene-Brown-Forsythe test for heteroskedasticity (Brown & Forsythe, 1974), which is one of the assumptions that impair the efficiency of panel regression analysis, is performed. According to the results obtained, the presence of heteroskedasticity is detected. Bhargava , Franzini Narendranathan, and Durbin-Watson's (1982) tests

for autocorrelation, which impairs the efficiency of panel regression, show that there is autocorrelation in the data. Finally, the Peseran CD test was performed to test the cross-section dependence assumption, and cross-section dependence was found. No assumptions that impair the efficiency of the panel regression are realized. For these situations, one of the recommended estimators for datasets with micro panel characteristics (N>T) is the Driscoll and Kraay estimator. The most important feature of this estimator is that it can be used not only in classical (OLS) models but also in fixed and random effects models (Driscoll & Kraay, 1998; Tatoğlu, 2020). Coefficient estimates are therefore made with the Driscoll and Kraay estimator, which is used when the assumptions are not met. The results obtained are summarized in Table 4.

Table 4. Driscoll and Kraay Estimators

	Coefficients	**Drisc/Kraay Std. Err.**
logva	-1.176854**	0.2470684
logrde	0.7135723***	0.3666232
GDP	0.1916825*	0.0762567
Prob > chi2	0.0000	
R^2	0.1019	

* $P<0.01$, ** $P<0.05$, *** $P<0.1$

According to the results obtained, it is possible to say that the model introduced in Equation (1) is significant. However, it is concluded that the value added (logva) created by US MNCs in the countries where they operate negatively affects the climate action performance (SDG) of the countries. R&D expenditures (logrde) and gdp growth (GDP), which are included in the model as control variables, have a positive effect on climate action.

6. Conclusion

The results of our research in the light of the data taken as basis in the study show that there is a significant negative relationship between the value added created by US MNCs in the countries where they invest and the SDG 13 score of that country. This result confirms the pollution haven hypothesis stated in the literature (Steenbergen & Saurav, 2023) and justifies environmentalists (Abdul-Gafaru, 2009) who are pessimistic about the contribution of MNCs to the protection of the natural environment. Therefore, our study contributes to the limited literature, which is generally dominated by company-level case studies and reporting, by offering a quantitative analysis perspective based on macroeconomic indicators (value added) regarding the impact of MNCs on SDGs and SDG 13 Climate Action.

7. Recommendations

7.1. Recommendations for MNCs

While the responsibility of MNCs towards the environment is well known, this responsibility has increased from the past to the present (Farha, 1990). In doing so, MNCs should follow a proactive path that will add value to environmental management rather than a "do no harm" approach when managing their impact on the environment (Yiu & Saner, 2017). Accordingly, MNCs can use their economic power and influence to enhance the impact of the SDGs (Nylund et al., 2021). To this end, MNCs should focus on SDGs where they can intervene without worsening others (Celone et al., 2022), integrate corporate social responsibility into their primary business strategies (Khan et al., 2021), and focus on clean energy technologies (Pinkse & Kolk, 2009).

Numerous MNCs are committed to reducing their environmental impact but face several challenges in doing so. Among these challenges are lack of awareness, lack of data and measurement, short-term focus, uncertainty and complexity, lack of government support, and internal organizational barriers (Anjanappa, 2023). As a solution, depending on the geographical, commercial, and political characteristics of the countries in which they operate, MNCs can adopt a local/regional approach and try to capture the environmental benefits of these elements. They can also apply the OECD Guidelines for Multinational Enterprises, updated in 2023, which expand and strengthen expectations for environmental due diligence and disclosure obligations for MNCs, including on climate change and biodiversity (Ahn, 2024; Aristova et al., 2024).

7.2. Recommendations for policy makers

MNCs alone cannot contribute to the effective realization of the SDGs (Hauska, 2019). Adapting to climate change, especially within the framework of SDG 13 Climate Action, requires the participation of all actors in society (Averchenkova et al., 2016) and requires joint efforts and regulatory guidance from government bodies, international organizations, and local actors, especially MNCs (Väätänen & Teplov, 2017; Wright & Nyberg, 2017). On the other hand, it is important to understand the positive roles that MNCs can play in climate change and the factors that can influence their behavior to help political, economic, social, and regulatory bodies make the right strategic decisions (Ivanaj et al., 2017).

MNCs can contribute to climate action in developing countries by financing projects related to the SDGs that will help them improve their competitive position and global image in the long run. Many companies are already capitalizing on these opportunities and financing infrastructure projects in these markets (Ghauri, 2022). Host country governments should establish performance-based conditionality mechanisms for investment incentives and subsidies directed at MNCs,

linking a specified percentage of the economic value added provided by the company to the country directly to SDG 13 Climate Action criteria such as reducing operational carbon intensity. On the other hand, MNCs with high levels of R&D expenditures have a great ability to produce technologies that contribute to controlling environmental pollution and climate change (Gonenc & Poleska, 2023). A suitable investment environment can be created for companies with this capability.

By supporting MNCs, governments can play an important role in contributing to SDG 13 (Anjanappa, 2023) and policymakers can support MNCs to align their strategies with the SDGs (Liou & Rao-Nicholson, 2021). Considering the sectoral heterogeneity revealed by the findings, rather than treating all foreign investments equally, stricter regulatory frameworks should be applied to specific sectors or regional clusters within the framework of the Pollution Haven approach, which will prevent multinational companies from shifting their pollution-intensive operations to low-regulation regions. As can be seen, government officials and policymakers who are tasked with taking active measures to halt or mitigate the effects of climate change must fulfill their responsibilities (Amaefula, 2022). Governments can and should do more to encourage MNCs to decarbonize their supply chains, facilitate green investments, and support the transition to a low-carbon industrial structure (Haddad et al., 2023; Steenbergen & Saurav, 2023). To this end, governments can encourage sectors to participate in the SDGs and organize the necessary infrastructure and legal framework (Song et al., 2022). Here, the main challenge for policymakers is to transform MNCs, often a short-term profit-oriented actor, into an actor that is also committed to long-term SDGs (Ewing-Chow & Soh, 2009).

MNCs often behave as if the rules we all follow do not apply to them (Foley et al., 2021). First of all, it is important to correct this increasingly widespread understanding. While MNCs have enjoyed significant investment rights and reaped huge benefits, they have also made a significant contribution to the climate crisis. But they do not bear enough responsibility in return. The huge gap between benefits and liability persists due to ineffective international regulation (Ma, 2023). According to Porter (1999), and Abdul-Gafaru (2009), the fear that MNCs will move their operations out of the country where they invest and the calculation of its impact on national economies may affect the degree to which countries are willing to impose strict environmental regulations on MNCs. To overcome the reluctance of individual countries to implement strict environmental regulations due to fears of capital flight, it is necessary to establish binding regulations that raise the environmental standards of multinational corporations and ensure their enforcement through international platforms such as the EU or OECD. By implementing and enforcing such regulations, the negative impact of MNCs on climate change can be mitigated. Besides, a solution can be considered as preventing MNCs that use support for the

SDGs within the framework of "greenwashing" (van Tulder et al., 2023) and imposing the necessary sanctions. In this context, transparency laws that are independently audited and include severe financial and legal penalties should be implemented immediately to deter 'greenwashing' attempts and eliminate inconsistencies between corporate statements regarding SDGs and actual performance. All these observations become more meaningful when evaluated within the framework of the findings of our study.

The limitation of the study is that it only covers US-based multinational companies and, due to data access constraints, the findings cannot be directly generalized to other country groups. In terms of future studies, the validity of our model can be tested for MNCs headquartered in other countries, such as European MNCs. Alternatively, research in the future could proceed further and different findings could be obtained by differentiating between developing and emerging countries. Finally, by including other SDGs besides SDG 13 separately in the models, the impacts of MNCs beyond climate action can be tested, and different climate indicators with reliable and uninterrupted data can also be used in the analyses.

Conflict of interest

The authors declared no conflicts of interest.

Authors' contributions

All authors contributed to the original idea, study design.

Ethical considerations

The authors have completely considered ethical issues, including informed consent, plagiarism, data fabrication, misconduct, and/or falsification, double publication and/or redundancy, submission, etc. This article was not authored by artificial intelligence.

Data availability

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

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