

Radboud Universiteit



**Nijmegen School of Management
Department of Economics and Business Economics
Master's Thesis Economics (MAN-MTHEC)**

How Does Inward FDI Affect CO2 Emissions? A Cross-Country Panel Analysis of the Moderating Effects of Regulatory Quality and Environmental Policy Stringency

Talitha Teunissen (s1059353)

Nijmegen, 27 June 2024

Program: Master's Program in Economics
Specialisation: International Business
Supervisor: Prof. dr. A.A.J. van Hoorn

Abstract

This thesis investigates the impact of Foreign Direct Investment (FDI) inflows on carbon emissions, with a particular focus on the moderating effects of Regulatory Quality and Environmental Policy Stringency (EPS). The thesis examines data from 33 countries, primarily OECD members, over the period from 1990 to 2020. A panel data analysis using a fixed-effect model is employed. The findings indicate that higher FDI inflows lead to an increase in CO₂ emissions. However, in countries with a high EPS, FDI inflows increase emissions less or may even lead to a decrease in emissions and an improvement in environmental quality. This latter result also holds true for countries that participate in more international environmental agreements, as examined in a larger sample of 163 countries worldwide. The results highlight the importance of investing in stringent environmental policies to mitigate environmental degradation.

Table of Contents

1	Introduction.....	4
2	Literature review and hypotheses development.....	7
2.1	The effect of FDI on emissions	7
2.2	Regulatory quality and the polluting effect of FDI.....	9
2.3	Environmental policy and the polluting effect of FDI	11
2.4	Conceptual model	12
3	Data and method.....	13
3.1	Data sources and sample	13
3.2	Variables and measures	14
3.2.1	Dependent variable.....	14
3.2.2	Explanatory variables	15
3.2.3	Control variables	17
3.3	Summary statistics	19
3.4	Empirical approach.....	23
4	Results	26
4.1	Baseline results.....	26
4.2	Robustness checks.....	30
4.2.1	Addressing autocorrelation.....	30
4.2.1.1	Analysis with Driscoll-Kraay standard errors.....	30
4.2.1.2	Analysis with lagged EPS.....	31
4.2.2	International environmental agreements as alternative measure of EPS.....	34
4.2.3	Analysis with sample including only OECD countries	38
4.2.4	Alternative measures for emissions.....	39

4.2.4.1	Renewable energy consumption as alternative measure for emissions.....	39
4.2.4.2	Greenhouse gas emissions as alternative measure for emissions.....	40
5	Discussion	42
5.1	Findings and contributions.....	42
5.2	Limitations and future research	44
6	Conclusion	46
	References	47
	Appendices.....	56
Appendix A: Figures		56
Appendix B: Included countries		57
Appendix C: OLS.....		60
Appendix D: Tests		64
Appendix E: Explanation international environmental agreements		65

1 Introduction

The world economy is currently confronted with challenges related to climate change and the rise in carbon emissions (Mills et al., 2019). The increasing trend in carbon emissions worldwide, due to globalization, poses a threat to global environmental sustainability. Foreign direct investment (FDI), a feature of economic globalization, has gathered a lot of attention due to its significant contribution to carbon emissions (Farooq et al., 2022). FDI is a crucial driver of economic growth (Olofsdotter, 1998), however, alongside the benefits, there are environmental concerns (Lee, 2013). Therefore, it is essential to understand the direct relationship between FDI inflows and emissions.

Currently, globalization, FDI, and environmental quality have received much attention in connection with the pollution haven hypothesis. Essentially, this hypothesis suggests that firms relocate their operations to less developed countries to benefit from less strict environmental regulations, contributing to an increase in emissions (Mabey & McNally, 1999). On the other hand, the halo hypothesis suggests that FDI brings expertise and environmental laws and standards to the host countries, resulting in a shift of environmental degradation to environmental sustainability (Mert & Çağlar, 2020).

There is an ongoing debate about the impact of FDI on environmental quality, primarily centered on these two competing hypotheses: the pollution haven hypothesis and the halo hypothesis. However, research also indicates that both hypotheses may not fully capture the complexities of the impact of FDI inflow on emissions (Boamah et al., 2023). Indicating that FDI inflow can both have increasing and decreasing effects on emissions, suggesting that the impact of FDI is not straightforward and depends on various factors. This complexity shows the need to investigate the conditions under which FDI reduces or increases emissions. This thesis aims to reconcile the pollution haven and halo hypotheses, and provide recommendations for governments aiming to achieve sustainable development goals.

Attention has already been given to investigating the direct impacts of FDI inflows on carbon emissions, but there has been limited focus on examining the indirect effects. Given the ongoing debate, there is a growing recognition of the importance of considering these indirect effects.

Globalization extends beyond economic aspects, with spillovers encompassing norms, skills, and activities. Political institutions contribute to shaping the dynamics of globalization through their involvement in international negotiations (Farooq et al., 2022). Research has already identified the broad indirect effect of institutional quality on the relationship (Hayat, 2019; Khan et al., 2022). Moreover, strong institutional quality motivates and empowers domestic firms to react to foreign firms entering the country, fostering the spillover effect of FDI (Hayat, 2019). Where the involvement of institutional quality can contribute not only to economic growth but also to the environmental performance of the country (Wang et al., 2021). So it is stated that institutional quality is important in the relationship. Nevertheless, a gap remains in the literature regarding the specific mechanisms through which different types of institutions influence the relationship between FDI inflows and carbon emissions.

To address this gap and contribute key knowledge to the literature, the primary aim of this thesis is to examine how specific types of institutions, namely governmental quality, environmental policy stringency, and international environmental agreements, moderate the relationship between FDI inflows and carbon emissions across countries worldwide. Focusing on these specific types of institutions is crucial because institutional quality is a broad concept. Regulatory quality is a critical factor that influences carbon emissions (Huang et al., 2022). It is more specific and allows for a closer examination of how regulations impact FDI and environmental outcomes. Environmental policy stringency is another critical factor. EPS, recently updated in 2021, provides a comprehensive measure of how strict environmental regulations are in a given country. The latest version of the EPS includes three subindices: market-based policies, non-market-based policies, and technology support policies (Kruse et al., 2022). This updated index offers new insights into how varying degrees of policy stringency affect the environmental impact of FDI, thereby adding knowledge to the existing scientific knowledge. Investigating the role of international environmental agreements also provides key knowledge by offering a better understanding of the global commitments that shape national policies and their enforcement. Aiming to mitigate carbon emissions while promoting FDI.

This thesis aims to explore the impact of FDI inflows on carbon emissions through an alternative channel, considering the moderating influence of regulatory quality and environmental policy stringency. The research encompasses 33 countries in the time frame from 1990 to 2020. A moderating effect between FDI and participation in selected international environmental agreements is investigated as an alternative operationalization measurement. Whereby a larger sample of 163 countries worldwide, covering the same period from 1990 to 2020, is included in this research. Exploring how these moderating effects influence FDI in promoting environmental sustainability can offer valuable lessons for policy regulations, guide international investment strategies, and give insights into the broader context of environmental and economic balance. Addressing the global issue: fostering economic development without decreasing environmental sustainability.

The structure of the thesis for the remainder of its content is organized as follows: Following this introduction, the subsequent section addresses previous literature, from which three hypotheses emerge. Thereafter, the methodological approach of the thesis is discussed. Chapter 4 presents and elaborates on the results. Finally, the conclusion and discussion, along with the limitations and suggestions for future research, are provided in Chapters 5 and 6.

2 Literature review and hypotheses development

This chapter examines empirical findings and various theories concerning FDI and its impact on emissions. It starts with explaining the pollution haven and halo hypotheses, which shape FDI decisions. Additionally, it explores the theory of technology spillovers. Subsequently, attention is directed towards institutional quality as a moderating factor in this relationship, with a focus on regulatory quality due to the broad nature of institutional quality. Following this, the moderating effects of specific environmental policies are examined, particularly environmental policy stringency and the participation in international environmental agreements of a country. In total, three hypotheses will be formulated. The last part of this section presents the conceptual model, to enhance clarity.

2.1 The effect of FDI on emissions

While many researchers have examined the relationship between FDI and economic growth (Johnson, 2006; Olofsdotter, 1998), there has also been a growing body of literature focusing on the role of FDI inflow on carbon emissions (Lee, 2013; Wang et al., 2021). The relationship between FDI and environmental quality can be categorized into two groups: the pollution haven hypothesis and the pollution halo hypothesis. The pollution haven hypothesis suggests that firms relocate their operations to less developed countries to benefit from less strict environmental regulations (Mabey & McNally, 1999). Leading to an increase in carbon emissions. Conversely, the pollution halo hypothesis occurs when international enterprises, equipped with management skills and advanced technology, provide strict environmental standards and regulations in host countries (Mert & Çağlar, 2020). Eventually leading to a decrease in emissions.

The pollution haven hypothesis and the halo hypothesis offer contrasting perspectives on the relationship between FDI and environmental emissions. In line with the halo hypothesis, different studies conclude that the inflow of FDI helps to promote energy efficiency in host countries (Eskeland & Harrison, 2003; Mielnik & Goldemberg, 2002). In addition, technology spillovers from FDI contribute to emissions reductions in FDI destinations (Lin et al., 2022). These spillovers involve the transfer of advanced technologies and management practices by MNEs,

resulting in increased environmental efficiency and a decrease in emissions. On the other hand, there are also many significant results where an increase in emissions follows FDI inflows, supporting the pollution haven hypothesis (Sapkota & Bastola, 2017; Singhania & Saini, 2021). Companies in developed countries might relocate their polluting industries to countries with lax environmental regulations. In this way, countries avoid stricter regulations and associated costs, but this shift in production often comes with a high environmental price for the host nation, experiencing a significant rise in emissions. Another reason is that developing countries with high levels of FDI inflow prioritize economic growth over environmental sustainability (Shahbaz et al., 2015). The environmental regulations are getting relaxed enforcement or even non-enforcement. Even if the regulations exist, developing countries might lack the infrastructure and technology for cleaner production processes, further contributing to increased emissions. So, while some evidence suggests that FDI may worsen emissions, there is also significant support for the idea that FDI can contribute to emission reduction. However, there is also research that states that both the pollution haven and halo hypotheses are not valid and that FDI inflow can have both an increasing and decreasing impact (Boamah et al., 2023).

With numerous divergent findings in the literature regarding the opposing theories of the effect of FDI on emissions, the conclusions have not come to a consensus. Theoretically, the relationship between FDI inflow and environmental quality can either lead to an increase or decrease in emissions, depending on the country's characteristics. This thesis aims to revisit the opposing hypotheses and settle the debate through the investigation of the direct impact of FDI. Consequently, it is anticipated that the net effect of FDI on emissions may approximate zero. However, when considering all countries collectively, it is expected that the pollution haven activities, particularly in less developed countries, could result in a modest overall expected increase in emissions. Thus, an increase in FDI inflow is expected to lead to higher levels of carbon emissions and lower environmental quality. This leads to the formulation of Hypothesis 1:

H1: Greater FDI inflows result in an increase in CO2 emissions

2.2 Regulatory quality and the polluting effect of FDI

High-quality institutions serve as a comparative advantage for a country, contributing to efficiency and promoting economic growth. At the same time, a well-designed institutional framework for the distribution of regional resources leads to enhanced resource allocation efficiency and an increase in environmental quality (Qiu & Chen, 2020). Research has stated that institutional quality contributes to an improvement in environmental quality by mitigating the polluting effects of FDI inflows (Bakhsh et al., 2021; Karim et al., 2022; Udemba, 2021). Using six indicators to measure institutional quality: voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption. Included in the Worldwide Governance Indicator (WGI) (Kaufmann & Kraay, n.d.).

However, institutional quality is a broad concept, and only specific types of institutions serve as moderators in the relationship between FDI inflows and emissions. Among these, regulatory quality is considered a critical factor influencing carbon emissions (Huang et al., 2022). The effectiveness of regulations determines how well environmental rules are followed, shaping industrial behaviour and their impact on emissions. Research found that regulatory quality has a significant effect on emission reduction (Lau et al., 2014; Samimi et al., 2012). Higher quality levels of regulations may mitigate the effects of FDI inflows on carbon emissions (Huang et al., 2022; Karim et al., 2022). However, it is noteworthy that some studies argue that regulatory quality may serve as a poor governance indicator (Khan et al., 2022).

Strong institutions are crucial for implementing and enforcing effective policies that lead to lower CO₂ emissions (Salman et al., 2019; Wawrzyniak & Doryń, 2020). In contrast, weak institutions often fail in enforcement, resulting in higher emissions. Developed countries often have strong environmental laws and effective enforcement mechanisms. While developing countries face challenges with weak enforcement and high levels of corruption, which can undermine the effectiveness of environmental policies (Harring, 2014). Therefore, the ability of the government to implement and enforce regulations is crucial. By adopting strategies to strengthen their institutions, countries enhance their regulatory quality, leading to more successful environmental policies and lower emissions.

This thesis examines the interaction between regulatory quality and FDI to determine its impact on environmental performance. This focus is due to the role that policies play in managing and addressing the adverse consequences of FDI. Enhancing regulatory quality can encourage the adoption of clean technologies, thereby supporting environmental quality in countries through both technique and composition effects (Mahmood et al., 2022). This means reducing emissions per unit of output and shifting the economic structure towards less polluting industries (Tsurumi & Managi, 2010). Understanding this interaction is crucial because FDI can have both positive and negative environmental impacts, and strong regulatory frameworks are essential to mitigating environmental harm. High regulatory standards ensure that FDI contributes to sustainable development, while weak regulation may lead to increased pollution.

The second hypothesis states that the relationship between FDI inflows and carbon emissions is influenced by regulatory quality. Specifically, higher regulatory quality mitigates the impact of FDI inflows on emissions. This moderation effect implies that countries with better regulatory quality manage and regulate the environmental impact of FDI inflows more effectively, resulting in a smaller increase, or even a decrease, in CO₂ emissions. Consequently, these countries achieve higher environmental quality compared to countries with lower regulatory quality. Hypothesis 2 is stated as follows:

H2: Greater FDI inflows increase CO₂ emissions more in countries with low regulatory quality

2.3 Environmental policy and the polluting effect of FDI

In recent years, the relationship between trade and the environment has been highly debated among proponents and opponents of trade globalization. The race-to-the-bottom hypothesis states that the increase in global competitiveness of economic resources is expected to lead to a decline in environmental quality, and an increase in emissions (Ibrahim & Law, 2015). As stated in Hypothesis 2 in this thesis, the moderating effect of regulatory quality and FDI is expected to decrease emissions. However, in line with the race-to-the-bottom hypothesis, the effect on the natural environment is expected to be the opposite due to governmental restrictions and environmental policies aimed at preserving short-term economic activity (Sadiqa et al., 2022). The laxity of environmental policy in a host country is a significant determinant of the relationship between FDI and emissions (Kolstad & Xing, 1998). These countries are likely to be preferred locations for pollution-intensive industries, supporting the pollution haven hypothesis.

A counterargument is the so-called gains-from-trade hypothesis, where trade gives rise to the adoption of environmentally friendly production (Ibrahim & Law, 2015). Moreover, the race-to-the-top hypothesis indicates that stringent environmental regulation leads toward green and clean development in the long-run (Sadiqa et al., 2022). Multinational corporations are driven by growing social and environmental responsibilities, and they face increasing pressure to integrate sustainability into their strategies (Bae et al., 2022). Furthermore, multinational corporations with established environmental management and technology can more easily transfer this knowledge to companies in foreign countries. This transfer of knowledge, facilitated by standardized practices, allows for a relatively good flow of expertise from home to host countries. Ultimately, FDI acts as a good way to transfer the policy stringency from the investing country to the host country, which can further stimulate emissions reduction.

To conclude, the level of strictness or effectiveness of policies and regulations implemented by the government to address environmental challenges plays an important role in the relationship between FDI and emissions. Hypothesis 3 considers the environmental policy stringency and is stated as follows:

H3: Greater FDI inflows increase CO2 emissions more in countries with low environmental policy stringency

In this thesis, higher environmental quality is defined as having relatively low carbon emissions. Vice versa, low environmental quality signifies high carbon emissions in a country. When referring to carbon emissions within the context of this thesis, the focus is specifically on carbon dioxide (CO₂). One reason for this choice is the importance of carbon emissions as a crucial environmental issue leading to climate change (Arora & Mishra, 2019). Another factor is that carbon emissions provide an auditable and direct measure of environmental performance, unlike measures such as the ESG index (Bose et al., 2021). The terms ‘carbon emissions’, ‘emission’, and ‘CO₂ emissions’ are used interchangeably. Similarly, in this thesis, ‘FDI’ and ‘FDI inflows’ refer to the same concept of foreign direct investment entering a country’s economy.

2.4 Conceptual model

A conceptual model of the hypothesis of this thesis is shown in Figure 1, providing a visual representation for clarity enhancement. *H1* is denoted by the orange plus sign, indicating an expected increase in emissions. The orange colour represents a decrease in environmental quality for the country. Conversely, the green minus sign associated with *H2*, *H3*, and *H''* indicates that the moderating effects lead to a reduction in emissions, while the green colour indicates an increase in environmental quality. *H''* shows the effect of the alternative operationalization measurement, discussed in Section 4.2.3.

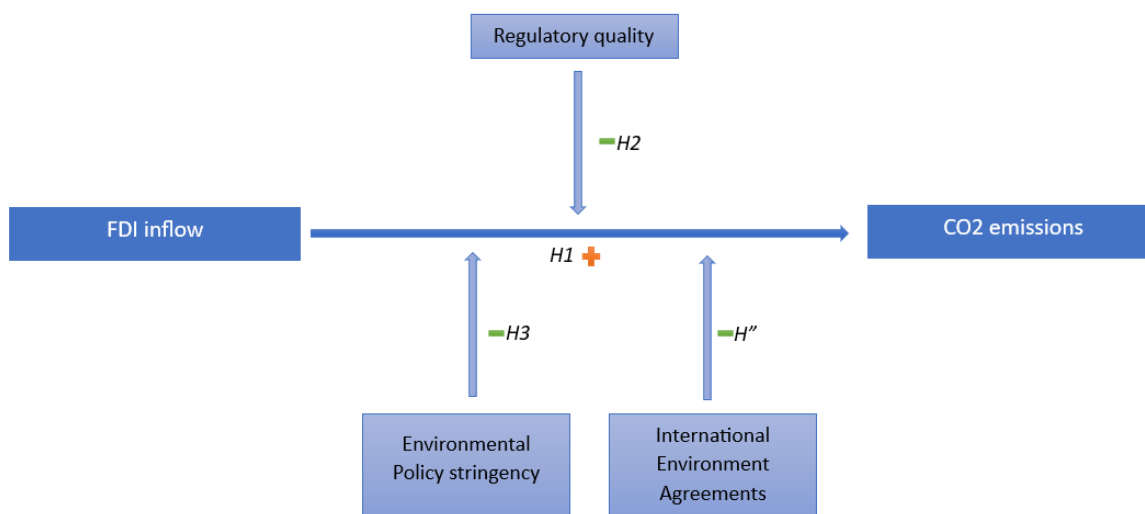


FIGURE 1: CONCEPTUAL MODEL HYPOTHESES

3 Data and method

This section outlines the methodology employed in the thesis. It begins with a description of the sample and the data sources utilized. Subsequently, it elaborates on the dependent, explanatory, and control variables. Additionally, it provides a brief discussion of the summary statistics and includes a table that defines the variables used. Thereafter, the empirical approach is discussed, followed by the construction of the regression model.

3.1 Data sources and sample

The time frame of the data covers the period from 1990 to 2020. This timeframe is used because the environmental data of countries available from the World Bank started in 1990 and is complete until 2020. The timeframe allows for analysis of historical trends and potential policy impacts. The data consist of 193 countries worldwide with different economic and institutional settings. These 193 countries are all members of the United Nations (United Nations, n.d.-a). The data of the Environmental Policy Stringency Index, which is used for measuring an interaction effect, is different and covers 33 countries for the period from 1990 to 2020. This sample of 33 countries is used to perform the panel data analysis for the baseline analysis in this thesis. Among the 33 countries, 27 are members of the Organisation for Economic Cooperation and Development (OECD) (OECD, n.d.). The remaining six countries are non-OECD economies and are classified as emerging markets, namely economies undergoing rapid industrialization and economic development. These six countries include Brazil, China, India, Indonesia, Russia, and South Africa. While often mentioned alongside BRICS+, Indonesia is not officially a member of this group (BRICS, n.d.). The countries included in the baseline analysis are shown in Table B1. A larger sample is used in the alternative operationalization measurement presented and explained in Section 4.2.2. This sample contains 163 countries, as shown in Table B2.

3.2 Variables and measures

3.2.1 Dependent variable

The dependent variable in this thesis is CO₂ emissions, measured in metric tons per capita. Emissions data are sourced from Climate Watch Historical GHG Emissions (1990-2020), provided by the World Bank. Using CO₂ emissions per capita accounts for population size and enables comparisons across countries with varying populations. The underlying assumption of this thesis is that environmentally friendly countries aim to achieve lower emissions.

However, it is important to acknowledge that the CO₂ emissions data do not capture all emission sources within a county. To address this limitation, an alternative operationalization using total greenhouse gas emissions is conducted in Section 4.2.4.2. This measure includes all gases in the atmosphere that contribute to the greenhouse effect, and thereby affecting global warming.

Additionally, the dependent variable is also measured using renewable energy consumption instead of CO₂ emissions. This is done as an alternative operationalization in Section 4.2.4.1. Renewable energy consumption is defined as the share of renewable energy in total final energy consumption. Higher renewable energy consumption is considered beneficial for environmental quality and is expected to have an inverse relationship with the baseline analysis using CO₂ emissions data. Including renewable energy consumption provides a comprehensive view of the environmental efforts of a country, because it captures the transitions towards sustainable energy sources. This data is sourced from the World Bank.

3.2.2 Explanatory variables

There are three explanatory variables in this thesis: FDI inflow, regulatory quality and environmental policy stringency. FDI inflow is measured as a percentage of GDP, and the direct relationship is expected to result in a net increase in emissions. The moderating variables that may influence this relationship are of particular interest.

There are two interaction effects investigated, namely: the interaction effect between FDI and regulatory quality, and the interaction effect between FDI and environmental policy stringency. For the second interaction effect, an alternative operationalization approach is examined by investigating participation in international environmental agreements. This allows for an examination of whether countries that participate in more environmental agreements experience a similar moderating effect of FDI on emissions compared to those with stricter environmental policies. This is examined with the interaction effect between FDI and participation in environmental agreements.

Regulatory quality assesses the ability of the government to create and enforce effective policies and regulations. This measure is sourced from the Worldwide Governance Indicators (WGI), provided by the World Bank. Regulatory quality plays a crucial role in influencing FDI and its impact on emissions. The estimates for regulatory quality range from -2.5, indicating weak governance performance, to 2.5, indicating strong governance performance.

Environmental policy stringency (EPS) refers to the extent to which environmental policies impose costs, either direct or indirect, on activities that produce pollution or harm the environment. The data for this variable is sourced from the OECD. The EPS is calculated with market-based policies, non-market-based policies, and technology support (Kruse et al., 2022). Figure A2 illustrates the aggregation structure of the EPS index. The EPS ranges from zero (no policy) to six (highest stringency). This thesis focuses on the interaction between FDI and EPS. EPS is a crucial variable because it captures the level of pressure a country brings into play to operate in a more environmentally friendly way. Stringent environmental policies can potentially discourage polluting FDI and encourage cleaner FDI.

An alternative operationalization to measure the EPS is by examining participation in selected international environment agreements. This method allows for the analysis of a significantly larger and more globally representative sample of countries. The original EPS variable deleted a lot of countries because of its relatively high missing values of 4,960 (Table B3). Therefore, the baseline analysis consists of 33 countries, with a predominance of western countries. After excluding countries with missing data, the sample size for this alternative approach consists of 163 countries. Leading to a considerably larger sample size, with 3,028 observations compared to 658 observations in the baseline analysis (Table 1).

It is expected that countries engaging in these agreements are aiming to increase environmental quality (Ringquist & Kostadinova, 2004). This represents an additional way to test Hypothesis 3, where the variable EPS is now replaced with participation in selected international environmental agreements. To become a participant in the international environment agreements, countries must sign the agreements, and it is also required for countries to participate by becoming a party to the convention or treaty. Countries that only signed the agreements are classified as non-participants. For the purpose of this thesis, only the environmental agreements that specifically address emissions reduction or environmental protection are included in the analysis. Based on this evaluation, the agreements included are: (1) Montreal Protocol, (2) United Nations Framework Convention on Climate Change (UNFCCC), (3) Kyoto Protocol, (4) Stockholm Convention, and (5) Paris Agreement. These agreements aim to reduce greenhouse gas emissions, protect the ozone layer, and address persistent organic pollutants. They offer essential insights into the relationship between FDI and environmental sustainability. Detailed explanations of the individual agreements can be found in Appendix F.

The alternative operationalization analysis combines dummy variables for five agreements into one factor to derive the overall effect. This approach reduces the dimensionality of the model. By combining these agreements into a single factor, the analysis can more effectively capture the impact of international environmental agreements on the relationship between FDI and emissions. Consequently, the minimum value is 0 (indicating non-participation in any agreements), while the maximum value becomes 5, representing participation in all five agreements.

3.2.3 Control variables

The control variables, economic size, trade openness, industrialization, and population, are selected based on previous studies (Huang et al., 2022; Wang et al., 2021). These are important because they influence both FDI inflows and emissions levels. Controlling for these variables helps to reduce the omitted variable bias by accounting for factors that could affect FDI and emissions individually. Including these control variables aims to isolate the relationship between FDI and emissions more accurately.

The control variable economic size is measured by real GDP. While studies suggest that increased economic activity leads to higher emissions through factors like energy consumption and industrial activity, the relationship is not always straightforward (Li & Lin, 2013). The path a country takes towards economic development can impact its environmental footprint. Countries with larger economic sizes have greater capacity to enhance both production technology and environmental regulation (Gani, 2012). This concept is in line with the Environmental Kuznets Curve (EKC) hypothesis. Suggesting that pollution tends to increase in the early stages of industrialization and decreases as countries become more mature (Selden & Song, 1994). Indicating an inverted U-shape relationship between income and environmental pollution (Aller et al., 2021). Additionally, emissions reduction in many developed countries is partly due to the shifting of polluting activities to developing countries with a lower GDP. Taking into account the different theories and countries, it is expected that higher GDP is associated with lower emissions. In addition, larger economies tend to attract more FDI, so controlling for economic size helps to separate the effect of FDI on emissions from the effect of overall economic activity.

Trade openness is measured as the proportion of imports and exports to GDP. Trade openness can influence both FDI inflows and emission levels. Open economies are more likely to attract FDI (Liargovas & Skandalis, 2011). Regarding emissions, it was initially argued that openness of trade worsens environmental degradation due to the phenomenon of environmental externalities (Rock, 1996) and leads to more exports of energy intensive products (Ang, 2009). In contrast to these studies, several more recent studies have provided evidence supporting the idea that trade openness is associated with reduced emissions (Ali et al., 2020; Huang et al., 2022). A decrease in emissions is expected when the exports of a country are higher than the imports

(Melitz, 2003). This is because countries with higher technological advancements and productivity levels are more competitive in the global trade area (Huang et al., 2022). As a result, these countries tend to adopt more efficient production, thereby reducing emissions per unit of output. Consequently, the more a country exports, the less carbon it emits. Mitigating the adverse environmental impacts associated with trade openings. Following this, countries that are more open to trade (i.e., countries with fewer trade restrictions) are expected to decrease carbon emissions.

The control variable industrialization is measured as the added value of industrial output as a percentage of gross domestic product. The production of industrial goods requires higher energy usage, leading to increased carbon emissions while also attracting more FDI (Huang et al., 2022). Likewise, larger populations result in greater energy consumption and subsequent more emissions (Chen et al., 2021). Population influences market size, which can attract and potentially increase FDI inflows (Aziz & Makkawi, 2012). Both industrialization and population growth are expected to lead to an increase in emissions.

Definitions and explanations of all variables used in this thesis are outlined in Table 1, along with their source and expected effects.

3.3 Summary statistics

The summary statistics for all variables are shown in Table 1, divided into a small sample (the baseline analysis) and a large sample (the alternative analysis using environmental agreements instead of EPS). To address missing values, any year with missing data for any country was excluded from the analysis. Remarkably, the missing values are primarily concentrated in the variable regulatory quality because this variable lacks data for all countries in the years 1997, 1999, and 2001. However, this does not pose a significant problem because the trend for this variable can still be observed over the other years. Methods such as imputing the mean for the missing values are not suitable in this case. For the large sample, it is acknowledged that some developing countries might have data gaps due to reporting challenges.

An important observation is that the mean value of regulatory quality is much lower in the alternative operationalization analysis, namely 0.07 (0.92), indicating a significantly weaker regulatory environment on average. In comparison, the main analysis shows a value of 1.00 (0.68), suggesting a slight bias towards stronger regulatory environments in the sample. This means that the alternative analysis incorporates a broader range of countries with more diverse regulatory quality levels.

TABLE 1: DEFINITIONS OF THE VARIABLES EMPLOYED IN THE ANALYSES

						Baseline study with <i>small</i> sample (N=658)	Alternative study with <i>large</i> sample (N=3,028)
	Variable name	Symbol	Variable Definition	Source	Expected effect	Mean (Std. Dev)	Mean (Std. Dev.)
Dependent variable	CO2 Emissions	<i>CO2</i>	Measured in metric tons per capita. Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.	World Bank	n/a	8.04 (3.97)	4.62 (5.56)
	Renewable energy consumption	n/a Alternative measure	Renewable energy consumption is the share of renewable energy in total final energy consumption. It is measured of % of total final energy consumption.	World Bank	n/a	n/a	n/a
	Greenhouse gas emissions (kt of CO2 equivalent)	n/a Alternative measure	Total greenhouse gas emissions are measured in kt of CO2 equivalent. Encompassing CO2 totals excluding short-cycle biomass burning (such as agricultural waste burning and savanna burning) but including other biomass burning (such as forest fires, post-burn decay, peat fires and decay of drained peatlands), all anthropogenic CH4 sources, N2O sources and F-gases (HFCs, PFCs and SF6).	World Bank	n/a	n/a	n/a
Independent variable	Foreign Direct Investment, net inflows	<i>FDI</i>	Measured as percentage of GDP. Foreign direct investment are the net inflows of investment to acquire a lasting management interest (10 percent or more	World Bank	Increase	4.98 (9.40)	5.87 (17.97)

			of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series shows net inflows (new investment inflows less disinvestment) in the reporting economy from foreign investors, and is divided by GDP.				
	Regulatory Quality	<i>RQ</i>	Reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Estimate of governance (ranges from approximately -2.5 (weak) to 2.5 (strong) governance performance). This measure is part of the Worldwide Governance Indicators (WGI).	World Bank	Decrease	1.00 (0.68)	0.07 (0.92)
	Environmental Policy Stringency Index	<i>EPS</i>	Stringency is defined as the degree to which environmental policies put an explicit or implicit price on polluting or environmentally harmful behaviour. The index is based on the degree of stringency of 13 environmental policy instruments, primarily related to climate and air pollution. The index ranges from 0 (not stringent) to 6 (highest degree of stringency).	OECD	Decrease	2.29 (1.04)	n/a
	Participation in selected International Environment Agreements	n/a Alternative measure	The data presents the years of formalization of participation in a selection of international environmental treaties and conventions. Participation means that the country or area has become party to the agreements under the treaty or convention, which is achieved through a variety of	UNSD	Decrease	n/a	3.68 (1.02)

			means depending on country circumstances, namely: accession, acceptance, approval, formal confirmation, ratification, and succession. Countries or areas who have signed but not become party to the agreements under a given convention or treaty are thus indicated as non-participants. Yes means that they have become party and no means that they are non-participants. The including international agreements are: (1) Montreal Protocol, (2) United Nations Framework Convention on Climate Change (UNFCCC), (3) Kyoto Protocol, (4) Stockholm Convention, and (5) Paris Agreement				
Control variables	Economic size	X	GDP per capita is gross domestic product divided by midyear population	World Bank	Decrease	29,118.30 (20,386.22)	12,404.29 (17,613.96)
	Trade openness	X	Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product.	World Bank	Decrease	77.62 (41.22)	86.25 (50.43)
	Industrialization	X	Added value of industrial output as percentage of gross domestic product. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources.	World bank	Increase	16.18 (5.55)	13.13 (6.39)
	Population	X	Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship	World Bank	Increase	129,544,79 (299,231,487)	42,470,021.00 (149,241,032.15)

3.4 Empirical approach

A panel data analysis is conducted for this thesis, encompassing observations from the same countries in the sample across different time periods, from 1990 to 2020. Using panel data offers the advantage of controlling for the unobserved heterogeneity within the regression model using either fixed-effects or random-effects models. This thesis uses the fixed-effects model due to its focus on within-country variation. By differencing out the country effects, the fixed-effects model isolates the effect of the explanatory variables on CO2 emissions within each country over time. The really small p-value in the Hausman test (Table D3) also supports the fixed-effects model as the appropriate choice. To make the research realistic given time constraints, the analysis will focus solely on exploring the relationship of FDI on carbon emissions while considering two moderating effects. The regression model designed for the analysis is as follows:

$$(1) CO2_{it} = \beta_0 + \beta_1 FDI_{it} + \beta_2 FDI_{it} * RQ_{it} + \beta_3 FDI_{it} * EPS_{it} + \beta_4 X_{it} + D_t + \alpha_i + \varepsilon_{it}$$

A panel analysis with a fixed-effect model is utilized to investigate how changes in FDI inflows within a country are associated with changes in CO2 emissions levels specific to that country. Where β_1 represents the direct effect of FDI on emissions. The β_2 and β_3 represents the interaction effects, indicating how the relationship between FDI and emissions is moderated by regulatory quality and environmental policy stringency. β_4 represents the coefficients of the control variables. The abbreviations of the formula are formulated and explained in Table 1 for clarity.

The sample needs to be checked to see if there is the possibility of multicollinearity among the variables. This is done with the correlation matrix as shown in Table 2. The closer the value is to 1, the stronger the correlation between the two variables (Studenmund, 2017). Values exceeding 0.7 indicate a strong positive or negative correlation, indicating strong multicollinearity. The main variables show a relatively low correlation value, suggesting minimal multicollinearity concerns. However, moderate positive correlations exist between emissions and regulatory quality (0.592) and regulatory quality and EPS (0.521). This means that there is a noticeable trend, but not an extremely strong one. Looking at the control variables, the correlation between GDP and regulatory quality stands out (0.837), suggesting a strong positive linear relationship. This means that countries with a higher GDP tend to have higher regulatory quality scores.

TABLE 2: CORRELATION MATRIX

	Emissions	FDI	Regulatory Quality	EPS	GDP	Trade Openness	Industrialization	Population
Emissions	1							
FDI	0.082	1						
Regulatory Quality	0.592	0.259	1					
EPS	0.220	0.029	0.521	1				
GDP	0.637	0.152	0.837	0.655	1			
Trade Openness	0.162	0.495	0.341	0.274	0.275	1		
Industrialization	-0.087	0.004	-0.244	-0.153	-0.306	0.291	1	
Population	-0.358	-0.272	-0.587	-0.269	-0.533	-0.674	0.104	1

Before conducting the panel regression analysis, it is important to note that the variables emissions, FDI, GDP, and population are transformed into a logarithmic function. This transformation creates a more symmetrical distribution of the data, which improves the interpretation of the data. Additionally, to enhance the interpretability of interaction terms, the data is standardized. Standardization reduced concerns about multicollinearity. The variance inflation factors (VIFs) calculated on the standardized data (Table D2) are lower than the VIF values of the non-standardized data (Table D1). While the VIF values still remain relatively high, the standardization shows a positive reduction in multicollinearity concerns.

Table C1 shows the OLS regression with year dummies (1996-2020) and country dummies (including 33 countries in the baseline analysis). The year dummies capture the effect of each year relative to the chosen base year, which is 2020. The country dummies capture the effect of each country relative to the base country, the United States. This OLS model with dummies visualizes the control for both time-specific trends and country-specific trends. In contrast, the used fixed-effects model in this thesis isolates the effect within each country over time and focuses on the variations within each country, independent of these broader trends.

To ensure the validity of the regression results, it is crucial to address the potential issues of heteroskedasticity and autocorrelation. The Breusch-Pagan test (Table D4) is used to detect heteroskedasticity. The extremely small p-value ($<2.2e-16$) concludes that there is significant heteroskedasticity in the residuals. To address this issue, robust standard errors are used to give more reliable estimates of the regression coefficients. The Breusch-Godfrey test (Table D5), also known as the Wooldridge test, indicates the presence of autocorrelation in the residuals of the regression model (p-value $<2.2e-16$). This is visually confirmed in Figure A2. To address this problem, alongside using robust standard errors, the errors are clustered by country. Clustering adjusts the standard errors to account for the dependence within groups (e.g., countries), providing more valid estimates.

In conclusion, to ensure the validity of the regression analysis and address potential issues, clustered robust standard errors are used throughout this thesis. This approach is utilized in the following section, where the results are interpreted, allowing for more reliable estimates of coefficient standard errors and more accurate hypothesis testing.

4 Results

4.1 Baseline results

Table 3 represents the results for the baseline analysis, with clustered robust standard errors in parentheses. The coefficient of determination for the complete model (*Model 5*), represented by the R-squared (0.487), indicates that the regression model fits the data reasonably.

The regression results (of *Model 5*) show that the coefficient for FDI is 0.14, with a p-value of 0.005, indicating statistical significance at the 1 per cent level. This suggests that an increase in FDI inflows leads to an increase in emissions. So, the baseline analysis, applied to 33 countries, demonstrates that the net effect is an overall increase in emissions, thereby supporting *H1*.

The marginal effects plot of the interaction variable FDIxRegulatory is shown in Figure 2. The x-axis represents the level of regulatory quality, where higher values indicate better regulatory institutions and enforcement. The y-axis represented the marginal effect of FDI on emissions. The blue line, with a downward slope, suggests that the interaction effect is present (as opposed to a flat slope). This downward-sloping line suggests an amplifying effect, meaning that higher regulatory quality amplifies the impact of FDI on reducing emissions. Essentially, better regulatory institutions and enforcement enhance the ability of FDI to contribute to emission reduction. This observation is consistent with the analysis of *Model 5*, where the coefficient for the interaction variable between FDI and regulatory quality (FDIxRegulatory) shows a decreasing value of -0.01. However, the wide confidence interval (grey area) indicates greater uncertainty about the true effect. Despite the visual evidence, the findings of the statistical test ($p=0.749$) suggest no significant interaction. Consequently, *H2* cannot be accepted.

The visual representation of the interaction effect between FDI and environmental policy stringency (FDIxEPS) is shown in Figure 3. It shows the marginal effect of FDI on emissions at different values of EPS. The x-axis represents the level of EPS, where higher EPS indicates stricter environmental regulations. The y-axis represents the marginal effect of FDI on emissions, where a negative value indicates a decrease in emissions due to FDI. The key point of this figure is that the blue line has a negative slope, which means that as EPS increases, the marginal effect of FDI on emissions becomes more negative. This indicates that the emissions reduction effect of FDI is

stronger at higher levels of EPS (with stricter regulations). In other words, higher environmental policy stringency seems to amplify the pollution-reducing effect of FDI.

The statistical test of this interaction effect in *Model 5* shows a coefficient of -0.12, and is significant at the 1 per cent level. The observed negative interaction effect suggests that the effect of FDI on emissions is moderated by the stringency of environmental policies. Specifically, as environmental policy stringency increases, the positive impact of FDI on emissions decreases. In countries with high environmental policy stringency, the overall effect of FDI on emissions could even become negative, this relationship can be expressed as $0.14 - (12 * EPS) < 0$. This means that *H3* can be accepted, indicating that FDI inflows decrease emissions in countries with high environmental policy stringency. This result suggests that strong environmental policies can mitigate the adverse environmental impacts of FDI. In this way, FDI can lead to technological advancements and more efficient production processes that lower emissions.

The analysis shows an interesting finding regarding the control variable GDP. The coefficient of 0.67 is significant at the 0.1 per cent level. Contrary to expectations, this indicates that an increase in GDP is followed by an increase in emissions. Typically, economic growth in advanced OECD countries is associated with enhanced energy efficiency and a shift towards cleaner industries. According to the EKC hypothesis, when countries grow richer, they eventually have the potential to reduce emissions over time. However, the results indicate that the pattern predicted by the EKC, where economic growth leads eventually to environmental improvement, has not (yet) been achieved.

The other control variables show results that align with the expectations. Trade openness (-0.16) is significant at the 5 per cent level, implying that greater trade openness leads to a decrease in emissions. The control variable population is significant at the 10 percent level, indicating a rise in emissions as the population increases.

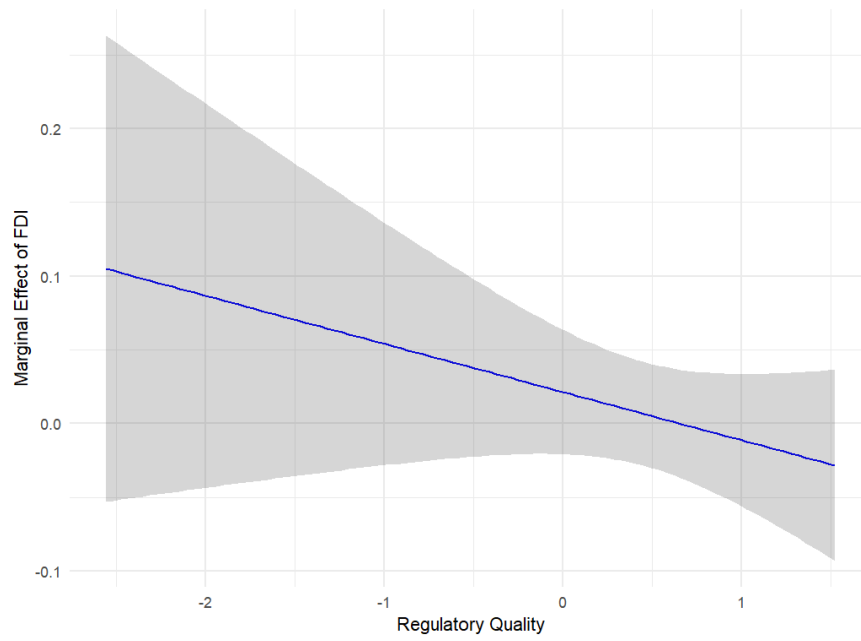


FIGURE 2: MARGINAL EFFECTS PLOT – INTERACTION FDI AND REGULATORY QUALITY AT DIFFERENT VALUES OF EMISSIONS

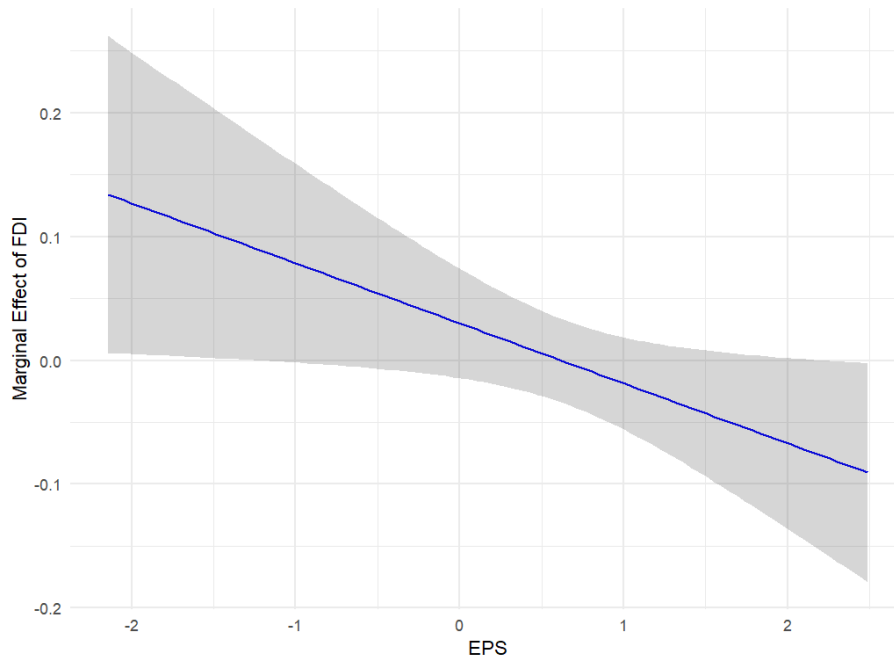


FIGURE 3: MARGINAL EFFECTS PLOT – INTERACTION FDI AND EPS AT DIFFERENT VALUES OF EMISSION

Note: 95% confidence interval

TABLE 3: RESULTS REGRESSION BASELINE ANALYSES

	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>	<i>Model 4</i>	<i>Model 5</i>
	Emissions	Emissions	Emissions	Emissions	Emissions
FDI		0.02 (0.05) [p=0.734]	0.07 (0.05) [p=0.177]	0.13 (0.05) [p=0.006]	0.14 (0.05) [p=0.005]
FDIxRegulatory			-0.06 (0.03) [p=0.061]		-0.01 (0.03) [p=0.749]
FDIxEPS				-0.13 (0.4) [p=0.001]	-0.12 (0.04) [p=0.002]
Regulatory Quality		0.02 (0.08) [p=0.832]	0.03 (0.08) [p=0.710]	0.01 (0.08) [p=0.892]	0.01 (0.08) [p=0.868]
EPS		-0.07 (0.04) [p=0.126]	-0.06 (0.04) [p=0.200]	-0.03 (0.04) [p=0.523]	-0.03 (0.04) [p=0.528]
GDP	0.65 (0.12) [p=9.548e-08]	0.65 (0.12) [p=6.410e-08]	0.65 (0.12) [p=7.059e-08]	0.67 (0.12) [p=2.748e-08]	0.67 (0.12) [p=2.891e-08]
Trade Openness	-0.20 (0.06) [p=0.002]	-0.20 (0.06) [p=0.002]	-0.20 (0.06) [p=0.002]	-0.16 (0.06) [p=0.015]	-0.16 (0.06) [p=0.014]
Industrialization	0.11 (0.09) [p=0.242]	0.10 (0.09) [p=0.279]	0.10 (0.09) [p=0.271]	0.09 (0.09) [p=0.363]	0.09 (0.09) [p=0.357]
Population	2.24 (1.19) [p=0.060]	2.18 (1.19) [p=0.067]	2.16 (1.19) [p=0.070]	2.19 (1.19) [p=0.066]	2.19 (1.19) [p=0.067]
Observations	658	658	658	658	658
R ²	0.443	0.457	0.465	0.487	0.487
log-Likelihood	268.341	276.675	281.532	295.491	295.610

Note: Clustered robust standard errors in parentheses

4.2 Robustness checks

To ensure the validity and robustness of the results, this research includes several checks. These include an analysis with Driscoll-Kraay standard errors instead of clustered robust ones, investigating lagged values of EPS, and exploring an alternative measure of EPS based on international environmental agreements. Additionally, the dependent variables are tested in two different ways: first, by examining its inverse relationship with renewable energy consumption, and second, by using total greenhouse gas emissions as an alternative measure. These checks provide a more in-depth understanding of the relationship between FDI and emissions.

4.2.1 Addressing autocorrelation

4.2.1.1 Analysis with Driscoll-Kraay standard errors

This thesis employs multiple strategies to ensure the validity of statistical results because of the presence of violated regression assumptions. The baseline analysis contains both the robust standard errors as well as the clustering standard errors to address heteroscedasticity and autocorrelation concerns. Another approach to address heteroscedasticity and autocorrelation (up to some lag) is the Newey-West standard error. A downside to these standard errors is that they were initially proposed for use with time series data. The Driscoll-Kraay standard error is an extension of the Newey-West and is designed for panel data. This accounts for cross-sectional dependence as well as heteroskedasticity and autocorrelation (Hoechle, 2007). The results of *Model 6* (Table 4) show the effectiveness of the Driscoll-Kraay standard errors. Notably, both FDI and FDIxEPS remain significant, implying consistent findings compared to the baseline analysis.

4.2.1.2 Analysis with lagged EPS

There is a possibility that the impact of EPS on emissions might not be immediate but have a delayed effect (Chen et al., 2021). Several factors contribute to this delay. The varying pace at which different groups adopt and implement environmental policies can result in delayed effects on emissions. The slow adoption of market-based and technology-supported policies means that the impact of these policies might not be visible immediately. By including the lagged EPS, the time lag between policy implementation and its impact is accounted for (Kruse et al., 2022).

To test these potential delays, a lagged value of EPS ranging from one to four years is included in the analysis (Table 4, *Model 7-10*). The regression results, including clustered robust standard errors, show minimal change in the coefficient estimates and significance levels. *Model 7*, including one-year lagged EPS, shows that the interaction effect between FDI and the lagged EPS is still significant at the 0.1 per cent level. However, the coefficient increases to -0.06, compared to -0.12 in the baseline analysis. This indicates that the immediate effect of EPS is more pronounced than the lagged effects. There are varying significance levels and coefficients of FDIxEPS across different lagged years. Nevertheless, the effect consistently shows a negative value, indicating that stronger EPS leads to less polluting FDI, thereby supporting *H3*.

An analysis with lagged values of regulatory quality showed no noticeable changes in the relationship, and the results remained insignificant. However, when incorporating the lagged values of EPS into the model, a remarkable result of the interaction effect between FDI and regulatory quality emerges. In *Model 8*, this interaction shows a decreasing effect of -0.06 at the 10 percent significance level. Interestingly, this effect strengthens with the inclusion of additional lags in EPS. For instance, *Model 9* shows a more pronounced decreasing effect of -0.08 at the 5 percent significance level, and in *Model 10*, this effect decreases further to -0.09, also significant at the 5 percent level.

This insight provides an interesting perspective on the variable regulatory quality. The results suggest a dynamic influence when lagged EPS is considered. Changes in EPS over time, captured by the lagged values, enhance the role of regulatory quality in moderating the environmental impact of FDI. Where regulatory quality may influence how well environmental regulations are implemented and enforced, especially considering the effect over several years.

This effect shows that the value of EPS has a really important direct and indirect role in reducing emissions, and that regulatory quality enhances this impact by potentially improving the effectiveness of environmental regulations. Despite the significance of the findings for FDIxRegulatory, *H2* cannot be conclusively accepted solely based on this result. More careful interpretations are necessary, especially considering that this is almost the only analysis showing significant results for this hypothesis.

TABLE 4: REGRESSION ANALYSIS WITH DRISCOLL-KRAAY STANDARD ERRORS

	<i>Model 6</i>	<i>Model 7</i>	<i>Model 8</i>	<i>Model 9</i>	<i>Model 10</i>
	Analysis with Driscoll-Kraay Standard Errors	Analysis with EPS lagged 1 year	Analysis with EPS lagged 2 years	Analysis with EPS lagged 3 years	Analysis with EPS lagged 4 years
	Emissions	Emissions	Emissions	Emissions	Emissions
FDI	0.14 (0.03) [p=3.850e-06]	0.06 -(0.04) [p=0.086]	0.05 (0.03) [p=0.114]	0.08 (0.04) [p=0.033]	0.08 (0.03) [p=0.010]
FDIxRegulatory	-0.01 (0.02) [p=0.677]	-0.06 (0.04) [p=0.993]	-0.06 (0.03) [p=0.071]	-0.08(0.04) [p=0.040]	-0.09 (0.03) [p=0.012]
FDIxEPS	-0.12 (0.03) [p=6.748e-06]				
FDIxEPS 1-year lag		-0.06 (0.01) [p=2.160e-05]			
FDIxEPS 2-year lag			-0.04 (0.02) [p=0.015]		
FDIxEPS 3-year lag				-0.02 (0.01) [p=0.111]	
FDIxEPS 4-year lag					-0.05 (0.01) [p=0.000]
Regulatory Quality	0.01 (0.02) [p=0.600]	0.00 (0.06) [p=0.993]	-0.00 (0.07) [p=0.999]	0.01 (0.08) [p=0.888]	0.02 (0.07) [p=0.818]
EPS	-0.03 (0.04) [p=0.518]				
EPS 1-year lag		0.06 (0.02) [p=0.012]			
EPS 2-year lag			-0.06 (0.07) [p=0.014]		

EPS 3-year lag				-0.02 (0.08) [p=0.512]	
EPS 4-year lag					0.02 (0.02) [p=0.318]
GDP	0.67 (0.7) [p=2.200e-16]	0.69 (0.10) [p=3.417e-11]	0.68 (0.11) [p=4.181e-10]	0.66 (0.12) [p=1.945e-08]	0.67 (0.11) [p=1.317e-09]
Trade Openness	-0.16 (0.05) [p=0.001]	-0.15 (0.05) [p=0.007]	-0.17 (0.06) [p=0.002]	-0.18 (0.07) [p=0.007]	-0.14 (0.06) [p=0.028]
Industrialization	0.09 (0.04) [p=0.035]	0.08 (0.09) [p=0.356]	0.10 (0.08) [p=0.202]	0.10 (0.09) [p=0.296]	0.09 (0.09) [p=0.341]
Population	2.19 (0.29) [p=2.235e-15]	2.17 (1.14) [p=0.574]	2.19 (1.19) [p=0.067]	2.19 (1.24) [p=0.079]	2.19 (1.15) [p=0.057]
Observations	658	657	656	655	654
R ²	0.487	0.508	0.496	0.466	0.491
log-Likelihood	295.610	308.344	299.527	280.306	297.279

Note: Model 6 contains Driscoll-Kraay standard errors in parentheses, and Models 7-10 contain clustered robust standard errors in parentheses

4.2.2 International environmental agreements as alternative measure of EPS

In the baseline analysis, the focus was on using EPS to explore the relationship between FDI and emissions, aiming to understand how countries manage their environmental impact. However, a different approach is to consider the signing of international environmental agreements as an alternative measure of EPS. This methodological shift allows to broaden the analysis significantly, as it expands the sample size from 33 countries, which mainly included OECD countries, to 163 countries worldwide (Table B2). The expanded dataset offers a more representative sample of countries across various levels of economic development, geographical regions, and environmental policy orientations.

Table 5 shows the results of the regression analysis incorporating environmental agreements instead of EPS. Notably, the R-squared for the complete model (*Model 15*) is 0.242, which is lower than the value obtained in the baseline analysis (namely 0.487). The difference could be due to several factors. The environmental agreements, while influential, are more global in scope and may not fully capture the specific environmental policies of individual countries. They represent one aspect of environmental regulation and might overlook broader environmental regulations and frameworks. However, it is important to note that the size of the R-squared is not the only factor determining the validity of the model (Stedenmund, 2017).

Consistent with the baseline analysis, the effect of FDI on emissions in *Model 15* shows a positive coefficient of 0.06, significant at the 1 per cent level. This indicates that an increase in FDI is associated with an increase in emissions, thereby also supporting *H1*.

The interaction effect of FDI and regulatory quality is insignificant, meaning that *H2* cannot be accepted. However, the interaction variable between FDI and the international environmental agreements shows a significant effect at the 5 per cent level. Specifically, the coefficient of -0.01 indicates that FDI inflows are associated with a greater reduction in emissions in countries that have participated in the environmental agreements. This moderating effect is also clearly visible in the marginal effects plot, shown in Figure 4. This finding is in line with the baseline analysis using the variable EPS. Therefore, *H3* can be supported, indicating that FDI inflows decrease CO2 emissions more in countries that have participated in the mentioned agreements.

However, the moderating effect of environmental agreements (-0.01) is considerably smaller than the baseline moderating effect of EPS (-0.12). This comparison highlights that while participating in international environmental agreements does influence the effectiveness of FDI in reducing emissions, the stringency of environmental policies (as captured by EPS) has a more considerable impact.

Similar to the baseline analysis, the control variable GDP shows a significant positive value at the 0.1 per cent level, contrary to expectations. This suggests that, even when considering environmental agreements with a larger sample, an increase in GDP is followed by an increase in emissions. The control variable trade openness presents an unexpected finding that is not in line with the baseline analysis. It shows an expected increase in emissions of 0.03, but this effect is not statistically significant. The population control variable shows a value of 0.47, significant at the 5 per cent level. Indicating that a larger population size is associated with higher CO₂ emissions, as expected according to the theory.

Model 13 shows an analysis with only the interaction variable between FDI and regulatory quality, considering the large sample size of 3,028 observations. The findings indicate that even with an increased sample size, the interaction effect of FDI and regulatory quality remains insignificant ($p=0.141$). Therefore, *H2* cannot be accepted, identical to the baseline analysis.

In conclusion, this alternative measure with a larger sample gives consistent results in line with the baseline analysis. Both *H1* and *H3* can be supported, indicating that an increase in FDI is associated with higher emissions and that FDI inflows lead to a greater reduction in emissions in countries that have participated in international environmental agreements.

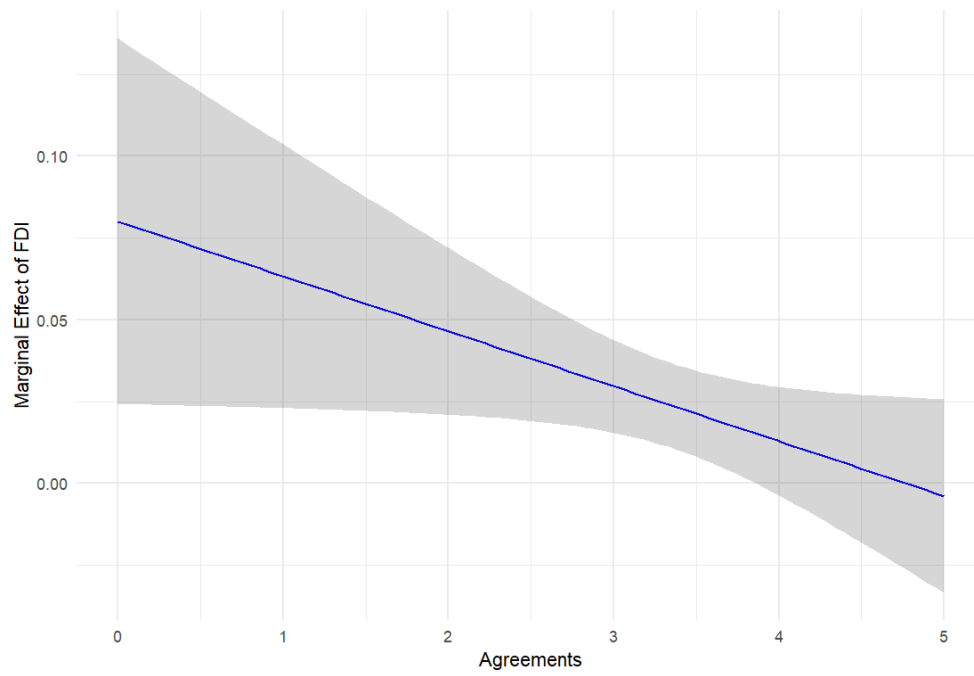


FIGURE 4: MARGINAL EFFECTS PLOT – INTERACTION FDI AND AGREEMENTS AT DIFFERENT VALUES OF EMISSIONS

Note: 95% confidence interval

TABLE 5: RESULTS REGRESSION ANALYSES ROBUSTNESS CHECK— INTERNATIONAL ENVIRONMENTAL AGREEMENTS

	<i>Model 11</i>	<i>Model 12</i>	<i>Model 13</i>	<i>Model 14</i>	<i>Model 15</i>
	Emissions	Emissions	Emissions	Emissions	Emissions
FDI		0.02 (0.01) [p=0.002]	0.02 (0.01) [p=0.003]	0.06 (0.02) [p=0.004]	0.06 (0.02) [p=0.008]
FDIxRegulatory			-0.01 (0.00) [p=0.139]		-0.00 (0.00) [p=0.631]
FDIxAgreements				-0.01 (0.01) [p=0.022]	-0.01 (0.01) [p=0.034]
Regulatory Quality		-0.01 (0.03) [p=0.646]	-0.02 (0.03) [p=0.602]	-0.02 (0.03) [p=0.572]	-0.02 (0.03) [p=0.563]
Agreements		0.00 (0.01) [p=0.907]	0.00 (0.01) [p=0.929]	-0.00 (0.01) [p=0.953]	-0.00 (0.01) [p=0.949]
GDP	0.42 (0.06) [p=1.094e-12]	0.42 (0.06) [p=1.381e-12]	0.42 (0.06) [p=9.788e-13]	0.43 (0.06) [p=2.398e-13]	0.43 (0.06) [p=2.144e-13]
Trade Openness	0.03 (0.02) [p=0.240]	0.03 (0.03) [p=0.307]	0.03 (0.03) [p=0.314]	0.03 (0.03) [p=0.208]	0.03 (0.03) [p=0.212]
Industrialization	0.02 (0.02) [p=0.480]	0.02 (0.02) [p=0.499]	0.02 (0.02) [p=0.511]	0.01 (0.02) [p=0.528]	0.01 (0.02) [p=0.531]
Population	0.51 (0.19) [p=0.009]	0.49 (0.19) [p=0.010]	0.48 (0.19) [p=0.012]	0.46 (0.19) [p=0.017]	0.46 (0.19) [p=0.017]
Observations	3028	3028	3028	3028	3028
R ²	0.223	0.231	0.233	0.242	0.242
log-Likelihood	2342.792	2358.714	2361.812	2380.967	2381.345

Note: Clustered robust standard errors in parentheses

4.2.3 Analysis with sample including only OECD countries

The results of the baseline analysis indicate that FDI inflows increase emissions; this is in line with the pollution haven hypothesis. The sample predominantly consists of OECD countries, which are generally recognized as advanced economies with a high level of economic development. In contrast, the countries Brazil, China, India, Indonesia, Russia, and South Africa in this sample are not OECD members. Considering the relatively small sample of 33 countries, these countries could have a significant influence on the emissions trends. To assess their impact, *Model 16* (Table 6) examines only OECD countries by excluding Brazil, China, India, Indonesia, Russia, and South Africa. This analysis explores whether the pollution haven hypothesis remains present or whether the halo hypothesis is evident within these OECD countries.

As seen in *Model 16* (Table 6), the direct effect of FDI on emissions is significant at the 1 per cent level. The effect shows an increase in emissions of 0.18, supporting *H1*, and thereby also supporting the pollution hypothesis. This increase in emissions is even higher than in the baseline analysis (0.18 compared to 0.14). Moreover, the moderating effect between FDI and regulatory quality within these generally more developed countries is significant at the 5 per cent level ($p=0.022$). This finding suggests that FDI increases emissions less in countries with higher regulatory quality. When considering only OECD countries, *H2* can be supported. In line with the baseline analysis, *H3* can also be supported.

4.2.4 Alternative measures for emissions

4.2.4.1 Renewable Energy Consumption as alternative measure for emissions

In the baseline analysis, CO₂ emissions serve as the dependent variable, but in this alternative operationalization, the focus shifts to examining the relationship with renewable energy consumption as the dependent variable. By doing so, it allows the thesis to explore a different and crucial aspect of sustainable development, aiming to assess whether FDI positively contributes to the adoption and usage of cleaner energy sources. Incorporating renewable energy consumption as a dependent variable enhances the analysis by diversifying the scope with an additional environmental indicator beyond emissions. Consequently, this approach enables the thesis to capture both the influence of pollutant emissions and the adoption of sustainable energy practices. It is important to note that the variable renewable energy consumption is expected to have an inverse effect. Because increased usage of renewable energy sources is beneficial for the environmental quality of a country.

Model 17 shows the results of the regression analysis with renewable energy consumption as the dependent variable (Table 6). The main effect of FDI on renewable energy consumption indicates that FDI inflows lead to a decrease in renewable energy consumption, significant at the 10 per cent level. This finding is in line with the baseline analysis, indicating that FDI has a polluting effect. The reduction in renewable energy consumption shows a decrease in environmental quality, thereby supporting *H1*.

The interaction variable between FDI and regulatory quality is insignificant. However, the interaction between FDI and EPS is significant at the 5 per cent level. The positive coefficient of the interaction term indicates that as EPS increases, the adverse impact of FDI on renewable energy consumption decreases. If EPS is sufficiently high, the interaction can even result in a positive overall effect, indicating that FDI might lead to higher renewable energy consumption, potentially contributing to improved environmental quality. The combined effect can be expressed as $-0.03 + (0.06 * EPS) > 0$. This finding supports *H3*, suggesting that greater FDI inflows decrease renewable energy more in countries with low environmental policy stringency. This result is also in line with the baseline analysis.

In summary, the regression analysis with the dependent variable renewable energy consumption is in line with the findings of the baseline analysis conducted with emissions as the dependent variable. Both hypotheses H1 and H3 can be accepted again, indicating that FDI leads to decreased renewable energy consumption, particularly in countries with lower EPS.

4.2.4.2 Greenhouse Gas Emissions as alternative measure for emissions

Using total greenhouse gas emissions as an alternative dependent variable helps mitigate the potential bias associated with focusing solely on CO₂ emissions. The broader set of greenhouse gases accounts for variations in emission sources and their contributions to climate change. Consequently, it provides a more holistic view of the environmental impact.

Model 18 presents the findings of the analysis and shows an adjusted R-squared of 0.566 (Table 6). This value is higher than the ones observed in the baseline and alternative analyses, indicating a model with enhanced explanatory power. The main variables all show the expected effect. However, the variable FDI is not significant anymore ($p=0.165$). The interaction variable FDI \times EPS (-0.02) is significant at the 1 per cent level. Despite the insignificance of the main effect, the negative coefficient of interaction term implies that the relationship between FDI and emissions is influenced by the level of EPS. In other words, the effect of FDI on emissions depends on the degree of EPS. Notably, the stringent environmental policies lead to a reduction in greenhouse gas emissions associated with FDI, thus supporting *H3*.

TABLE 6: RESULTS REGRESSION ANALYSES ROBUSTNESS CHECK – DEPENDENT VARIABLE

	<i>Model 16</i>	<i>Model 17</i>	<i>Model 18</i>
	Emissions OECD countries	Renewable energy consumption	Greenhouse gas emissions
FDI	0.18 (0.06) [p=0.003]	-0.03 (0.02) [p=0.068]	0.01(0.00) [p=0.165]
FDIxRegulatory	-0.03 (0.03) [p=0.022]	-0.02 (0.04) [p=0.533]	0.01 (0.01) [p=0.621]
FDIxEPS	-0.11(0.05) [p=0.017]	0.06 (0.03) [p=0.031]	-0.02 (0.01) [p=0.002]
Regulatory Quality	0.13(0.08) [p=0.137]	0.12 (0.13) [p=0.370]	-0.01 (0.06) [p=0.887]
EPS	-0.00 (0.05) [p=0.969]	0.08 (0.07) [p=0.231]	-0.03(0.02) [p=0.236]
GDP	0.48 (0.10) [p=4.726e-06]	-0.51 (0.14) [p=0.000]	0.32 (0.06) [p=7.666e-08]
Trade Openness	0.14 (0.05) [p=0.005]	0.00 (0.00) [p=0.201]	-0.00 (0.00) [p=0.007]
Industrialization	0.11 (0.05) [p=0.253]	0.03 (0.02) [p=0.070]	0.01 (0.01) [p=0.215]
Population	0.70 (1.25) [p=0.575]	-2.09 (0.90) [p=0.020]	1.46 (0.37) [p=0.000]
Observations	537	658	658
R ²	0.294	0.391	0.566
log-Likelihood	300.873	58.876	724.974

Note: Clustered robust standard errors in parentheses

5 Discussion

5.1 Findings and contributions

The findings of this thesis indicate that greater FDI inflows result in increased CO₂ emissions (*H1*). Furthermore, this relationship is more pronounced in countries with lower EPS (*H3*). In contrast, in countries with high EPS, FDI inflows may even lead to a reduction in emissions. These results highlight the crucial role that environmental policies play in mitigating the adverse environmental impacts of FDI.

The significant increase in emissions due to higher FDI inflows emphasizes the importance of revisiting the debate of the pollution havens and the halo hypothesis. The results align with the pollution haven hypothesis, suggesting that firms may relocate to countries with less stringent environmental regulations, thereby increasing emissions (Mabey & McNally, 1999). Notably, this increase in emissions due to FDI is evident in both the large and small samples. While the pollution hypothesis is often expected to apply in developing countries (Singhania & Saini, 2021), the finding that increased FDI inflows also lead to higher emissions in a sample consisting of only OECD countries indicates that the pollution haven hypothesis is still present, contrary to expectations from the halo hypothesis. These findings highlight that even in developed countries, it is important for policymakers to facilitate the transfer and adoption of efficient and the latest environmentally friendly technology to reduce emissions.

The interaction variable between FDI and regulatory quality was not significant in the baseline analysis, contrary to different theories suggesting that regulatory quality is important for emissions reduction (Huang et al., 2022; Karim et al., 2022). However, these results are consistent with Khan et al. (2022), who argue that regulatory quality serves as a poor governance indicator. At first sight, regulatory quality seems to serve as a poor indicator, but it can still play an important role considering different factors. Namely, the results of the interaction variable became significant when considering lagged EPS (Table 4). This finding contributes to the literature showing that having strong EPS initially (measured with the lagged values) is important, and then how high regulatory quality further strengthens this effect. In this way, both regulatory quality and EPS interact to influence environmental outcomes and the effectiveness of FDI.

While this latter finding is not tested in different ways in this thesis, the results afterwards provided some insights. Firstly, EPS targets and discourages polluting behaviour by setting explicit or implicit costs. Through these associated costs, companies are incentivized to reduce pollution. High regulatory quality can amplify its effects by ensuring that policies are implemented effectively and efficiently that align with EPS. High regulatory quality ensures that businesses comply with environmental policies, due to better enforcement mechanisms. Moreover, the moderating effect between FDI and regulatory quality within generally more developed OECD countries is significant (Model 16, Table 6). This may be because developed countries have more environmental agreements and higher EPS, allowing regulations to play a more effective role. As a result, countries with high regulatory quality are better positioned to participate in (and benefit from) international environmental agreements, further strengthening their environmental policies. Overall, while *H2* still cannot be accepted, the results from different analyses provide room for discussion and interpretation, indicating that regulatory quality is important.

The interaction variable between FDI and EPS also provides important insights. This thesis contributes to research by considering the impact of the recently updated EPS in 2021. The moderating variable indicated in the baseline, as well as in almost all alternative analyses, shows a significant effect, meaning that FDI can contribute to greater environmental quality when having high EPS. This supports the halo hypothesis, and shows the importance that environmental policies putting an explicit or implicit price on polluting or environmentally harmful behaviour.

The findings also offer insights into participation in international environmental agreements. Countries involved in these agreements experience that FDI inflows result in a lower increase (or even decrease) in emissions. Although this effect is less pronounced compared to the impact of EPS, it is still significant. Consequently, countries should continue striving to harmonize environmental standards and norms to prevent a race to the bottom in environmental regulations. This supports the theory that environmental collaboration is important for environmental quality (Gölgeci et al., 2019). Ultimately leading to a reduction in emissions.

In summary, this thesis enhances the understanding of the adverse environmental consequences of FDI inflows, highlighting the crucial role of environmental policy stringency in mitigating emissions. Policymakers must recognize that these challenges exist, even in relatively more developed countries. Therefore, policies need to focus on the stringency of their environmental policies to reduce emissions associated with economic activities. This can be achieved through investments in implementing an implicit or explicit price on polluting behaviours. Additionally, participating in international agreements also enhances overall environmental quality, highlighting the importance of continued engagement in these agreements.

5.2 Limitations and future research

Despite the valuable insights of this thesis, there are several limitations. One important concern is the issue of endogeneity, where there is the possibility that the relationship between FDI inflows and emissions is influenced by factors not included in the model. These factors may affect both FDI inflows and emissions. Future research can apply more advanced economic techniques, such as the instrumental variable (IV) method, to address these potential endogeneity issues more robustly. Although this thesis did not incorporate such techniques due to time constraints, it did include multiple control variables grounded in theory, which already reduced the risk of endogeneity. The variables include the broad and influential effects of overall economic activity, market size, and trade dynamics, which are critical in influencing both environmental and FDI outcomes. While the control variables may not completely eliminate endogeneity, they significantly mitigate its impact, particularly in the context of emissions and FDI. This approach ensures that the primary relationships are already largely accounted for.

The regulatory quality variable is insignificant in almost all analyses, in contrast to the expected theory. A potential reason for this is that while regulatory quality is less broad than institutional quality, it still encompasses a wide range of factors. Regulatory quality includes other institutional quality determinants beyond environmental factors, with financial elements also influencing its impact (Abbas et al., 2021). While the theory is strong, a potential reason for the insignificant results lies in the measurement of the variable in this thesis. An explanation for this could be that the thesis only focused on one of the six aggregate governance indications. Future

research should explore alternative approaches to measure regulatory quality, particularly because the current method results in insignificant effects that do not align with the theory.

Moreover, the interaction between FDI and regulatory quality shows a significant effect on reducing emissions when including lagged values of EPS. This finding is noteworthy, but it should be noted that this is almost the only time where the variable remains significant. This could imply that regulatory quality alone, without considering changes in EPS over time, does not strongly influence how FDI affects emissions. It suggests that regulatory quality may be influenced by various factors and could be sensitive to different model specifications. Moreover, it is crucial for future studies to incorporate moderating variables that interact with regulatory quality, thereby clarifying its specific effects.

There are also limitations regarding international environmental agreements. The dataset treats countries that have signed but have not become parties to the agreements under a given convention or treaty as non-participants. However, this approach may overlook situations where countries do not fully comply or only meet minimal requirements to decrease their emissions. Moreover, greenwashing is also a potential issue. This reduces the credibility of the international environmental agreement variable and affects interpretations of the results in the alternative operationalization analysis.

Furthermore, the baseline data for this research primarily focuses on OECD countries, excluding the poorest countries. This focus may limit the generalizability of the findings to non-OECD countries, particularly those with significantly different economic structures and environmental policy impacts. For future research, it is essential to gain better insights into the climate regulations in poorer countries. Understanding how environmental policies interact with FDI inflows and their impact on emissions is crucial for developing strategies to mitigate environmental degradation globally. Future research should focus on the EPS of low-income countries, as this data is currently lacking. The EPS index is based on the degree to which policies put an implicit or explicit price on environmentally harmful behaviour. Future research can also take a look into the difference between the implicit and explicit focus of policies.

Addressing these limitations and exploring the opportunities for future research contributes to a more comprehensive understanding of the complex interactions between FDI, regulatory quality, EPS, and emissions outcomes globally.

6 Conclusion

This thesis aimed to explain the environmental impacts of FDI inflows, specifically examining their effect on CO₂ emissions and the moderating roles of regulatory quality and environmental policy stringency. The analysis provided strong support for *H1* and *H3*. The data consistently showed that higher FDI inflows lead to increased emissions, a relationship that also remained significant across different robustness checks and alternative operationalization measures. This finding is in line with concerns that FDI inflows increase environmental degradation, particularly in terms of CO₂ emissions.

H2, which proposed that the impact of FDI on emissions would be higher in countries with low regulatory quality, is not supported by the data. The results for *H3* are significant for all robustness checks and alternative operationalization measures. Both the baseline analysis measured with EPS and the alternative operationalization, including participation in international environmental agreements, support the hypothesis. These results suggest that the presence and enforcement of strong environmental policies are crucial in mitigating the negative impacts that are associated with FDI.

The conclusion from this thesis is that while FDI inflows bring economic benefits, without environmental safeguards, FDI can also lead to significant environmental harm. Policymakers should be aware of these potential downsides and work towards strengthening environmental policy to ensure that the economic benefits of FDI do not come at an unsustainable environmental cost. However, when strong environmental policies are in place, FDI can lead to reduced emissions, supporting the pollution halo hypothesis. In summary, this thesis contributes to the understanding of the environmental consequences of FDI, emphasizing the importance of environmental policy stringency in controlling emissions.

References

- Abbas, H. S. M., Xu, X., Sun, C., Ullah, A., Nabi, G., Gillani, S., & Raza, M. a. A. (2021). Sustainable Use of Energy Resources, Regulatory Quality, and Foreign Direct Investment in Controlling GHGs Emissions among Selected Asian Economies. *Sustainability*, *13*(3), 1123. <https://doi.org/10.3390/su13031123>
- Ali, S., Dogan, E., Chen, F., & Khan, Z. (2020). International trade and environmental performance in top ten-emitters countries: The role of eco-innovation and renewable energy consumption. *Sustainable Development*, *29*(2), 378–387. <https://doi.org/10.1002/sd.2153>
- Aller, C., Ductor, L., & Grechyna, D. (2021). Robust determinants of CO2 emissions. *Energy Economics*, *96*, 105154. <https://doi.org/10.1016/j.eneco.2021.105154>
- Ang, J. B. (2009). CO2 emissions, research and technology transfer in China. *Ecological Economics*, *68*(10), 2658–2665. <https://doi.org/10.1016/j.ecolecon.2009.05.002>
- Arora, N. K., & Mishra, I. (2019). United Nations Sustainable Development Goals 2030 and environmental sustainability: race against time. *Environmental Sustainability*, *2*(4), 339–342. <https://doi.org/10.1007/s42398-019-00092-y>
- Aziz, A., & Makkawi, B. (2012). Relationship between Foreign Direct Investment and Country Population. *International Journal of Business and Management*, *7*(8). <https://doi.org/10.5539/ijbm.v7n8p63>
- Bae, M. G., Wang, Y. C., & Liu, N. (2022). Revisiting the relationship between the strength of environmental regulation and foreign direct investment. *Frontiers in Psychology*, *13*, 8. <https://doi.org/10.3389/fpsyg.2022.899918>

Bakhsh, S., Yin, H., & Shabir, M. (2021). Foreign investment and CO2 emissions: do technological innovation and institutional quality matter? Evidence from system GMM approach.

Environmental Science and Pollution Research, 28(15), 19424–19438.

<https://doi.org/10.1007/s11356-020-12237-2>

Boamah, V., Tang, D., Zhang, Q., & Zhang, J. (2023). Do FDI Inflows into African Countries Impact Their CO2 Emission Levels? *Sustainability*, 15(4), 3131.

<https://doi.org/10.3390/su15043131>

Bose, S., Minnick, K., & Shams, S. (2021). Does carbon risk matter for corporate acquisition decisions? *Journal of Corporate Finance*, 70, 102058.

<https://doi.org/10.1016/j.jcorpfin.2021.102058>

BRICS. (n.d.). *BRICS*. Retrieved May 22, 2024, from <https://infobrics.org/>

Chen, F., Hussain, M., Khan, J. A., Mir, G. M., & Khan, Z. (2021). Voluntary disclosure of greenhouse gas emissions by cities under carbon disclosure project: A sustainable development approach. *Sustainable Development (Bradford)*, 29(4), 719–727.

<https://doi.org/10.1002/sd.2169>

Chen, Q., Mao, Y., & Morrison, A. M. (2021). Impacts of environmental regulations on tourism carbon emissions. *International Journal of Environmental Research and Public Health/International Journal of Environmental Research and Public Health*, 18(23),

12850. <https://doi.org/10.3390/ijerph182312850>

12850. <https://doi.org/10.3390/ijerph182312850>

Eskeland, G. S., & Harrison, A. E. (2003). Moving to greener pastures? Multinationals and the pollution haven hypothesis. *Journal of Development Economics*, 70(1), 1–23.

[https://doi.org/10.1016/s0304-3878\(02\)00084-6](https://doi.org/10.1016/s0304-3878(02)00084-6)

- Farooq, S., Öztürk, İ., Majeed, M. T., & Akram, R. (2022). Globalization and CO2 emissions in the presence of EKC: A global panel data analysis. *Gondwana Research*, 106, 367–378.
<https://doi.org/10.1016/j.gr.2022.02.002>
- Gani, A. (2012). THE RELATIONSHIP BETWEEN GOOD GOVERNANCE AND CARBON DIOXIDE EMISSIONS: EVIDENCE FROM DEVELOPING ECONOMIES. *Journal of Economic Development*, 37(1), 77–93. <https://doi.org/10.35866/caujed.2012.37.1.004>
- Gölgeci, I., Gligor, D. M., Tatoglu, E., & Arda, O. A. (2019). A relational view of environmental performance: What role do environmental collaboration and cross-functional alignment play? *Journal of Business Research*, 96, 35–46.
<https://doi.org/10.1016/j.jbusres.2018.10.058>
- Harring, N. (2014). Corruption, inequalities and the perceived effectiveness of economic pro-environmental policy instruments: A European cross-national study. *Environmental Science & Policy*, 39, 119–128. <https://doi.org/10.1016/j.envsci.2013.08.011>
- Hayat, A. (2019). Foreign direct investments, institutional quality, and economic growth. *Journal of International Trade & Economic Development*, 28(5), 561–579.
<https://doi.org/10.1080/09638199.2018.1564064>
- Hoechle, D. (2007). Robust Standard Errors for Panel Regressions with Cross-Sectional Dependence. *the Stata Journal*, 7(3). <https://doi.org/10.1177/1536867x0700700301>
- Huang, Y., Chen, F., Wei, H., Xiang, J., Xu, Z., & Akram, R. (2022). The Impacts of FDI inflows on carbon emissions: Economic development and regulatory quality as moderators. *Frontiers in Energy Research*, 9. <https://doi.org/10.3389/fenrg.2021.820596>

- Ibrahim, M. H., & Law, S. H. (2015). Institutional Quality and CO2 Emission–Trade Relations: Evidence from Sub-Saharan Africa. *South African Journal of Economics*, 84(2), 323–340. <https://doi.org/10.1111/saje.12095>
- Johnson, A. (2006). The effects of FDI inflows on host country economic growth. *RePEc: Research Papers in Economics*. <https://EconPapers.repec.org/RePEc:hhs:cesisp:0058>
- Karim, S., Appiah, M., Naeem, M. A., Lucey, B. M., & Li, M. (2022). Modelling the role of institutional quality on carbon emissions in Sub-Saharan African countries. *Renewable Energy*, 198, 213–221. <https://doi.org/10.1016/j.renene.2022.08.074>
- Kaufmann, D., & Kraay, A. (n.d.). *Worldwide Governance Indicators*. World Bank. Retrieved April 19, 2024, from <https://www.worldbank.org/en/publication/worldwide-governance-indicators>
- Khan, H., Weili, L., & Khan, I. (2022). The role of institutional quality in FDI inflows and carbon emission reduction: evidence from the global developing and belt road initiative countries. *Environmental Science and Pollution Research*, 29(20), 30594–30621. <https://doi.org/10.1007/s11356-021-17958-6>
- Kolstad, C. D., & Xing, Y. (1998). Do lax environmental regulations attract foreign investment. *RePEc: Research Papers in Economics*. <https://econpapers.repec.org/RePEc:cdl:ucsbec:qt3268z4rx>
- Kruse, T., Dechezleprêtre, A., Saffar, R., Robert, L., & De Serres, A. (2022). Measuring environmental policy stringency in OECD countries. In *OECD Economics Department Working Papers*. <https://doi.org/10.1787/90ab82e8-en>

- Lau, L., Choong, C., & Eng, Y. (2014). Carbon dioxide emission, institutional quality, and economic growth: Empirical evidence in Malaysia. *Renewable Energy*, 68, 276–281. <https://doi.org/10.1016/j.renene.2014.02.013>
- Lee, J. W. (2013). The contribution of foreign direct investment to clean energy use, carbon emissions and economic growth. *Energy Policy*, 55, 483–489. <https://doi.org/10.1016/j.enpol.2012.12.039>
- Li, X., & Lin, B. (2013). Global convergence in per capita CO2 emissions. *Renewable & Sustainable Energy Reviews*, 24, 357–363. <https://doi.org/10.1016/j.rser.2013.03.048>
- Liargovas, P. G., & Skandalis, K. S. (2011). Foreign Direct Investment and trade openness: The case of developing economies. *Social Indicators Research*, 106(2), 323–331. <https://doi.org/10.1007/s11205-011-9806-9>
- Lin, H., Wang, X., Bao, G., & Xiao, H. (2022). Heterogeneous spatial effects of FDI on CO2 emissions in China. *Earth's Future*, 10(1). <https://doi.org/10.1029/2021ef002331>
- Mabey, N., & McNally, R. (1999). Foreign Direct Investment and the Environment: From Pollution Havens to Sustainable Development. In *WWF-UK*. WWF-UK.
- Mahmood, H., Hassan, S., Tanveer, M., & Ahmad, A. (2022). The effects of rule of law, regulatory quality, and renewable energy on CO2 emissions in South Asia. *International Journal of Energy Economics and Policy*, 12(6), 16–21. <https://doi.org/10.32479/ijeep.13468>
- Melitz, M. J. (2003). The impact of trade on Intra-Industry reallocations and aggregate industry productivity. *Econometrica*, 71(6), 1695–1725. <https://doi.org/10.1111/1468-0262.00467>
-

- Mert, M., & Çağlar, A. E. (2020). Testing pollution haven and pollution halo hypotheses for Turkey: a new perspective. *Environmental Science and Pollution Research*, 27(26), 32933–32943. <https://doi.org/10.1007/s11356-020-09469-7>
- Mielnik, O., & Goldemberg, J. (2002). Foreign direct investment and decoupling between energy and gross domestic product in developing countries. *Energy Policy*, 30(2), 87–89. [https://doi.org/10.1016/s0301-4215\(01\)00080-5](https://doi.org/10.1016/s0301-4215(01)00080-5)
- Mills, B. J. W., Krause, A. J., Scotese, C. R., Hill, D. J., Shields, G., & Lenton, T. M. (2019). Modelling the long-term carbon cycle, atmospheric CO₂, and Earth surface temperature from late Neoproterozoic to present day. *Gondwana Research*, 67, 172–186. <https://doi.org/10.1016/j.gr.2018.12.001>
- OECD. (n.d.). *Our global reach*. Retrieved May 22, 2024, from <https://www.oecd.org/about/members-and-partners/>
- Olofsdotter, K. (1998). Foreign direct investment, country capabilities and economic growth. *Weltwirtschaftliches Archiv*, 134(3), 534–547. <https://doi.org/10.1007/bf02707929>
- Qiu, Q., & Chen, J. (2020). Natural resource endowment, institutional quality and China's regional economic growth. *Resources Policy*, 66, 101644. <https://doi.org/10.1016/j.resourpol.2020.101644>
- Ringquist, E. J., & Kostadinova, T. (2004). Assessing the effectiveness of international environmental agreements: the case of the 1985 Helsinki Protocol. *American Journal of Political Science*, 49(1), 86–102. <https://doi.org/10.1111/j.0092-5853.2005.00112.x>
- Rock, M. T. (1996). Pollution intensity of GDP and trade policy: Can the World Bank be wrong? *World Development*, 24(3), 471–479. [https://doi.org/10.1016/0305-750x\(95\)00152-3](https://doi.org/10.1016/0305-750x(95)00152-3)
-

Sadiqa, B. A., Zaman, K., Rehman, F. U., Nassani, A. A., Haffar, M., & Abro, M. M. Q. (2022).

Evaluating race-to-the-top/bottom hypothesis in high-income countries: controlling emissions cap trading, inbound FDI, renewable energy demand, and trade openness.

Environmental Science and Pollution Research, 29(33), 50552–50565.

<https://doi.org/10.1007/s11356-022-19385-7>

Salman, M., Long, X., Dauda, L., & Mensah, C. N. (2019). The impact of institutional quality on

economic growth and carbon emissions: Evidence from Indonesia, South Korea and

Thailand. *Journal of Cleaner Production*, 241, 118331.

<https://doi.org/10.1016/j.jclepro.2019.118331>

Samimi, A. J., Ahmadpour, M., & Ghaderi, S. (2012). Governance and environmental degradation

in MENA region. *Procedia - Social and Behavioral Sciences*, 62, 503–507.

<https://doi.org/10.1016/j.sbspro.2012.09.082>

Sapkota, P., & Bastola, U. (2017). Foreign direct investment, income, and environmental

pollution in developing countries: Panel data analysis of Latin America. *Energy*

Economics, 64, 206–212. <https://doi.org/10.1016/j.eneco.2017.04.001>

Selden, T. M., & Song, D. (1994). Environmental quality and development: Is there a Kuznets

curve for air pollution emissions? *Journal of Environmental Economics and Management*,

27(2), 147–162. <https://doi.org/10.1006/jeem.1994.1031>

Shahbaz, M., Nasreen, S., Abbas, F., & Anis, O. (2015). Does foreign direct investment impede

environmental quality in high-, middle-, and low-income countries? *Energy Economics*,

51, 275–287. <https://doi.org/10.1016/j.eneco.2015.06.014>

Singhania, M., & Saini, N. (2021). Demystifying pollution haven hypothesis: Role of FDI. *Journal of Business Research*, 123, 516–528. <https://doi.org/10.1016/j.ibusres.2020.10.007>

Studenmund, A. H. (2017). *Using Econometrics: A Practical guide* (Vol. 7).

Tsurumi, T., & Managi, S. (2010). Decomposition of the environmental Kuznets curve: scale, technique, and composition effects. *Environmental Economics and Policy Studies*, 11(1–4), 19–36. <https://doi.org/10.1007/s10018-009-0159-4>

Udemba, E. N. (2021). Mitigating environmental degradation with institutional quality and foreign direct investment (FDI): new evidence from asymmetric approach. *Environmental Science and Pollution Research International*, 28(32), 43669–43683. <https://doi.org/10.1007/s11356-021-13805-w>

UN. (n.d.-a). *Ozone Secretariat*. UN Environment Programme. Retrieved April 1, 2024, from <https://ozone.unep.org/>

UN. (n.d.-b). *Stockholm Convention*. Pops. Retrieved April 1, 2024, from <https://chm.pops.int/>

United Nations. (n.d.-a). *Member States*. Retrieved February 25, 2024, from <https://www.un.org/en/about-us/member-states>

United Nations. (n.d.-b). *The Paris Agreement*. United Nations Climate Change. Retrieved April 1, 2024, from <https://unfccc.int/process-and-meetings/the-paris-agreement>

United Nations. (n.d.-c). *United Nations Framework Convention on Climate Change*. UNFCCC. Retrieved April 1, 2024, from <https://unfccc.int/>

United Nations. (n.d.-d). *What is the Kyoto Protocol?* United Nations Climate Change. Retrieved April 1, 2024, from https://unfccc.int/kyoto_protocol

Wang, M. L., Ntim, V. S., Yang, J., Qiongjie, Z., & Li-Min, G. (2021). Effect of institutional quality and foreign direct investment on economic growth and environmental quality: evidence from African countries. *Ekonomika Istraživanja-economic Research*, 35(1), 4065–4091.

<https://doi.org/10.1080/1331677x.2021.2010112>

Wawrzyniak, D., & Doryń, W. (2020). Does the quality of institutions modify the economic growth-carbon dioxide emissions nexus? Evidence from a group of emerging and developing countries. *Ekonomika Istraživanja/Ekonomika Istraživanja*, 33(1), 124–144.

<https://doi.org/10.1080/1331677x.2019.1708770>

Appendices

Appendix A: Figures

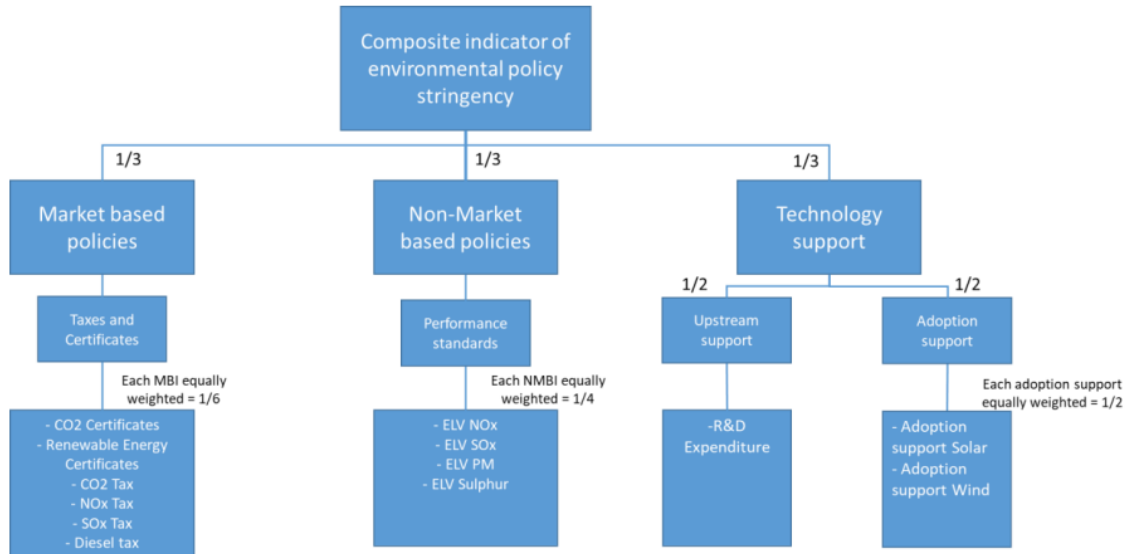


FIGURE A1: ENVIRONMENTAL POLICY STRINGENCY INDEX - THE AGGREGATION STRUCTURE (KRUSE ET AL., 2022)

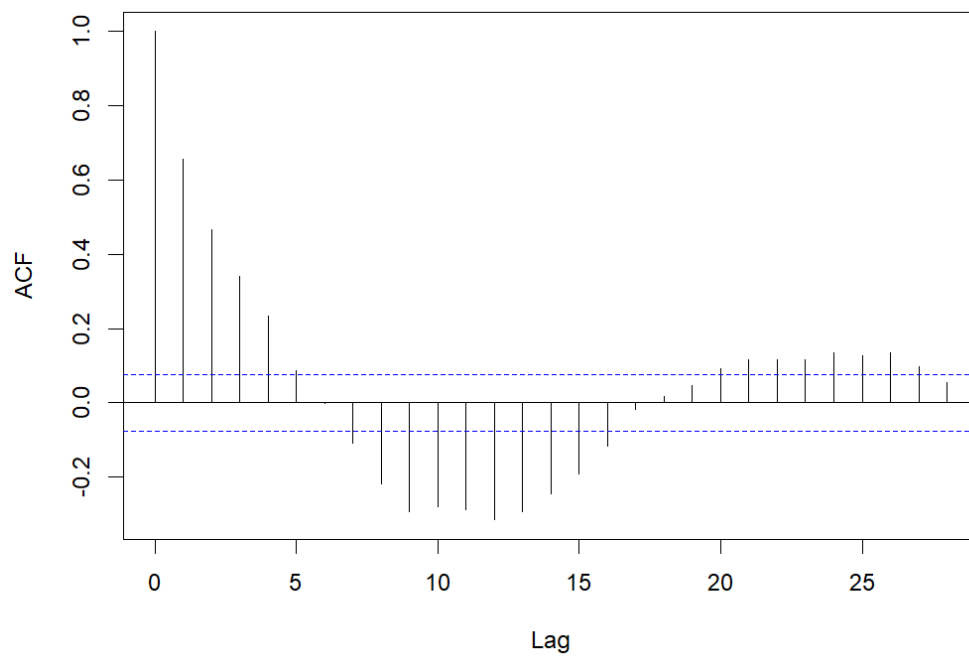


FIGURE A2: AUTOCORRELATION IN THE RESIDUALS – BASELINE ANALYSIS

Appendix B: Included countries

TABLE B1: INCLUDED COUNTRIES BASELINE ANALYSIS

1. Australia
2. Austria
3. Belgium
4. Brazil
5. Canada
6. China
7. Czechia
8. Denmark
9. Finland
10. France
11. Germany
12. Greece
13. Hungary
14. India
15. Indonesia
16. Ireland
17. Italy
18. Japan
19. Korea, Rep.
20. Netherlands
21. Norway
22. Poland
23. Portugal
24. Russian Federation
25. Slovak Republic
26. Slovenia
27. South Africa
28. Spain
29. Sweden
30. Switzerland
31. Turkey
32. United Kingdom
33. United States

TABLE B2: INCLUDED COUNTRIES ROBUSTNESS CHECK

1. Afghanistan	51. Eritrea	101. Mauritius	151. Turkmenistan
2. Albania	52. Estonia	102. Mexico	152. Uganda
3. Algeria	53. Eswatini	103. Micronesia, Fed. Sts.	153. Ukraine
4. Angola	54. Ethiopia	104. Moldova	154. United Arab Emirates
5. Antigua and Barbuda	55. Fiji	105. Mongolia	155. United Kingdom
6. Argentina	56. Finland	106. Montenegro	156. United States
7. Armenia	57. France	107. Morocco	157. Uruguay
8. Australia	58. Gabon	108. Namibia	158. Uzbekistan
9. Austria	59. Gambia, The	109. Nepal	159. Vanuatu
10. Azerbaijan	60. Georgia	110. Netherlands	160. Venezuela, RB
11. Bahamas, The	61. Germany	111. New Zealand	161. Viet Nam
12. Bahrain	62. Ghana	112. Nicaragua	162. Zambia
13. Bangladesh	63. Greece	113. Niger	163. Zimbabwe
14. Barbados	64. Guatemala	114. North Macedonia	
15. Belarus	65. Guinea	115. Norway	
16. Belgium	66. Guinea-Bissau	116. Oman	
17. Belize	67. Guyana	117. Pakistan	
18. Benin	68. Haiti	118. Panama	
19. Bhutan	69. Honduras	119. Papua New Guinea	
20. Bolivia	70. Hungary	120. Paraguay	
21. Bosnia and Herzegovina	71. Iceland	121. Peru	
22. Botswana	72. India	122. Philippines	
23. Brazil	73. Indonesia	123. Poland	
24. Brunei Darussalam	74. Iran, Islamic Rep.	124. Portugal	
25. Burkina Faso	75. Iraq	125. Qatar	
26. Burundi	76. Ireland	126. Romania	
27. Cabo Verde	77. Israel	127. Russian Federation	
28. Cambodia	78. Italy	128. Rwanda	
29. Cameroon	79. Jamaica	129. Saudi Arabia	
30. Canada	80. Japan	130. Senegal	
31. Central African Republic	81. Jordan	131. Serbia	
32. Chad	82. Kazakhstan	132. Seychelles	
33. Chile	83. Kenya	133. Sierra Leone	
34. China	84. Kiribati	134. Singapore	
35. Colombia	85. Korea, Rep.	135. Slovak Republic	
36. Congo, Dem. Rep.	86. Kuwait	136. Slovenia	
37. Congo, Rep.	87. Kyrgyz Republic	137. South Africa	
38. Costa Rica	88. Lao PDR	138. Spain	
39. Cote d'Ivoire	89. Latvia	139. Sri Lanka	
40. Croatia	90. Lebanon	140. Sudan	
41. Cyprus	91. Lesotho	141. Sweden	
42. Czechia	92. Libya	142. Switzerland	
43. Denmark	93. Lithuania	143. Tajikistan	
44. Djibouti	94. Luxembourg	144. Tanzania	
45. Dominica	95. Madagascar	145. Thailand	
46. Dominican Republic	96. Malaysia	146. Timor-Leste	
47. Ecuador	97. Mali	147. Togo	
48. Egypt, Arab Rep.	98. Malta	148. Tonga	
49. El Salvador	99. Marshall Islands	149. Tunisia	
50. Equatorial Guinea	100. Mauritania	150. Turkey	

TABLE B3: MISSING VALUES - WHOLE DATASET

	Missing values
Emissions	83
FDI	936
Regulatory	1890
EPS	4960
AgreeKyoto	0
AgreeMontreal	0
AgreeParis	0
AgreeStockholm	0
AgreeUN	0
GDP	241
Trade Openness	1031
Industrialization	1026
Population	0

Appendix C: OLS

TABLE C1: OLS YEAR AND COUNTRY DUMMIES

Predictors	Emissions Estimates
(Intercept)	-2.74 *** (0.46)
FDI	0.14 *** (0.02)
Regulatory Quality	0.01 (0.03)
EPS	-0.03 (0.02)
FDIxRegulatory	-0.01 (0.02)
FDIxEPS	-0.12 *** (0.02)
GDP	0.67 *** (0.04)
Trade Openness	-0.16 *** (0.04)
Industrialization	0.09 ** (0.03)
Population	2.19 *** (0.32)
yeardummiesyear1996	0.79 *** (0.08)
yeardummiesyear1998	0.78 *** (0.08)
yeardummiesyear2000	0.79 *** (0.07)
yeardummiesyear2002	0.81 *** (0.07)
yeardummiesyear2003	0.73 *** (0.07)

yearummiesyear2004	0.62 *** (0.06)
yearummiesyear2005	0.57 *** (0.06)
yearummiesyear2006	0.56 *** (0.05)
yearummiesyear2007	0.44 *** (0.05)
yearummiesyear2008	0.37 *** (0.05)
yearummiesyear2009	0.34 *** (0.05)
yearummiesyear2010	0.36 *** (0.05)
yearummiesyear2011	0.28 *** (0.05)
yearummiesyear2012	0.28 *** (0.05)
yearummiesyear2013	0.24 *** (0.05)
yearummiesyear2014	0.18 *** (0.05)
yearummiesyear2015	0.24 *** (0.05)
yearummiesyear2016	0.22 *** (0.05)
yearummiesyear2017	0.19 *** (0.04)
yearummiesyear2018	0.18 *** (0.05)
yearummiesyear2019	0.11 * (0.05)
countryummiesCountryAustralia	3.86 *** (0.53)

countrydummiesCountryAustria	4.03 *** (0.72)
countrydummiesCountryBelgium	4.23 *** (0.66)
countrydummiesCountryBrazil	-1.80 *** (0.13)
countrydummiesCountryCanada	3.25 *** (0.44)
countrydummiesCountryChina	-2.35 *** (0.34)
countrydummiesCountryCzechia	4.89 *** (0.66)
countrydummiesCountryDenmark	4.62 *** (0.80)
countrydummiesCountryFinland	4.98 *** (0.81)
countrydummiesCountryFrance	0.59 (0.31)
countrydummiesCountryGermany	1.08 *** (0.26)
countrydummiesCountryGreece	4.05 *** (0.67)
countrydummiesCountryHungary	4.01 *** (0.67)
countrydummiesCountryIndia	-3.71 *** (0.34)
countrydummiesCountryIndonesia	-1.60 *** (0.14)
countrydummiesCountryIreland	5.20 *** (0.83)
countrydummiesCountryItaly	1.09 ** (0.33)
countrydummiesCountryJapan	0.26 (0.19)

countrydummiesCountryKorea, Rep	2.30 *** (0.37)
countrydummiesCountryNetherlands	3.61 *** (0.57)
countrydummiesCountryNorway	4.46 *** (0.83)
countrydummiesCountryPoland	2.79 *** (0.41)
countrydummiesCountryPortugal	3.46 *** (0.67)
countrydummiesCountryRussian Federation	1.57 *** (0.17)
countrydummiesCountrySlovak Republic	5.21 *** (0.79)
countrydummiesCountrySlovenia	6.40 *** (0.99)
countrydummiesCountrySouth Africa	2.55 *** (0.36)
countrydummiesCountrySpain	1.51 *** (0.38)
countrydummiesCountrySweden	2.97 *** (0.70)
countrydummiesCountrySwitzerland	3.28 *** (0.73)
countrydummiesCountryTurkiye	0.81 ** (0.29)
countrydummiesCountryUnited Kingdom	1.11 *** (0.32)
Observations	658
R ²	0.976
log-Likelihood	295.610

* p<0.05 ** p<0.01 *** p<0.001

Appendix D: Tests

TABLE D1: VARIANCE INFLATION FACTOR TEST – NON-STANDARDIZED DATA

	VIF	1/VIF
FDI	3.9407e+04	2.5376e-05
Regulatory Quality	1.7402e+03	5.7466e-04
EPS	8.6385e+03	1.1576e-04
FDIxRegulatory	6.4488e+04	1.5507e-05
FDIxEPS	3.2745e+05	3.0539e-06
GDP	2.1934e+03	4.5591e-04
Trade Openness	6.5253e+06	1.5325e-07
Industrialization	1.8807e+05	5.3171e-06
Population	7.6601e+01	1.3055e-02

TABLE D2: VARIANCE INFLATION TEST – STANDARDIZED DATA

	VIF	1/VIF
FDI	9672.9793	1.0338e-04
Regulatory Quality	1376.5004	7.2648e-04
EPS	2922.4572	3.4218e-04
FDIxRegulatory	7682.7762	1.3016e-04
FDIxEPS	10386.1948	9.6282e-05
GDP	747.36535	1.3380e-03
Trade Openness	1413.2255	7.0760e-04
Industrialization	2245.6308	4.4531e-04
Population	11.2667	8.8757e-02

TABLE D3: HAUSMAN TEST

chisq	df	p-value
345.98	9	<2.2e-16

TABLE D4: BREUSCH-PAGAN TEST

BP	df	p-value
118.92	9	<2.2e-16

TABLE D5: BREUSCH-GODFREY / WOOLDRIDGE TEST

chisq	df	p-value
329.82	15	<2.2e-16

Appendix E: Explanation international environmental agreements

The United Nations Statistics Division included thirteen agreements in the data on participation in selected international environmental agreements. However, this research includes only five agreements to provide a comprehensive understanding of the international efforts to mitigate CO₂ emissions and their potential interaction with FDI. The other agreements address a variety of environmental issues, but their direct relevance to CO₂ emissions or greenhouse gas reduction is less pronounced compared to agreements like the Montreal Protocol, UNFCCC, Kyoto Protocol, Stockholm Convention, and Paris Agreement, which specifically target emissions. The five included agreements are explained in more detail below:

- 1. Montreal Protocol on Substances that Deplete the Ozone Layer:** The Montreal Protocol landmark agreement was signed in 1987 and entered into force in 1989. While not directly related to greenhouse gas emissions, this protocol aims to protect the ozone layer, which indirectly contributes to environmental protection and mitigating climate change (UN, n.d.-a).
- 2. United Nations Framework Convention on Climate Change (UNFCCC):** This framework convention serves as the foundation for international efforts to combat climate change and reduce greenhouse gas emissions. The UNFCCC entered into force in 1994 and provides a platform for countries to work together on solutions (United Nations, n.d.-c).
- 3. Kyoto Protocol:** The Kyoto Protocol was adopted in December 1997. It is an international treaty under the UNFCCC that aims to reduce emissions (mainly CO₂) by developed countries. Developed countries have a heavier burden because of the principle of 'common but differentiated responsibility and respective capabilities'. This principle recognizes that these countries are largely responsible for the current high levels of emissions in the atmosphere. The protocol set specific reduction targets and allowed for emissions trading and clean development projects (United Nations, n.d.-d).

- 4. Stockholm Convention on Persistent Organic Pollutants:** This convention was adopted in 2001. It addresses the elimination or restriction of the production and use of persistent organic pollutants (POPs), some of which are greenhouse gases or contribute to air pollution. The global treaty aims to protect human health and the environment from the effects of POPs (UN, n.d.-b).
- 5. Paris Agreement:** Similar to the Kyoto Protocol, the Paris Agreement focuses on mitigating greenhouse gas emissions and adapting to climate change. It is a global agreement adopted under the UNFCCC in December 2015. Aiming to limit global warming below 2 degrees Celsius, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. By 2020, zero-carbon solutions could be competitive in sectors representing over 70% of global emissions (United Nations, n.d.-b)