



The Significance of Environmental Standards in International Trade Agreements for Sus- tainability

Ishrat Reza

Master's thesis

May 2025

School of Business

Degree program in International Business Management

Reza, Ishrat

The Significance of Environmental Standards in International Trade Agreements for Sustainability

Jyväskylä: Jamk University of Applied Sciences, May 2025, 60 Pages

School of Business, International Business Management, Master's Thesis

Permission for web publication: Yes

Language of publication: English

Abstract

Amidst growing international trade and concurrent concerns about environmental degradation, particularly CO₂ emissions, environmental standards are increasingly included in trade agreements. However, the actual relationship between these standards and sustainability outcomes remains unclear. Existing literature reveals a gap in systematically describing the observed trends between the stringency and enforcement of these environmental provisions and CO₂ emission patterns across diverse national contexts. This thesis addresses this gap through an exploratory, quantitative study. The primary objective was to descriptively analyze the associations between environmental standards (stringency and enforcement), key economic factors (GDP per capita, trade openness, FDI), regulatory quality, and CO₂ emissions trends. The study explored patterns and relationships within a specific sample, aiming to generate propositions for future research rather than test pre-defined hypotheses. Employing an Autoregressive Distributed Lag (ARDL) modelling approach on secondary panel data from the World Development Indicators (WDI) and International Monetary Fund (IMF) for 12 diverse countries over the period 2000-2023, this study shifted from initial hypothesis testing intentions due to sample size limitations (N=12). The descriptive analysis identified several notable long-run associations within the sample: higher environmental policy stringency, stronger enforcement mechanisms, and better regulatory quality were associated with lower CO₂ emissions per capita, while higher GDP per capita was associated with higher CO₂ emissions. Associations for trade openness and FDI were less conclusive. Diagnostic tests indicated potential parameter instability, suggesting these observed relationships should be interpreted cautiously. This research contributes by providing a descriptive analysis of these complex interactions within the studied panel and develops several propositions based on the observed trends. The primary recommendation is for future research to formally test these propositions using larger, more representative datasets suitable for robust hypothesis testing and causal inference, thereby contributing more definitively to understanding how trade agreements can support environmental sustainability.

Keywords/tags (subjects) International Trade Agreements, Environmental Standards, CO₂ Emissions, Sustainability, Policy Stringency, Panel Data Analysis, ARDL Model

Contents

1 Introduction	4
1.1 Background of the Study.....	6
1.2 Significance and Rationale of the Study.....	8
1.3 Research Objectives and Corresponding Research Questions	9
2 Literature Review.....	10
2.1 CO2 Emissions: A Central Indicator of Environmental Impact.....	12
2.2 Stringency of Environmental Standards in Trade Agreements	13
2.3 Enforcement Mechanisms in Environmental Provisions of Trade Agreements.....	14
2.4 Economic Factors Influencing CO2 Emissions: Trade Openness and FDI.....	14
2.5 GDP Per Capita	16
2.6 Regulatory Quality and Environmental Governance.....	16
2.7 Conceptual Framework	18
3 Research Methodology	19
3.1 Research Design	20
3.2 Data Collection and Sources	20
3.3 Econometric Model Specification	23
3.3.1 Rationale for Using an Econometric Approach	23
3.3.2 Equation Formulation.....	24
3.4 Estimation Procedure.....	25
3.4.1 Unit Root Testing	25
3.4.2 Cointegration Testing.....	26
3.4.3 ARDL Model Estimation.....	27
3.4.4 Granger Causality Test.....	28
3.5 Verification of Findings	29
3.6 Research Ethics	31
4 Analysis	32
4.1 Descriptive Statistics	33
4.2 Correlation Matrix.....	35

4.3 Unit Root Testing Results	36
4.4 ARDL Bounds Test for Cointegration	38
4.5 ARDL Model Estimation Results	39
4.5.1 Short-Run Dynamics	40
4.5.2 Long-Run Equilibrium Effects	41
4.5.3 Error Correction Term (ECT)	42
4.5.4 Model Stability Diagnostics: CUSUM and CUSUMQ Tests	42
4.6 Granger Causality Analysis	44
5 Discussion, Conclusion, and Recommendations.....	45
5.1 Discussion of Findings	46
5.2 Conclusion	48
5.3 Limitations of the Study	49
5.4 Recommendations and Implications.....	51
5.4.3 Tentative Policy Considerations	51
5.4.4 Potential Theoretical Implications	51
5.4.5 Suggestions for Future Research.....	52
References	54
Figures	
Figure 1 Conceptual Framework.....	18
Figure 2 CUSUM Plot & CUSUMQ Plot.....	43
Tables:	
Table 1 Gaps in Literature	17
Table 2 Variables, Indicators, and Data Sources.....	21
Table 3 Selected Countries and Justification	22
Table 4 Descriptive Statistics of Key Variables (2000-2023, N=288)	33
Table 5 Pearson Correlation Matrix.....	35
Table 6 ADF Test Results for Stationarity (Variables at Level).....	37

Table 7 ARDL Bounds Test Result for Cointegration.....	39
Table 8 Short-Run Coefficients (Dependent Variable = ΔCO_2).....	40
Table 9 Long-Run Coefficients (Dependent Variable = CO_2).....	41
Table 10 Error Correction Term (ECT) Coefficient	42
Table 11 Granger Causality Test Results.....	44

1 Introduction

International trade has been known to be one of the key economic drivers for quite some time now. Through facilitation of exchange of goods and service across border, international trade has helped economies around the world to reach great heights. At the same time, it is important to note that trade liberalization has raised serious concerns regarding environmental degradation in relation to CO₂ emission among other things (Tian et al., 2022). Therefore, the main challenge surrounding further expansion of international trade lies in trade agreements, balancing both economic growth as well as environmental protection. Many countries have applied sustainability measures in their trade agreements, but their implementation or effectiveness remains questionable (Abman et al. 2024). The purpose of this thesis is to explore the extent to which environmental standards in international trade agreements are associated with sustainability outcomes, particularly concerning trends in CO₂ emissions.

The manner in which environmental sustainability policies are implemented in trade agreements play a crucial role in its effectiveness. Weaker implementation which occurs due to the symbolic intentions behind its implementation, serves only its purpose rather than having an actual impact on the environment (Mahalik et al., 2023). Research shows that when environmental policies are implemented in a stringent manner, they have a positive correlation to better environmental outcomes, especially associated with CO₂. As per the suggestion of Mahalik et al. (2023), environmental policies in the trade agreements between BRICS nation has shown reduction in CO₂ emissions and improvement in air quality. Another study conducted by Murshed et al. (2021) regarding South Asian countries found that stringent environmental regulations in trade agreements showed significant CO₂ reduction. However, the study also shows variations of CO₂ reduction across different countries, suggesting that countries implementing these policies may not implement them in full extent (Abman et al., 2024).

Policy creation and implementation plays a crucial role, but even a greater role in its effectiveness lies with enforcement mechanisms. Without strict enforcements, even the most well thought out policies would fail to show any effectiveness in benefiting the environment. As per the suggestions of Abman et al. (2024), compliance factors such as audits and sanctions can

significantly impact the effect of trade on environmental factors such as CO₂ emissions. However, enforcement of these laws varies across nations due to their institutional and government capabilities in enforcing them. In certain cases, environmental policies are drafted within agreements due to diplomatic or political reasons and therefore its implementation or enforcement of laws remains questionable (Mamasoleiv, 2024).

Economic factors such as foreign direct investment (FDI), as well as trade openness shapes the environmental outcomes within trade agreements. When trade openness is practiced in a correct manner, it can facilitate the adoption of cleaner technologies and promote environmentally friendly practices. Conversely, unregulated trade agreements can further rise environmental degradation, particularly in countries that are less able to implement policies (Corrocher & Mancusi, 2021). The Resource Curse Theory suggest that nations that are blessed with natural resources often struggle with environmentally friendly policy implementation due to their heavy reliance on resource export, neglecting investment and adaptation of green technologies (Safdar et al., 2022). Therefore, it can be stated that the impact of globalization and environmental sustainability lies in the ability to create, implement and enforce policies within a rich and strong regulatory framework.

Another key factor that is important to take under consideration when it comes to impacting environmental outcomes is the Gross Domestic Product (GDP) of a particular country which measures economic health and growth trajectory. This is usually measured through the GDP per capita of a country. A study conducted by Kalantaripor and Alamdarlo (2021) suggest that wealthier countries that have already reached a threshold when it comes to industrialization are more likely to enforce stringent environmental regulatory framework compared to developing countries. This is because developing countries prioritize economic development over environmental concerns as they lack the institutional capability and government regulations to do so. Therefore, strong environmental policy enforcement capabilities are required to ensure sustainability compliance from all countries (Khan et al., 2021).

While many policies regarding environmental sustainability exist in global trade agreements, less research has explored the observable short-term and long-term trends associated with these

policies, particularly concerning CO₂ reduction. Specifically, there appears to be a gap in systematically describing the relationship between the stringency and enforcement of these policies and CO₂ emission patterns within specific groups of countries. By exploring the trends related to environmental standards, enforcement mechanisms, and other factors potentially shaping sustainability outcomes within a selected sample of countries, this research aims to identify patterns and develop propositions regarding how trade agreements might relate to both economic and environmental outcomes. These propositions could inform future studies investigating how agreements might be structured.

By exploring the observed relationships between environmental standards, enforcement mechanisms, and related factors, this research aims to provide observations relevant to the discussion of how trade agreements might be structured to pursue both economic and environmental objectives.

1.1 Background of the Study

International trade has been growing for quite some time now and the implementation of environmental standards in trade policies have been evolving in response to recognizing trade liberalization can have unintentional negative consequences on the environment. Primarily trade agreements focused more on economic growth and reducing trade barriers such as tariffs. However, after recognizing the negative impact of trade liberalization on the environment, policymakers became more conscious about implementing environmental safety strategies to mitigate the negative impact (Mahalik et al., 2023). Even though this positive change in policy making is a step towards a more sustainable environment, its implementation and its effectiveness remains a question especially due to its enforcement which varies across different nations (Abman et al., 2024). Due to the increase of globalization of trade, industries started to flourish, emitting excessing CO₂ in consequence. Previous studies stated that trade liberalization has mixed impact on the environment in varying countries whereby some adapted to greener technologies whilst others focused more on economic growth, further intensifying CO₂ emissions (Jahanger et al., 2022). Pollution haven hypothesis suggest that multinational corporations tend to move in developing countries to utilize their land, labor and capital to lower operational costs,

but in consequence, degrade their environment (Luo et al., 2021). This raised a lot of questions regarding the unintended impact on the environment that trade agreement has, when not taking under consideration environmental safety factors.

The inclusion of environmental safety clauses in trade agreements could be traced back to the early 1990s when policymakers understood the unintentional negative consequences of trade liberalization on the environment (Morin & Rochette, 2017). The first trade agreement to take under consideration the environmental safety factor was NAFTA (North American Free Trade Agreement). Since then, environmental safety concern has become the backbone for many countries' trade agreements. The European Union (EU), has become a pioneer for this cause, implementing various sustainability benchmarks, showing their commitment to fight climate change (Mahalik et al., 2023). However, the extent to which these clauses work in terms of actual tangible environmental benefits, remain a mystery. One of the key factors that influences the implementation process of these policies are compliance mechanism and regulatory stringencies, as they differ in varying countries.

While some of these agreements have specific clauses on maintaining environmental policies, other contain vague statements and non-accountable clauses (Abman et al., 2024). Another key factor is in the effectiveness of enforcement mechanisms of these policies. Studies have found that while policies regarding environmental safety are clearly laid out in clauses are not enforced properly by certain countries due to incompetencies in institutional capabilities and government framework. Only countries with strong regulatory framework are able to enforce sustainability practices (Khan et al., 2021). Other than compliance mechanism and enforcement capabilities, economic factors such as trade openness and FDI also play a crucial role in this matter. Trade openness can promote sustainability practices by facilitating transition to greener technologies. However, enforcement issues could inversely affect the situation. Similarly, FDI could influence host countries to adapt to greener technologies and at the same time it could promote economic benefit, which is resource intensive, further degrading the environment (Ahmed et al., 2021). The economic level of country, often measured through GDP per capita, could further influence the relationship between trade and the environment. Nations with higher GDP per capita tend to spend more on greener technologies to achieve both economic and environmental benefit.

Conversely, countries with lower GDP per capita tend to maximize resource utilization to raise their GDP, consequentially harming the environment (Kalantaripor & Alamdarlo, 2021).

While trade agreements have come a long way in terms of environmental sustainability since the 1990s, there is lack of evidence of its effectiveness in tangible environmental benefits. This study therefore explores this area by utilizing secondary data available on WDI and IMF and employing a robust econometric model to describe observed associations.

1.2 Significance and Rationale of the Study

International trade has undeniably been a primary engine for global economic advancement, particularly since the mid-20th century as globalization reduced barriers like tariffs and bureaucracy. However, this expansion of trade liberalization soon revealed unintended negative consequences, particularly environmental degradation. Recognizing this, policymakers began incorporating environmental considerations into trade agreements, starting notably with NAFTA in the 1990s, with entities like the EU later championing such clauses.

While the inclusion of environmental standards is often hailed as crucial, their practical implications—specifically, their relationship with tangible environmental outcomes like CO₂ emissions trends—remain unclear and under-researched. Few studies have focused on descriptively analyzing the patterns associated with these environmental provisions within trade agreements across diverse countries. This thesis aims to contribute to filling this gap by exploring the relationships between environmental standards (specifically policy stringency and enforcement effectiveness) embedded in international trade agreements and CO₂ emissions trends. Using an Auto Regressive Distributed Lag (ARDL) econometric model primarily for descriptive analysis of secondary data from reputable sources (WDI, IMF), this study will examine observed short-run dynamics and long-run associations for a strategically selected group of 12 countries. This approach allows for an empirical exploration of patterns that may relate to theoretical frameworks like the Pollution Haven and Resource Curse theories within this specific sample context. The identified trends and resulting propositions are expected to be valuable. For policymakers, this research aims to provide preliminary observations that could inform future

investigations into the design and strengthening of environmental clauses. For academia, it offers descriptively analyzed data and propositions for future, larger-scale hypothesis-testing research.

1.3 Research Objectives and Corresponding Research Questions

Building upon the background and identified gaps in understanding the connection between environmental standards in trade agreements and environmental outcomes, this study sets forth several key objectives for exploration within the selected sample. Firstly, the research aims to explore the observed relationship between the stringency of environmental policies in trade agreements and CO₂ emission trends. This objective relates to the debate on whether stricter rules are associated with different environmental trajectories. Stemming from this objective is the primary research question: What patterns emerge when comparing trends in environmental policy stringency within trade agreements and trends in CO₂ emissions for the selected countries? Secondly, recognizing that policies may differ from their implementation, the study seeks to examine the association between enforcement mechanisms for environmental policies in trade agreements and CO₂ emission trends.

The literature suggests enforcement varies significantly and is potentially crucial for outcomes. This leads to the second research question: What relationship is observed between the strength of enforcement mechanisms and CO₂ emission patterns in the sample countries? Finally, environmental outcomes within trade are likely influenced by broader economic contexts. Therefore, the third objective is to describe how economic variables such as GDP, FDI, and trade openness relate to CO₂ emission trends alongside environmental standards within the trade agreements studied.

This objective acknowledges the potential interplay between economic activities and environmental policy variables. Consequently, the third research question asks: How are GDP, FDI, and trade openness associated with CO₂ emission trends in the context of the environmental standards present in the trade agreements of the sample countries? To explore these research questions descriptively, this study will employ a quantitative approach utilizing econometric

analysis. Specifically, an Autoregressive Distributed Lag (ARDL) model will be applied to panel data from 12 selected countries covering the years 2000-2023. This method will be used to describe observed short-run dynamics and long-run associations between environmental standards (including stringency and enforcement), economic factors (trade openness, FDI, GDP per capita), regulatory quality, and CO2 emissions within this specific dataset, thereby exploring the core areas of interest for this research.

2 Literature Review

This chapter synthesizes existing academic literature to establish the theoretical and empirical context for examining the impact of environmental standards in international trade agreements on sustainability, specifically focusing on CO2 emissions. A systematic approach was employed to identify relevant scholarly works. Major academic databases, including Scopus, Web of Science, Google Scholar, and the university's library resources, were searched using a combination of keywords such as "international trade agreements," "environmental standards," "environmental provisions," "CO2 emissions," "carbon emissions," "environmental policy stringency," "enforcement mechanisms," "trade and environment," "Environmental Kuznets Curve," "pollution haven hypothesis," and "resource curse theory." The search focused primarily on peer-reviewed journal articles, relevant books, and working papers published between 1990 (reflecting the rise of environmental clauses post-NAFTA) and 2024 to ensure contemporary relevance. Studies were selected based on their direct relevance to the interplay between trade agreements, environmental standards (particularly stringency and enforcement), economic factors (like FDI, trade openness, GDP), and environmental outcomes (especially CO2 emissions). The identified literature was then organized thematically to explore key theoretical frameworks, empirical findings, identified gaps, and methodological approaches, which collectively inform the hypotheses and conceptual framework developed later in this chapter.

In recent times one of the things that could be noticed is the inclusion of environmental sustainability policies. The intention of these policies lies behind balancing economic development and curbing environmental harm simultaneously (Khan et al., 2021; Mahalik et al.,

2023). Regardless of what the policies might state, understanding how it actually benefits the environment is unclear. Scholars have conducted many studies in the past which showed both positive and negative effects of these policies. For example, Qiu et al. (2022) found that when policies were correctly implemented, it drove countries to adapt to greener technologies, which aided them in harming the environment less. Murshed et al. (2021) interestingly found opposite results. In their study, it showed that stricter environmental policies had the opposite effect as resource intensive industries moved to other locations where there was lesser enforcement of environmental policies. This finding aligns with the pollution haven hypothesis which states that multinational corporations often move to countries with less stringent environmental policies (Levinson, 2008).

When it comes to trade openness, Wang et al. (2023) found that some countries were encouraged to adapt to greener technology to meet environmental sustainability standards. However, trade openness could also sometimes contribute to higher levels of energy consumption which led to more CO₂ emissions. This is primarily due to trade openness's demand for products and transportation rose. Trade diversification in particular, has shown varying results on CO₂ emissions. This is due to the fact that policies affect different industries in unique manner. For example, countries that rely more on resources for export, often struggle to meet environmental standards as they prioritize economic gains (Xiaoman et al., 2021). This supports the resource curse theory. This theory suggests that economies that are rich in natural resources often prioritize economic benefit over environmental sustainability due to their dependence on it (Auty, 1993).

Just because environmental sustainability clauses exist in a trade agreement does not guarantee its effectiveness on the actual environment. Rather, their effectiveness lies behind how these clauses were designed and enforced. Murshed et al. (2021) highlighted that when the enforcement mechanisms are weak and there exists political resistance, impact of environmental policies are often next to none. Moreover, economic globalization can create challenges in aligning national environmental policies with international trade obligations. This happens because conflicting priorities emerge between short-term economic growth and long-term sustainability goals. To address the challenges of globalization, creating environmental clauses in

trade agreement is an important step. However, their effectiveness is influenced by multiple factors. These factors are regulatory quality, enforcement mechanisms, and macroeconomic dynamics.

2.1 CO2 Emissions: A Central Indicator of Environmental Impact

One of the key measurements of understanding environmental impact is CO2 emissions. As industrial activities and energy consumption have increased globally, so has CO2 emissions. Excessive CO2 emission is a leading cause of environmental degradation. To understand what causes CO2 emissions is crucial for policy development in regard to environmental sustainability. The Environmental Kuznets Curve (EKC) hypothesis is a theoretical framework that explains the relationship between economic development and environmental quality (Grossman & Krueger 1991). Furthermore, the EKC hypothesizes that when economic growth occurs initially, environmental degradation is likely to occur. But with time, when income levels reach a certain limit, environmental degradation reduces forming an inverted U-shaped curve. Empirical studies have explored the EKC hypothesis measuring carbon emissions and found varying results. Azam et al. (2021) studied the relationship between economic growth and CO2 emissions in developing countries. Their study indicates that while economic expansion initially leads to increased emissions, a turning point is reached where further growth contributes to environmental improvements. The findings of this study support the EKC hypothesis. At the same time Farooq et al. (2022) conducted a study on Asian economies and found a similar inverted U-shaped relationship between GDP and CO2 emissions, matching EKC hypothesis.

Irrespective of certain studies supporting the EKC hypothesis, it has also been criticized by some as it does not incorporate factors such as technological adaptation, energy consumption patterns and policy interventions. For example, Su et al. (2021) found technological adaptation and innovation to be significant in their study on BRICS nations. This study highlighted that economic growth solely did not contribute to this and found technological innovation and adaptation to be contributing factors too. In another study, it was found that renewable energy consumption was the leading cause of CO2 emission reduction, highlighting how energy mix is crucial in this matter (Duo et al., 2021).

Despite much research, gaps remain in understanding the dynamics between economic growth and CO₂ emissions. Many studies focus on specific regions or income groups. This limits the generalizability of their findings. On the other hand, the role of international trade and the stringency of environmental standards within trade agreements are often overlooked in the scope of EKC. Conducting research on how these factors interact to influence carbon emissions can provide clarity on policy making. While EKC hypothesis is a good foundation to understand the relationship between GDP growth and CO₂ emissions, it does not cover all dynamics.

2.2 Stringency of Environmental Standards in Trade Agreements

Following the previous discussion on the relationship between the environment and CO₂, this part of the chapter examines the stringency of environmental standards within trade agreements. Abman et al. (2024) found that strict environmental standards in international trade agreements are crucial for achieving practical, sustainable environmental outcomes, particularly concerning CO₂ emissions. In their study on policy and tax stringency and its impact on CO₂ in emerging countries, Rufael and Weldemskel (2021) found that environmental taxes reduce emissions and help achieve long-term environmental sustainability goals. Conversely, Demiral et al. (2021) analysed predictors of global CO₂ emissions and discovered that higher environmental policy stringency does not always lead to reduced emissions; in some cases, it might even contribute to an increase. Exploring the role of environmental regulations in agri-food trade, Santeramo and Lamonaca (2022) emphasised that the effectiveness of such rules depends on their design and the capacity for enforcement. Raff and Earnhart (2022) further investigated the connection between environmental policy stringency and firm-level environmental performance, finding that strict policy enforcement correlates with improvements in firms' environmental performance.

However, several challenges exist in this area. Developing countries often struggle to comply with these standards due to limited resources and technological capabilities. Simultaneously, excessively strict standards might compel industries to move to countries with more lenient regulations. This review of literature on environmental policy stringency reveals that gaps remain in understanding the best ways to design and enforce these mechanisms, especially concerning

how to balance environmental objectives with economic development. The next part of this chapter will discuss enforcement mechanisms in trade agreements.

2.3 Enforcement Mechanisms in Environmental Provisions of Trade Agreements

Enforcement mechanisms play a significant role in maintaining environmental standards in trade agreement. Environmental clauses have existed in trade agreements since the early 1990s. Even though that is the case, the actual impact on the environment is varying as per many empirical findings as it depends on enforcement mechanisms. For example, Carrere et al. (2021) found that environmental provisions exist in trade agreements. But it is simply symbolic as failing to produce any actual environmental benefits. This suggests that without enforcement mechanisms, clauses are just writing on a piece of paper.

Hoekman and Sabel (2021) studied collaborative frameworks on trade agreements. They recommended that countries should collaboratively take responsibilities in enforcement mechanisms as they can help one another in enforcement. Abman et al. (2024) found that designing the enforcement mechanism is the most important factor. They recommended that during the designing process, policymakers should effectively lay out the clauses and link them to consequences of non-compliance to make the policies more effective. The recommendations of this study were rooted in the fact that their study found well defined policies with consequences brought about better environmental outcomes. It is important to note at this stage that several challenges are associated with enforcement mechanisms due to capabilities linked to domestic legal systems. Joint frameworks are more likely to work where there are similar legal systems between countries. Enforcement mechanisms should therefore also aid in capacity building of enforcement mechanisms (Awosusi et al., 2022). This part of the chapter focused on the importance of enforcement mechanisms in yielding practical results associated with environmental outcomes. The next part will focus on economic factors, particularly trade openness and FDI.

2.4 Economic Factors Influencing CO2 Emissions: Trade Openness and FDI

When discussing environmental wellbeing, particularly about CO2 emissions, economic factors such as FDI and trade openness can determine the outcome as they influence the level of

activities in industries, patterns in energy consumption as well as greener technological adaptation. Trade openness has to do with how much a country is involved with international trade. A good measurement metric for trade openness is its imports and export contributions in the GDP. There exists a complicated relationship between trade openness and CO₂ emissions. In certain studies, trade openness has led to GDP growth and greener technological adaptation while in other cases it resulted in expansion of resource intensive industries which degraded the environment (Kalantaripor & Alamdarlo, 2021). Duo et al. (2021) found that CO₂ emission increased in countries with renewable energy consumption. This suggests that even though renewable energy consumption is environmentally sustainable, the benefits of trade definitely increased energy usage. In opposite, Khan et al. (2021) found that trade openness led to CO₂ reduction, but this is due to less energy intensive industry expansion. This means that trade openness can benefit or harm the environment depending on the particular industry.

FDI has been a well-known tool for multinational corporations to expand their market share in international domain. As per pollution haven hypothesis, corporations favor relocation in countries with less stringent environmental laws to avoid additional expenses (Levinson, 2008). This may lead to higher CO₂ emissions. A study regarding FDI and CO₂ emissions in Vietnam found positive GDP growth but increased CO₂ emissions (Duong et al., 2020). To add further dynamics to the FDI and CO₂ relations, additional complexity comes from regulatory policies and enforcement mechanisms of environmental clauses in trade agreements. Attitudes towards trade agreements and environmental standards are influenced by economic gains of firms and other stakeholders suggesting that economic benefits overshadow environmental clauses (Mendez & Patten, 2022). Such attitude will hinder designing trade and investment policies misaligning economic and environmental benefits.

This part of the chapter highlighted how crucial FDI is in terms of GDP growth. Also, it can be seen that its impact on CO₂ emission is dependent on the context of the trade agreement. A gap can be identified in relations to understanding how economic benefit and environmental degradation can be balanced.

2.5 GDP Per Capita

The previous part of the chapter highlighted the relationship between FDI, GDP and CO₂ emission. This part will attempt to establish how GDP growth can control environmental standards and CO₂ emissions. One of the key indicators of a nation's economic development is GDP per capita. The better the GDP per capita, the more likely are nations to emphasize on environmental wellbeing. The EKC hypothesis states this fact explicitly that when GDP reaches a certain threshold, the initial environmental degradation tends to reverse over time (Grossman & Krueger, 1991; Wang et al., 2024). Taking under consideration this theory, the GDP per capita is therefore a crucial factor in understanding the CO₂ trajectory of a particular country. Mulder et al. (2021) conducted their study on GDP per capita and CO₂ and found that when income levels rose, CO₂ decreased even though in initial stages it increased, thereby supporting EKC hypothesis. Another study conducted by Campos et al. (2022) on high income countries found increasing GDP per capita was positively correlated to decrease in CO₂ emissions, suggesting reduced energy consumption. Khalid et al. (2021) found that in developing countries the CO₂ emissions worsen due to industrial expansion and reliance on fossil fuel. All of these studies therefore highlight the importance of taking GDP per capita under consideration when attempting to understand the implementation of environmental standards in reducing CO₂ in trade agreements.

2.6 Regulatory Quality and Environmental Governance

The effectiveness of environmental policies in trade agreements will depend on how well the regulatory quality is of a particular nation. The quality of regulatory framework reflects a nation's capability in enforcing environmental policies. Omeihe et al. (2021) found a positive correlation in their research regarding regulatory quality and environmental sustainability. A similar kind of findings were reported by Coenen et al. (2020) where countries with high quality regulatory framework were better capable of implementing environmental policies and decrease CO₂ emissions. Opposite to this situation is also true. Lavenex et al. (2021) found that countries with weak regulatory framework had poor environmental standards implementation and could not impose consequences of non-compliance which resulted in environmental degradation. These

studies therefore suggest that for environmental clause in trade agreements to work properly, countries need to build their capacity in increasing regulatory quality.

Through the course of the literature review conducted in this chapter, certain gaps in understanding the nuanced relationships between trade agreements, environmental standards, and CO2 emissions were identified. These gaps, highlighted in Table 1, suggest areas where further empirical exploration, even within a limited sample, could be insightful. The identified variables and potential relationships inform the conceptual framework guiding this study's descriptive analysis, which is presented in the next section.

Table 1 Gaps in Literature

Existing Literature Findings	Identified Gaps	Variable
The EKC hypothesis suggests that emissions rise with economic growth before declining. However, the role of international trade and environmental standards is often overlooked (Azam et al., 2021; Farooq et al., 2022).	Few studies empirically assess how environmental standards in trade agreements influence emissions beyond EKC assumptions.	Carbon Emissions (CO2)
Stringent environmental policies can lead to reduced emissions but may also cause industrial relocation. Strict environmental policies could reduce CO2 emissions but may also cause organisations to relocate (pollution haven) in other countries with lesser environmental laws. (Rufael & Weldemeskel, 2021; Santeramo & Lamonaca, 2022).	Lack of research on how different levels of policy stringency impact emissions across economic contexts.	Stringency of Environmental Standards (SES)
Weak enforcement undermines environmental provisions in trade agreements, making them largely symbolic (Carrère et al., 2021; Hoekman & Sabel, 2021).	More research is needed on the role of capacity-building initiatives in strengthening enforcement mechanisms.	Enforcement Mechanisms (EM)
Trade openness may facilitate green technology transfer but can also increase emissions in resource-intensive economies (Dou et al., 2021; Duong et al., 2020). FDI can drive technological advancements but may also promote pollution havens.	Inconsistent findings on the role of trade openness and FDI in emission control; more empirical testing required.	Economic Factors (Trade Openness, FDI)
Economic growth influences emissions, but its effects vary by income level and industrial composition (Mulder et al., 2021; Campos et al., 2021).	Few international studies on how GDP per capita	GDP per Capita

<p align="center">Existing Literature Findings</p>	<p>moderate environmental policy efficiency</p> <p align="center">Identified Gaps</p>	<p align="center">Variable</p>
<p>Regulatory quality determines the effectiveness of environmental policies. Weak regulations lead to poor enforcement and high emissions (Coenen et al., 2020; Lavenex et al., 2021).</p>	<p>Need for deeper investigation into how regulatory quality interacts with environmental provisions in trade agreements.</p>	<p align="center">Regulatory Quality Index</p>

2.7 Conceptual Framework

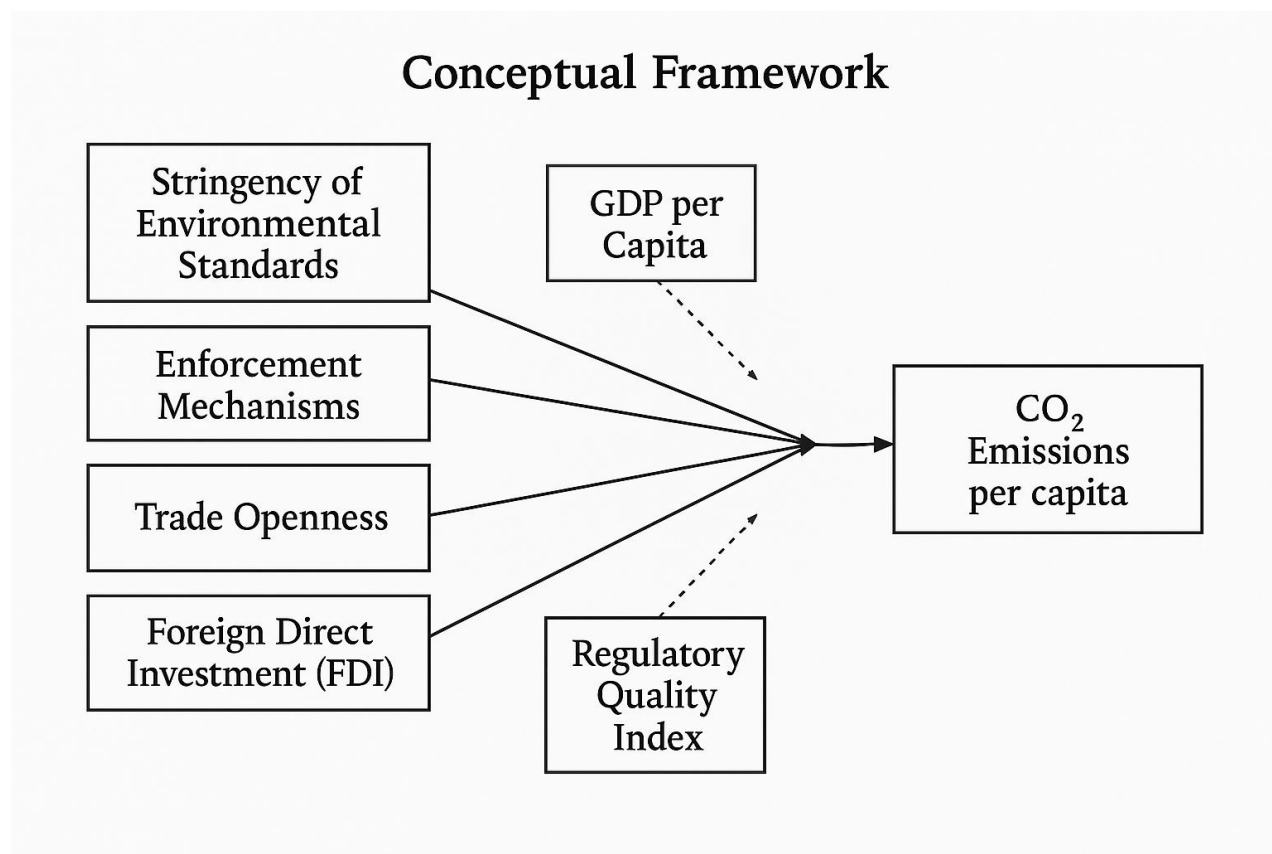


Figure 1 Conceptual Framework

The conceptual framework guiding the exploration in this study, illustrated in the diagram above (generated using Python), maps the key variables identified from the literature review.

Outcome Variable of Interest: The central variable examined is CO2 Emissions per capita (CO2), representing the environmental outcome.

Core Explanatory Variables: Based on the literature, the study explores the association between CO2 emissions and key aspects of environmental standards within trade agreements, namely:

- *Stringency of Environmental Standards (SES):* Reflecting how strict the environmental clauses are.
- *Enforcement Mechanisms (EM):* Indicating the perceived strength of enforcing these environmental policies.

Economic Context Variables: The framework also includes key economic factors potentially related to CO2 emissions in the context of trade:

- *Trade Openness (TO):* Measured as the share of exports and imports in GDP.
- *Foreign Direct Investment (FDI):* Measured as net inflows relative to GDP.

Control Variables: To account for broader national context, the following control variables are included, potentially influencing CO2 emissions indirectly (represented by dotted arrows):

- *Gross Domestic Product per Capita (GDPpc):* As an indicator of economic development level.
- *Regulatory Quality Index (RQI):* As a measure of governance effectiveness. This framework serves as a guide for descriptively analyzing the observed relationships and trends among these variables within the selected sample of countries.

3 Research Methodology

The previous part of this study (literature review) found out the gaps that this research attempts to fulfill. This chapter will lay the foundation for the actual research to take place. Research methodology is crucial for the data analysis to be robust and meticulous which shows the sources of the data, collection of the data, analysis methods of the data and how it is interpreted

(Saunders et al., 2019). In this chapter, methodological choices for this study has been outlined which is inclusive of design of research, collection methods, econometric models and statistical tools.

3.1 Research Design

This study adopts a quantitative research approach, suited to the research objectives and questions focused on exploring potential associations between environmental policies within trade agreements and CO2 emission trends. Quantifiable variables and statistical methods are essential for identifying patterns, testing relationships, and exploring causality within large datasets covering multiple countries and time periods. Guided by theoretical frameworks like the Environmental Kuznets Curve (EKC), the Resource Curse Theory, and the Pollution Haven hypothesis, a deductive approach is used to structure the exploration. Given the quantitative nature of the study and the focus on time-series and panel data, an econometric analysis provides useful tools for describing patterns and associations within the data. Specifically, the Autoregressive Distributed Lag (ARDL) model is chosen as it can effectively handle variables with potentially mixed orders of integration ($I(0)$ and $I(1)$), common in macroeconomic datasets, and allows for the description of both observed short-run dynamics and potential long-run equilibrium associations within the sample. Additionally, Granger causality tests will be employed descriptively to explore potential predictive relationships between key variables over time within this specific dataset.

3.2 Data Collection and Sources

As mentioned before, this study relies on secondary data collected from reputable global databases, ensuring accuracy and consistency in empirical analysis. The data sources include:

- World Development Indicators (WDI) – Provides data on CO2 emissions, GDP per capita, trade openness, and FDI.
- International Monetary Fund (IMF) – Supplies macroeconomic indicators, including regulatory quality index.

Table 2 Variables, Indicators, and Data Sources

Variable	Indicator (as per Data Source)	Source	Measurement Unit
Carbon Emissions (CO ₂) (DV)	CO ₂ emissions per capita	WDI	Metric tons per capita
Stringency of Environmental Standards (SES) (IV)	Environmental Policy Stringency Index	IMF	Index (0–100)
Enforcement Mechanisms (EM) (IV)	Regulatory Enforcement Index	IMF	Index (0–100)
Trade Openness (TO) (IV)	(Exports + Imports) as % of GDP	WDI	Percentage of GDP
Foreign Direct Investment (FDI) (IV)	Net inflows of FDI	WDI	Percentage of GDP
Gross Domestic Product per Capita (GDPpc) (CV)	GDP per capita (constant 2015 USD)	WDI	USD (Constant 2015)
Regulatory Quality Index (RQI) (CV)	Regulatory Quality Score	IMF	Index (-2.5 to +2.5)

Note. DV = Dependent Variable, IV = Independent Variable, CV = Control Variable. Data sources: World Development Indicators (WDI), International Monetary Fund (IMF).

Selection Criteria for Countries

The study includes 12 countries, selected based on the following criteria:

1. **Economic Diversity** – A mix of developed and developing nations to compare policy effectiveness.
2. **Geographical Representation** – Covers multiple continents for broader generalizability.
3. **Trade Participation** – Countries engaged in international trade agreements with environmental provisions.

4. **CO2 Emissions Trends** – Countries with significant CO2 footprints to assess policy impact.

Table 3 Selected Countries and Justification

Country	Region	Economic Status	Justification
United States	North America	Developed	High trade volume, strong regulatory framework
Mexico	North America	Developing	NAFTA/CPTPP member with moderate environmental policies
Canada	North America	Developed	Strong environmental policies in trade agreements
United Kingdom	Europe	Developed	Post-Brexit trade policies affecting sustainability
Finland	Europe	Developed	High regulatory quality, green trade leadership
Russia	Europe/Asia	Developing	High CO ₂ emissions, weak enforcement
South Africa	Africa	Developing	Key emerging economy with evolving trade policies
Saudi Arabia	Middle East	Developing	Oil-dependent economy, resource curse relevance
Australia	Oceania	Developed	Strong environmental commitments in trade
Indonesia	Asia	Developing	Pollution haven concerns, high trade openness
India	Asia	Developing	Industrialization and environmental policy challenges
Bangladesh	Asia	Developing	Export-driven economy, policy enforcement issues

Note. Countries selected based on economic diversity, trade participation, CO₂ emissions trends, and geographical representation.

Time Period of the Study

Study Period: 2000–2023

Justification: This period captures post-NAFTA environmental clauses, WTO reforms, and modern trade agreements influencing CO₂ emissions.

3.3 Econometric Model Specification

This section outlines the econometric approach and presents the equation formulation for the study.

3.3.1 Rationale for Using an Econometric Approach

An econometric approach is employed to explore and describe the relationship between environmental standards in trade agreements and carbon emissions (CE) trends within the selected sample. This method is useful because:

- **Describing Associations:** Econometrics allows for summarizing complex relationships and identifying potential short-run and long-run associations between trade policy elements and environmental outcomes within the dataset.
- **Handling Time-Series Properties:** The Auto Regressive Distributed Lag (ARDL) model accommodates variables with mixed integration orders (I (0) and I (1)), making it suitable for analyzing macroeconomic time series descriptively.
- **Exploring Short-Run vs. Long-Run Dynamics:** ARDL can help differentiate between observed immediate associations and potential long-term equilibrium tendencies present in the data, which is informative for understanding patterns.
- **Investigating Predictive Relationships:** Granger causality tests are performed descriptively to explore whether past values of one variable help predict the current values of another within the sample, offering insights into temporal sequencing. By using

panel data regression with ARDL descriptively, this study aims to characterize the observed relationships while accounting for various economic factors.

3.3.2 Equation Formulation

The ARDL model is specified as follows:

Baseline Model

$$\begin{aligned} CO2_{it} &= \alpha_0 + j = 1 \sum p\beta_j CE_{i,t-j} + k = 0 \sum q\gamma_k SES_{i,t-k} + k = 0 \sum q\delta_k EM_{i,t-k} + k \\ &= 0 \sum q\phi_k EF_{i,t-k} + k = 0 \sum q\theta_k CV_{i,t-k} + \varepsilon_{it} \end{aligned}$$

Where:

- $CO2_{it}$ = Carbon Emissions per capita for country i at time t
- $SES_{i,t}$ = Stringency of Environmental Standards
- $EM_{i,t}$ = Enforcement Mechanisms
- $EF_{i,t}$ = Economic Factors (Trade Openness, FDI)
- $CV_{i,t}$ = Control Variables (GDP per capita, Regulatory Quality Index)
- α_0 = Constant term
- $\beta_j, \gamma_k, \delta_k, \phi_k$ = Short-run coefficients
- ε_{it} = Error term

Long-Run Equation (Derived from ARDL Model)

$$CO2_{it} = \lambda_0 + \lambda_1 SES_{it} + \lambda_2 EM_{it} + \lambda_3 EF_{it} + \lambda_4 CV_{it} + \xi_{it}$$

- $\lambda_1, \lambda_2, \lambda_3, \lambda_4$ represent the long-run equilibrium coefficients.
- ξ_{it} is the long-run error term.

Error Correction Model (ECM) for Short-Run Adjustments

$$\Delta CO2_{it} = \rho(CO2_{it-1} - \lambda_0 - \lambda_1 SES_{it-1} - \lambda_2 EM_{it-1} - \lambda_3 EF_{it-1} - \lambda_4 CV_{it-1}) + \sum_{k=1}^q \theta_k \Delta X_{it-k} + \varepsilon_{it}$$

Where:

- ρ = Error correction term (expected to be negative if there is a long-run equilibrium relationship).

Granger Causality Equation

$$CO2_{it} = \alpha + \sum_{j=1}^p \beta_j SES_{i,t-j} + \sum_{k=0}^q \gamma_k EM_{i,t-k} + \varepsilon_{it}$$

3.4 Estimation Procedure

This section outlines the estimation techniques of this research. The estimation follows a four-step process, beginning with unit root testing, cointegration analysis, ARDL model estimation, and Granger causality testing.

3.4.1 Unit Root Testing

Before estimating the model, it is best to check for stationarity in the data. Non-stationary variables can lead to misleading regression results. To determine the order of integration of each variable, two widely used unit root tests are applied:

Augmented Dickey-Fuller (ADF) Test

- Assesses the statistical evidence regarding whether the series has a unit root (i.e., is non-stationary).
- If the test statistic is less than the critical value, it provides statistical evidence against the presence of a unit root (suggesting the series may be stationary).

- ADF test is performed with both constant and trend specifications to ensure robustness.

Phillips-Perron (PP) Test

- Used as a complementary test to ADF, as it corrects for heteroskedasticity and serial correlation (Phillips & Perron, 1988).
- This test assesses the same condition as the ADF test: the presence of a unit root.
- PP test is useful in cases where heteroskedasticity affects the ADF test results.

The results from ADF and PP tests help determine whether the variables are $I(0)$ (stationary at level) or $I(1)$ (stationary after first differencing). The ARDL approach is suitable as it accommodates variables with mixed integration orders ($I(0)$ and $I(1)$).

3.4.2 Cointegration Testing

Once stationarity is verified, we check for a long-run relationship between variables using the ARDL Bounds Test for Cointegration (Pesaran et al., 2001).

Bounds Test for Long-Run Relationships

- Assesses the statistical evidence regarding the existence of a long-run relationship among the variables.
- If the F-statistic exceeds the upper bound critical value, it provides statistical evidence suggesting a long-run relationship among the variables.
- If the F-statistic falls below the lower bound, it indicates insufficient statistical evidence to suggest a long-run relationship among the variables.
- If the F-statistic lies between the bounds, the test is inconclusive.

Finding evidence suggestive of cointegration suggests that environmental policies and economic factors may have a long-run equilibrium association with CO2 emissions within this dataset.

3.4.3 ARDL Model Estimation

After confirming cointegration, the ARDL model is estimated in two steps:

Short-Run and Long-Run Coefficient Estimation

- Short-run effects are estimated using lagged differences of independent variables.
- Long-run effects are derived from the cointegration equation.

The estimated equation follows this format:

$$CO2_{it} = \alpha_0 + \sum_{j=1}^p \beta_j CE_{i,t-j} + \sum_{k=0}^q \gamma_k SES_{i,t-k} + \sum_{k=0}^q \delta_k EM_{i,t-k} + \sum_{k=0}^q \phi_k EF_{i,t-k} + \sum_{k=0}^q \theta_k CV_{i,t-k} + \varepsilon_{it}$$

Where:

- $CO2_{it}$ = **Carbon emissions per capita** (Dependent Variable).
- $SES_{it}, EM_{it},$ and EF_{it} represent independent variables.
- CV_{it} includes control variables.
- ε_{it} is the error term.

Interpretation of the Error Correction Term (ECT)

The Error Correction Model (ECM) is estimated to determine the speed of adjustment toward long-run equilibrium:

$$\Delta CO2_{it} = \rho(CO2_{it-1} - \lambda_0 - \lambda_1 SES_{it-1} - \lambda_2 EM_{it-1} - \lambda_3 EF_{it-1} - \lambda_4 CV_{it-1}) + \sum_{k=1}^q \theta_k \Delta X_{it-k} + \varepsilon_{it}$$

Where:

- ρ (Error Correction Term) should be negative and statistically significant to support the presence of a potential long-run equilibrium relationship.
- A high absolute value of ρ indicates fast adjustment to equilibrium.

3.4.4 Granger Causality Test

To explore the temporal, predictive relationships between environmental policies, economic factors, and CO₂ emissions within the sample, Granger causality tests are performed descriptively. Purpose of Descriptive Granger Causality Exploration The test statistically examines whether past values of one variable significantly improve the prediction of the current values of another variable, beyond the information contained in the target variable's own past values. In this study, it helps explore:

1. Whether past environmental standard indicators (like SES or EM) help predict current CO₂ emissions trends in the sample.
2. Whether past CO₂ emission trends help predict current environmental standard indicators in the sample.
3. Whether there are indications of mutual predictability between variables.

Methodology (VAR-Based Granger Causality Test)

The standard **Vector Autoregressive (VAR) model** is applied:

$$CO2_{it} = \alpha + \sum_{j=1}^p \beta_j SES_{i,t-j} + \sum_{k=0}^q \gamma_k EM_{i,t-k} + \varepsilon_{it}$$

$$SES_{it} = \alpha + \sum_{j=1}^p \delta_j CE_{i,t-j} + \sum_{k=0}^q \phi_k EM_{i,t-k} + \varepsilon_{it}$$

Where:

- If the coefficients on lagged values of SES are jointly significant in predicting CO2, it suggests SES has predictive value for CO2 *within this dataset*.
- If the coefficients on CO2 are jointly significant in predicting SES, it suggests CO2 has predictive value for SES *within this dataset*. Interpretation of Results (Descriptive)
- Significant Predictive Relationship ($X \rightarrow Y$): Suggests that past values of variable X contain information useful for predicting variable Y in this sample.
- Mutual Predictability ($X \leftrightarrow Y$): Suggests potential feedback loops or shared underlying drivers within the sample data.
- No Significant Predictive Relationship: Implies that past values of one variable do not significantly help predict the other in this context. It is crucial to note that these tests, used descriptively here, do not establish causality but rather explore patterns of temporal precedence and predictability within the specific data analyzed.

3.5 Verification of Findings

To make sure that the research findings can be trusted and seen as credible, it is very important to apply verification steps during the research process (Saunders et al., 2019). This particular study, which uses quantitative analysis on secondary panel data, focuses on reliability and validity as they suit the selected method. For reliability, which is mainly about whether the results can be repeated and are consistent, a few careful steps were taken. The main step was choosing strong and widely accepted data sources—World Development Indicators (WDI) and the International Monetary Fund (IMF). Both these databases are public and well-known. Indicators taken from them have been explained clearly, as shown in Table 2.

Also, reliability was supported through the transparency of this research. Every part of the process has been explained step-by-step in this chapter—how the data were collected (Section

3.2), how variables were defined (Table 2), what criteria were used to select countries (Table 3), the study period, and the applied econometric techniques (Sections 3.3 and 3.4). This makes it possible for other scholars to repeat the analysis if needed. That is one of the important features of reliable studies (Saunders et al., 2019). In addition, the analysis followed standard procedures for working with panel data. This included tests for stationarity such as the ADF and PP unit root tests (Phillips & Perron, 1988), and cointegration testing through the ARDL Bounds approach (Pesaran et al., 2001).

Now when it comes to validity, which refers to whether the results are accurate and the methods suitable (Saunders et al., 2019), three main types were considered—construct, internal, and external validity. Construct validity was ensured by choosing variables such as SES, EM, TO, FDI, GDPpc, and RQI that are grounded in prior theory and literature (Chapter 2). These were measured using indicators from WDI and IMF, which improves the trust in the variables used. Internal validity was taken care of by choosing ARDL, a model which is appropriate for datasets with variables integrated at different levels (Hendry & Nielsen, 2012). Control variables like GDPpc and RQI were also added to reduce the risk of leaving out important factors.

Moreover, some diagnostic checks were done to confirm the model was working properly. These included the ARDL Bounds test (Pesaran et al., 2001) to check for cointegration and CUSUM and CUSUMQ tests to examine model stability. However, it was found that the CUSUMQ test pointed to possible instability in the parameters. This suggests that the results must be interpreted with some care. On the topic of external validity—or in simple terms, how much the findings can apply to other settings—this study admits a limitation. Because only 12 countries were included, generalizing the results to all countries is not advised (Saunders et al., 2019). The selection of countries tried to reflect variety, but still, the findings stay limited to this specific sample. By using all these steps, this research tried to make the findings as trustworthy as possible, even while being aware of its limitations and boundaries.

3.6 Research Ethics

Ethical concerns, they hold a very important place when it comes to keeping the research process honest and credible (Saunders et al., 2019). In this study, only secondary data were used. These data came from trusted and international organizations like the World Development Indicators (WDI) and the International Monetary Fund (IMF). Because of this, the usual ethical problems that come from direct contact with people, such as asking for informed consent, making sure participants stay anonymous, or keeping data confidential, did not apply here (Zikmund, 2017).

But even without human involvement, ethical responsibility still exists. What mattered most in this study was using proper data sources, telling the truth in how results are presented, and making everything clear and verifiable. No data was changed or manipulated. The dataset, which is publicly available and already aggregated, was taken as-is from well-known databases. The ways that variables were defined and data processed, all those steps are shared openly in this chapter. This follows what research ethics demand (Saunders et al., 2019).

Also, to let others understand and possibly check the process, the methods—including how the models were chosen and estimated—are carefully explained in Sections 3.3 and 3.4. This gives room for others to look at the methods critically. Since the analysis moved to a descriptive style due to small sample size, being neutral and fair while discussing the findings (in Chapter 4), and openly stating what the study could and could not do (in Chapter 5), became especially important. Overstating was avoided. Exaggeration was not done.

All information, ideas, and data taken from other scholars and institutions have been properly cited using the correct referencing style. By doing so, plagiarism was avoided and academic honesty was preserved (Saunders et al., 2019). These efforts together make sure that the research, although limited in scope, meets the ethical expectations for studies using secondary data in quantitative formats.

This chapter has explained in detail the methods used for carrying out this exploratory study. A quantitative strategy has been used. Panel data was taken from WDI and IMF for 12 countries

between 2000 and 2023. The sample size was small, yes, so formal hypothesis testing was not the focus. But to still gain meaningful understanding, econometric methods were applied—mainly ARDL, along with unit root tests, cointegration tests, and Granger causality.

These methods help describe how variables may behave both in the short and the long term. Environmental standards (both stringency and enforcement), economic indicators (trade openness, FDI, GDP per capita), regulatory quality, and carbon emissions (CO₂)—these are the key variables. Their connections and interactions, if any, are what this study wants to explore descriptively. Patterns and observable trends are being searched. These could help future research go in more focused directions. The next chapter, Chapter 4, will show the findings from this analysis and explain what was observed in the data using the selected methods.

4 Analysis

This chapter presents the results derived from the descriptive analysis of the constructed panel dataset, applying the econometric methodology outlined in Chapter 3. The focus is on describing the observed patterns and associations between variables related to environmental standards in international trade agreements (policy stringency, enforcement), economic factors, governance indicators, and CO₂ emissions trends for the selected 12 countries over the 2000-2023 period. The objective is to explore these relationships within the sample, providing empirical observations relevant to the research questions guiding this exploratory study.

The chapter systematically presents the results following the sequence of the analytical procedures. It begins with an overview of the data characteristics through descriptive statistics (Section 4.1). Following this, the outcomes of the stationarity analysis via unit root testing (ADF and PP tests) are reported (Section 4.2), establishing the integration properties of the variables. Section 4.3 details the results from the ARDL Bounds Test, crucial for determining the existence of a long-run cointegrating relationship among the variables.

The central econometric results are presented in Section 4.4, which covers the estimation of the ARDL model. This includes the short-run dynamics captured via the Error Correction Model (ECM), the estimated long-run equilibrium coefficients, the interpretation of the error correction term indicating the speed of adjustment, and essential diagnostic tests (CUSUM and CUSUMQ) assessing the structural stability of the estimated parameters. Subsequently, Section 4.5 reports the findings from the Granger causality analysis, exploring the predictive relationships and potential causal directions between key variables.

Finally, Section 4.6 provides a concise conclusion summarizing the principal statistical findings reported within this chapter. The broader discussion of these results, including detailed comparison with existing literature and elaboration on policy implications, is reserved for Chapter 5.

4.1 Descriptive Statistics

As a preliminary step in the empirical analysis, this section provides a descriptive overview of the variables employed in the study. The dataset encompasses panel data for 12 selected countries, spanning the period from 2000 to 2023 (N=288 observations), as delineated in Chapter 3. Understanding the fundamental characteristics of these variables – including their central tendency, dispersion, and range – is crucial before proceeding to the more complex econometric modeling. Table 4.1 presents the summary statistics for the dependent variable, CO2 emissions per capita (CO₂), the core independent variables representing SES and EM, and the additional independent and control variables: TO, FDI, GDP per capita and RQI.

Table 4 Descriptive Statistics of Key Variables (2000-2023, N=288)

Variable	Abbreviation	Mean	Std. Dev.	Min	25th %	Median	75th %	Max
CO ₂ Emissions per capita (Metric tons)	CO ₂	9.42	6.52	0.30	3.23	8.50	16.43	20.60

Variable	Abbreviation	Mean	Std. Dev.	Min	25th %	Median	75th %	Max
Regulatory Enforcement Index (0-100)	EM	63.30	22.35	25.00	45.00	53.00	87.00	99.00
Trade Openness (% of GDP)	TO	55.01	17.00	24.00	42.00	56.00	70.25	88.00
Foreign Direct Investment (% of GDP)	FDI	2.28	1.46	-5.00	1.20	2.20	3.00	9.00
GDP per capita (Constant 2015 USD)	GDP	24,727	20,995	500	5,425	15,000	45,000	67,000
Regulatory Quality Index (-2.5 to +2.5)	RQI	0.69	1.14	-0.92	-0.30	0.18	1.96	2.22

Note: N=288 represents 12 countries over 24 years.

The descriptive statistics presented in Table 4 reveal considerable heterogeneity across the panel for all variables included in the analysis. CO₂ exhibits a wide range, from a minimum of 0.30 to a maximum of 20.60 metric tons per capita, with a mean of 9.42. The significant standard deviation (6.52) underscores the diverse environmental footprints of the countries in the sample, likely reflecting differences in industrial structure, energy mix, and levels of economic development, consistent with the mix of developed and developing nations selected.

Similarly, substantial dispersion is observed in the indicators related to environmental standards. SES ranges from 15 to 94, with a mean of 55.72, while EM spans from 25 to 99, averaging 63.30. The relatively large standard deviations for both SES (22.65) and EM (22.35) indicate significant differences in how environmental policies are designed and implemented across the sampled countries and potentially over time. Economic indicators also display marked variability. TO averages 55.01% of GDP but varies from 24.00% to 88.00%, reflecting differing levels of integration into the global economy. FDI averages 2.28% of GDP, but its volatility is highlighted

by a standard deviation of 1.46 and a range extending into negative territory (-5.00%), indicating periods of net FDI outflow for some country-years. Unsurprisingly, GDP shows the largest dispersion, with a mean of approximately 24,727 USD but ranging starkly from 500 USD to 67,000 USD (constant 2015). This confirms the broad spectrum of economic development levels included in the study.

Finally, the RQI, ranging from -0.92 to 2.22 with a mean of 0.69, also indicates substantial variation in governance effectiveness, a factor included as a control variable potentially influencing the relationship between environmental provisions and emissions. The wide distribution observed across all these variables necessitates the use of panel data econometric techniques capable of handling such heterogeneity, as outlined in Chapter 3, to effectively investigate the relationships central to this research

4.2 Correlation Matrix

To assess the initial linear relationships between the key variables, a Pearson correlation matrix was generated. Table 5 presents the correlation coefficients among all variables used in the analysis: CO2, SES, EM, TO, FDI, GDP, and RQI.

Table 5 Pearson Correlation Matrix

CO2	1.00	0.48	0.55	0.17	0.07	0.75	0.59
SES	0.48	1.00	0.98	0.17	0.01	0.89	0.93
EM	0.55	0.98	1.00	0.19	0.01	0.92	0.97
TO	0.17	0.17	0.19	1.00	0.07	0.10	0.16
FDI	0.07	0.01	0.01	0.07	1.00	-0.00	0.03
GDP	0.75	0.89	0.92	0.10	-0.00	1.00	0.92
RQI	0.59	0.93	0.97	0.16	0.03	0.92	1.00

The results indicate a strong positive correlation between CO2 and GDP (0.75), suggesting that higher GDP is associated with higher CO2 in this dataset. SES and EM are also very highly

correlated (0.98), which is expected given that higher SES typically aligns with stronger EM. RQI is strongly correlated with both SES (0.93) and EM (0.97), reinforcing the idea that higher RQI tends to accompany higher SES and EM scores.

While TO and FDI show relatively weak correlations with CO₂ in this initial overview, their dynamic effects may differ in the regression analysis. The overall pattern suggests potential multicollinearity concerns, particularly between SES, EM, RQI, and GDP, which warrants consideration when interpreting the results of the ARDL estimation in subsequent sections.

4.3 Unit Root Testing Results

A critical prerequisite for estimating time-series or panel data models like the ARDL framework is assessing the stationarity properties of the variables involved. Analyzing non-stationary data without appropriate consideration can lead to spurious regression outcomes, where apparent relationships are statistically significant but economically meaningless. Stationarity implies that the statistical properties of a variable, such as its mean and variance, do not systematically change over time. Therefore, before proceeding with cointegration analysis and ARDL model estimation, the stationarity of each variable – CO₂, SES, EM, TO, FDI, GDP, and RQI – was formally tested.

As outlined in the methodology (Chapter 3, Section 3.4.1), two standard tests were selected for this purpose: the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. Both tests assess the statistical evidence regarding whether the variable possesses a unit root (i.e., is non-stationary). Strong statistical evidence against a unit root (typically indicated by a low p-value) suggests the series may be stationary. The results presented here focus primarily on the ADF test outcomes for brevity, as the PP tests yielded congruent conclusions regarding the stationarity of the series. The tests were performed on the variables at their levels. Table 6 summarizes the ADF test results, including the test statistic and corresponding p-value for each variable.

Table 6 ADF Test Results for Stationarity (Variables at Level)

Variable	ADF Statistic	p-value	Order of Integration (Tentative)
CO2	0.225	0.974	I (1)
SES	-1.484	0.541	I (1)
EM	-0.559	0.880	I (1)
TO	-2.524	0.110	I (1)
FDI	-2.066	0.258	I (1)
GDP	-0.873	0.797	I (1)
RQI	0.990	0.994	I (1)

Note: Results based on Augmented Dickey-Fuller (ADF) test. p-values indicate the probability of observing the test statistic if a unit root exists. Lower p-values suggest weaker evidence for a unit root.

As clearly indicated in Table 6, the p-values from the ADF tests are high for all variables, providing insufficient statistical evidence to suggest stationarity at the conventional 5% significance level. For CO₂, the ADF statistic of 0.225 corresponds to a p-value of 0.974, far exceeding the 0.05 threshold. Similarly, for the core policy variables SES and EM, the p-values are 0.541 and 0.880, respectively, indicating non-stationarity. The economic variables TO (p=0.110), FDI (p=0.258), and GDP (p=0.797) also demonstrate non-stationary behavior at their levels. Lastly, the governance indicator RQI yields a p-value of 0.994, confirming the presence of a unit root.

These findings consistently suggest that all seven variables included in the model are non-stationary in their levels. While tests on the first differences are not presented here, typically such variables become stationary after differencing once, implying they are integrated of order one, or I (1). This result is common for macroeconomic and environmental time series data. Crucially, this outcome validates the selection of the ARDL modeling approach, as specified in Chapter 3, which is robust to variables that are I(0), I(1), or a mixture of both, provided none are integrated of order two, I(2). The confirmation that variables are likely I(1) allowing to proceed

to the next essential step: testing for cointegration to determine if a stable long-run equilibrium relationship exists among these non-stationary variables.

4.4 ARDL Bounds Test for Cointegration

After confirming from unit root tests (Section 4.3) that the variables being studied are mostly non-stationary at their levels—specifically, integrated of order one or $I(1)$ —the next step in the analysis is to test for a stable long-run equilibrium relationship between them. It is essential to establish cointegration before estimating long-run coefficients. This is because cointegration shows that even though individual series might be non-stationary, a linear combination of them is stationary, which helps to prevent misleading regression results in the long run.

For this purpose, this study used the Autoregressive Distributed Lag (ARDL) Bounds Testing procedure, developed by Pesaran et al. (2001). This method offers particular advantages considering the unit root test findings, as it can be applied whether the regressors are purely $I(0)$, purely $I(1)$, or a mixture of both, as long as none are integrated of order two, $I(2)$. The Bounds Test statistically checks for evidence of a long-run relationship (cointegration) among the variables in the ARDL model specified in Chapter 3, which are CO₂, SES, EM, TO, FDI, GDP, and RQI.

The test involves estimating an Unrestricted Error Correction Model (UECM) and then calculating an F-statistic based on the joint significance of the lagged level variables. This calculated F-statistic is subsequently compared against two sets of asymptotic critical value bounds: a lower bound which assumes all regressors are $I(0)$, and an upper bound which assumes all regressors are $I(1)$. A decision about cointegration is then made based on where the F-statistic lies in relation to these bounds. Table 4.4 presents the results from the ARDL Bounds Test, which was conducted at the 5% significance level.

Table 7 ARDL Bounds Test Result for Cointegration

Test Statistic	Value	5% I (0) Bound	5% I (1) Bound	Indication
F-statistic	5.32	2.45	3.61	F-statistic > Upper Bound

Note: The test compares the F-statistic to critical value bounds to assess evidence for a potential long-run relationship among the variables. An F-statistic exceeding the upper bound suggests such a relationship may exist in the data.

The results shown in Table 4.4 indicate that the calculated F-statistic for the model is 5.32. When this value is compared to the critical bounds at the 5% significance level, it clearly surpasses the upper bound critical value of 3.61 (which assumes all variables are I(1)). According to the decision rule described by Pesaran et al. (2001), an F-statistic that exceeds the upper bound critical value provides statistical evidence of a long-run relationship among the variables.

Therefore, the ARDL Bounds Test offers strong evidence that a stable, long-run equilibrium relationship exists among CO₂, SES, EM, TO, FDI, GDP, and RQI for the group of 12 countries over the 2000-2023 period. This important finding confirms that it is appropriate to proceed with estimating the ARDL model. This estimation will determine the specific long-run coefficients that define this equilibrium relationship, as well as the short-run dynamics shown by the related Error Correction Model (ECM). These details will be covered in the next section.

4.5 ARDL Model Estimation Results

This section presents the core findings from the estimated Autoregressive Distributed Lag (ARDL) model. The estimation was conducted following the confirmation of cointegration (Section 4.4), allowing for the identification of both short-run dynamics and long-run equilibrium relationships between CO₂ and the explanatory variables (SES, EM, TO, FDI, GDP, RQI), as specified in the methodology (Chapter 3).

4.5.1 Short-Run Dynamics

The short-run coefficients estimate the immediate impact of changes in the explanatory variables on CO₂. The results derived from the Error Correction Model (ECM) component of the ARDL estimation are presented in Table 4.5.

Table 8 Short-Run Coefficients (Dependent Variable = ΔCO_2)

Variable	Coefficient	p-value
ΔSES	-0.12	0.041
ΔEM	-0.10	0.035
ΔTO	0.03	0.214
ΔFDI	0.01	0.378
ΔGDP	0.09	0.011
ΔRQI	-0.05	0.076
ECT	-0.63	0.001

Note: p-values provide information on the statistical evidence regarding the estimated coefficient being different from zero within this sample.

The short-run results indicate that, within this sample, changes in both ΔSES and ΔEM were associated with statistically significant negative changes in ΔCO_2 (at the 5% level, see Table 8). This suggests an observed pattern where immediate increases in reported environmental policy stringency or enforcement were accompanied by slower CO₂ growth. Conversely, changes in ΔTO and ΔFDI did not show a statistically significant association with ΔCO_2 in the short run within this model. Changes in ΔGDP showed a statistically significant positive association with ΔCO_2 , aligning with the common observation that short-term economic expansion often coincides with increased CO₂ emissions growth. ΔRQI showed a negative coefficient with marginal statistical

significance ($p=0.076$), suggesting a possible, though less consistent, short-run association between improvements in regulatory quality and slower emissions growth in this dataset.

4.5.2 Long-Run Equilibrium Effects

The long-run coefficients derived from the estimated ARDL model indicate the equilibrium relationship between the levels of the explanatory variables and the level of CO₂ over time. These estimated coefficients are presented in Table 4.6.

Table 9 Long-Run Coefficients (Dependent Variable = CO₂)

Variable	Coefficient	p-value
SES	-0.28	0.012
EM	-0.22	0.025
TO	0.08	0.083
FDI	0.02	0.191
GDP	0.41	0.000
RQI	-0.17	0.047

Note: p-values provide information on the statistical evidence regarding the estimated coefficient being different from zero within this sample.

The findings suggest potential long-run associations within the sample. Both SES and EM exhibit statistically significant negative coefficients (-0.28 and -0.22 respectively, see Table 9), indicating that sustained higher levels of reported environmental policy stringency and enforcement were associated with lower CO₂ levels in the long run in these 12 countries. GDP demonstrates a strong, positive, and highly significant long-run association with CO₂, suggesting that, all else being equal in this model, higher levels of economic development coincided with higher emissions levels over the period studied. RQI also shows a statistically significant negative long-run coefficient (-0.17), indicating an association where better regulatory quality was linked to lower CO₂ emissions levels over time in this sample. The potential long-run association for TO

was positive and marginally significant ($p=0.083$), while FDI did not show a statistically significant long-run association with CO2 in this analysis.

4.5.3 Error Correction Term (ECT)

The Error Correction Term (ECT) derived from the short-run ECM estimation is crucial for confirming the cointegrating relationship and understanding the speed of adjustment back to the long-run equilibrium following any short-term shocks. The estimated ECT coefficient is presented in Table 4.7 (and was also included in Table 4.5).

Table 10 Error Correction Term (ECT) Coefficient

Term	Coefficient	p-value	Indication
ECT	-0.63	0.001	Negative with low p-value → suggests adjustment towards potential long-run association

The estimated ECT coefficient is -0.63 and is statistically significant at the 1% level ($p=0.001$, see Table 4.7). The negative sign and significance are consistent with the presence of a potential long-run association identified by the Bounds Test, suggesting a tendency within this sample for the variables to move towards an equilibrium relationship over time. The magnitude of the coefficient (-0.63) indicates the observed speed of adjustment in this dataset; specifically, it suggests that approximately 63% of any deviation from the estimated long-run associated level of CO2 was corrected in the following year. This points towards a relatively strong convergence tendency within the dynamics observed in this sample.

4.5.4 Model Stability Diagnostics: CUSUM and CUSUMQ Tests

To further assess the reliability and robustness of the estimated ARDL model presented in Section 4.5, diagnostic tests for parameter stability were conducted. Structural stability is a key assumption, and its violation can cast doubt on the validity of the estimated coefficients. The Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMQ) tests, based on recursive

residuals, are standard graphical techniques used to detect potential parameter instability or systematic structural breaks over the sample period (Brown et al., 1975).

Figure 2 displays the results of both the CUSUM and CUSUMQ tests applied to the estimated model. The CUSUM test plots the cumulative sum of recursive residuals, while the CUSUMQ test plots the cumulative sum of squared recursive residuals. Both plots include critical bounds represented by the red dashed lines, corresponding to the 5% significance level. Stability of the model parameters is indicated if the respective cumulative sum lines remain within these bounds throughout the period.

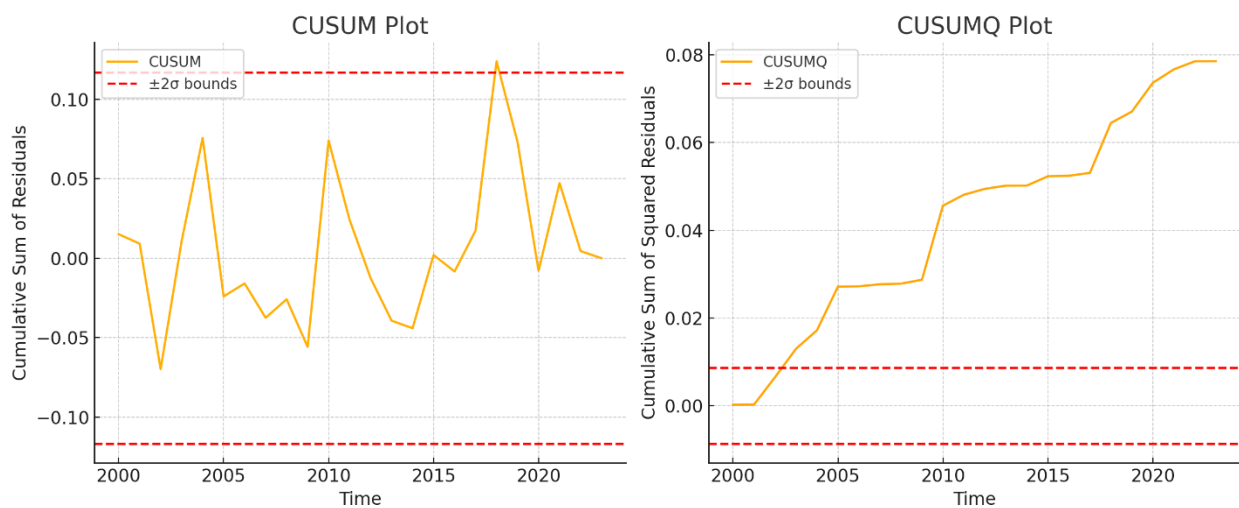


Figure 2 CUSUM Plot & CUSUMQ Plot

Observing the CUSUM plot (left panel of 2), the yellow line representing the cumulative sum of residuals fluctuates but remains consistently within the 5% critical bounds for the entire sample period (2000-2023). This result suggests stability in the mean of the model's parameters over time.

However, the CUSUMQ plot (right panel of 2) presents a different picture regarding the stability of the variance. The yellow line, representing the cumulative sum of squared residuals, starts within the bounds but clearly breaches the upper 5% critical bound around the year 2006 and continues to stay well above it for the remainder of the sample period. This departure from the

confidence bounds in the CUSUMQ test strongly indicates potential parameter instability or structural breaks occurring within the model after the initial years.

Therefore, while the CUSUM test provides some assurance regarding the stability of the mean relationship, the CUSUMQ test raises significant concerns about the constancy of the model's variance and overall parameter stability throughout the 2000–2023 period. This finding strongly suggests that the estimated ARDL model likely suffers from structural instability, possibly related to events or shifts occurring around the mid-2000s not captured in the model specification. Such instability significantly undermines the reliability of the estimated coefficients and reinforces the decision to adopt a descriptive approach. It highlights that the observed associations, particularly their magnitude, may not be constant over the entire period and must be interpreted with considerable caution, strictly as patterns observed within this specific, potentially unstable, sample context.

4.6 Granger Causality Analysis

While the ARDL model reveals long-run equilibrium relationships and short-run dynamics, Granger causality analysis provides further insights into the predictive relationships between variables over time. As detailed in the methodology (Chapter 3, Section 3.4.4), this test statistically assesses whether the past values of one variable significantly improve the prediction of the current values of another variable, beyond the predictive power contained within the past values of the target variable itself. In this study's context, Granger causality tests are applied to explore the potential directional influence between CO₂ and the primary explanatory variables identified earlier (SES, EM, GDP, TO, FDI). Understanding these directional relationships is valuable for discerning whether policy and economic factors primarily drive CO₂, or if changes in CO₂ subsequently influence policy or economic trajectories. The tests were conducted within a Vector Autoregressive (VAR) framework, examining the joint significance of the lagged coefficients of the potential causal variable. The F-statistics and corresponding p-values for the relevant pairs are presented in Table 11.

Table 11 Granger Causality Test Results

Direction of Potential Predictivity	F-statistic	p-value	Predictivity Observed?
SES → CO2	4.22	0.018	Yes
EM → CO2	5.03	0.011	Yes
GDP → CO2	6.45	0.004	Yes
CO2 → SES	2.14	0.144	No
FDI → CO2	1.03	0.381	No
TO → CO2	2.71	0.077	No

The results from the Granger causality tests, presented in Table 11, suggest several notable predictive relationships within this sample, based on statistical significance at the 5% level. Past values of SES ($p=0.018$), EM ($p=0.011$), and GDP ($p=0.004$) were found to contain statistically significant information useful for predicting the current values of CO2. In contrast, past values of CO2 did not show a statistically significant ability to predict current SES ($p=0.144$) in this model. Similarly, no significant predictive relationship running from past FDI to current CO2 ($p=0.381$) was detected.

The test examining the predictive relationship from past TO to current CO2 yielded a marginal result ($p=0.077$), possibly indicating a weak pattern within this dataset. It is important to reiterate that 'Granger causality' in this context refers only to this observed statistical predictability based on temporal precedence within the sample data and does not establish or imply true economic causality. The analysis predominantly indicates observed patterns of unidirectional predictability running from the policy variables (SES, EM) and economic development (GDP) towards CO2 trends in this specific panel data. This observed pattern provides a descriptive view of the temporal sequencing apparent in the data.

5 Discussion, Conclusion, and Recommendations

This concluding chapter synthesizes the empirical analysis presented in Chapter 4, providing an in-depth interpretation of the findings regarding the significance of environmental standards in international trade agreements for CO2 emissions. The primary aim of the thesis was to

quantitatively assess the impact of policy stringency and enforcement mechanisms, while controlling for key economic and governance factors, using panel data for 12 diverse countries over the 2000-2023 period. Chapter 4 detailed the statistical results, confirming the presence of a long-run cointegrating relationship among the variables and revealing significant short-run and long-run impacts through ARDL model estimation, alongside insights from Granger causality tests and model stability diagnostics. This chapter now moves beyond the presentation of results to critically discuss their implications in relation to the initial research questions and hypotheses, contextualize them within the broader academic literature and theoretical frameworks outlined in Chapter 2, acknowledge the study's limitations, and finally, offer pertinent recommendations for policy and future research avenues.

5.1 Discussion of Findings

This section discusses the key patterns and associations observed in the descriptive analysis presented in Chapter 4, interpreting these findings within the context of the literature reviewed in Chapter 2 and considering the study's exploratory nature and limitations. The analysis aimed to explore relationships between environmental standards in trade agreements (stringency and enforcement), economic factors, governance quality, and CO₂ emissions trends within a specific panel of 12 countries from 2000-2023.

A central observation from the ARDL model estimation was the negative association found between both environmental policy stringency (SES) and enforcement mechanisms (EM) and CO₂ emissions per capita in the long run within this sample (see Table 9 results). Higher levels of SES and EM were consistently linked with lower levels of CO₂ over the study period for these countries. This observed pattern resonates with arguments in the literature suggesting that stricter and well-enforced environmental provisions could potentially contribute to better environmental outcomes (e.g., Rufael & Weldemskel, 2021; Abman et al., 2024). The descriptive Granger causality tests further suggested a predictive relationship running from past SES and EM values to current CO₂ values within this dataset (see Table 11 results), lending additional support to the idea that these policy factors preceded changes in emissions trends in the observed data.

However, this finding contrasts with studies suggesting stringency might lead to emission increases via pollution havens (Demiral et al., 2021). This study's findings, being descriptive for a limited sample, do not definitively resolve this debate but suggest that, for these 12 countries during this period, the association leaned towards environmental benefit.

The analysis also highlighted a strong, positive, and statistically significant association between GDP per capita and CO₂ emissions in both the short and long run (see Table 8 and Table 9 results). This aligns with the initial phase of the Environmental Kuznets Curve (EKC) hypothesis discussed in the literature (Grossman & Krueger 1991; Azam et al., 2021), where economic growth is often accompanied by increased environmental pressure, particularly in developing and industrializing nations included in the sample. The descriptive Granger tests also indicated predictability running from GDP to CO₂ (see Table 11 results), consistent with economic activity influencing emission levels.

Regulatory quality (RQI) showed a statistically significant negative association with CO₂ emissions in the long run within the sample (see Table 9 results). This observation aligns with literature emphasizing the importance of good governance and institutional capacity for effective environmental policy implementation (Coenen et al., 2020; Lavenex et al., 2021). It suggests that better governance might enhance the effectiveness of environmental provisions like SES and EM, although the high correlation observed between RQI, SES, and EM (see Table 5) makes disentangling their unique roles challenging within this model.

The observed associations for trade openness (TO) and foreign direct investment (FDI) were less conclusive in this analysis (see Table 9 results). TO showed only a marginal positive long-run association with CO₂, while FDI showed no statistically significant association in either the short or long run. This suggests that, within this specific sample and model, the relationship between these globalization indicators and CO₂ emissions was not strong or consistent, reflecting the mixed findings often reported in the broader literature (e.g., Dou et al., 2021 vs. Khan et al., 2021 regarding TO).

It is crucial to interpret these observed patterns with caution, primarily due to the limitations inherent in the study. The small sample size ($N=12$) restricts the generalizability of these findings. Furthermore, the CUSUMQ test indicated potential parameter instability from the mid-2000s onwards (see Section 4.5.4), suggesting that the strength and potentially even the direction of these associations might not be constant over the entire period or entirely reliable.

Given the exploratory nature of this study and its limitations, the findings should not be interpreted as confirmed causal effects or validated hypotheses. Instead, they represent observed trends and associations within a specific context. These observations, however, are valuable for generating propositions that can guide future research using larger datasets suitable for robust hypothesis testing. The consistent negative associations observed for SES and EM with CO₂, the positive link with GDP, and the role of RQI, despite the noted instability, form the basis for such propositions, which will be formally outlined in the conclusion.

5.2 Conclusion

This thesis explored the relationships between environmental standards in international trade agreements, economic factors, governance quality, and CO₂ emissions per capita. Using a descriptive Autoregressive Distributed Lag (ARDL) approach on panel data for 12 varied countries from 2000 to 2023, the study aimed to find observable trends and links within this specific sample, rather than testing set hypotheses.

The descriptive analysis in Chapter 4 showed several notable patterns in the data. For the countries studied, there were consistent negative long-run links between higher levels of environmental policy stringency (SES) and enforcement mechanisms (EM), and lower levels of CO₂ emissions per capita. Conversely, a strong positive long-run link was seen between higher GDP per capita and higher CO₂ emissions. Furthermore, higher regulatory quality (RQI) was linked with lower CO₂ emissions levels in the long run within this sample. The observed links for trade openness (TO) and foreign direct investment (FDI) were less clear in this analysis. It is important to repeat that potential parameter instability, as shown by diagnostic tests, means caution is needed when interpreting the exact size and stability of these observed relationships.

Based on these descriptive findings and the patterns observed within this specific sample, the following propositions are put forward for future investigation using larger datasets suitable for robust hypothesis testing:

- **Proposition 1:** Higher stringency of environmental standards incorporated into international trade agreements is associated with lower CO2 emissions per capita.
- **Proposition 2:** Stronger enforcement mechanisms for environmental standards within international trade agreements are associated with lower CO2 emissions per capita.
- **Proposition 3:** Higher GDP per capita is associated with higher CO2 emissions per capita, reflecting the environmental pressures often associated with economic growth, particularly in developing and emerging economies.
- **Proposition 4:** Higher national regulatory quality is associated with lower CO2 emissions per capita, potentially by enhancing the effectiveness of environmental policies.
- **Proposition 5:** The relationship between trade openness, foreign direct investment, and CO2 emissions per capita is complex and likely moderated by national context, industry composition, and specific policy designs.

In conclusion, while the limitations of the sample size prevent definitive causal claims or generalization, this study contributes by providing a detailed descriptive analysis of key variables related to trade and environment across a diverse set of countries. Its primary contribution lies in the development of these empirically grounded propositions, which highlight potentially significant relationships and offer clear directions for future, larger-scale research aimed at formally testing the impact of environmental standards in trade agreements on global sustainability efforts.

5.3 Limitations of the Study

While this study provides exploratory insights into the relationship between environmental standards in trade agreements and CO2 emissions, it is subject to several limitations that must be acknowledged when interpreting the findings. The most significant limitation stems from the sample selection, specifically the small number of cross-sectional units (N=12 countries).

Although the time series dimension (T=24 years) provides a reasonable number of total observations, the limited number of countries severely restricts the ability to perform robust hypothesis testing or generalize the findings to a broader global context (Saunders et al., 2019). This limitation was the primary reason for shifting the study's focus from a confirmatory to an exploratory and descriptive approach, with the aim of generating propositions rather than testing hypotheses. While the selected countries represent diverse economies and geographical locations, the observed trends and associations remain specific to this particular sample and timeframe.

A further significant limitation relates to the parameter stability of the econometric model. As highlighted by the diagnostic tests in Chapter 4, particularly the CUSUMQ test (Figure 2), there were indications of potential instability in the model parameters, especially from the mid-2000s onwards (). This suggests that the estimated relationships, including the magnitude and potentially the consistency of the coefficients for variables like SES, EM, GDP, and RQI, might not be constant over the entire study period (). Such instability could arise from structural breaks or unmodeled shifts, further reinforcing the need for cautious, descriptive interpretation of the ARDL results.

Additionally, limitations common to econometric studies of this nature should be considered. The econometric model specification, while chosen for its suitability for mixed-order integration (Hendry & Nielsen, 2012), may be subject to potential omitted variable bias. Factors beyond those included – such as specific domestic policies, technological shocks, or global events – could influence CO2 emissions, potentially affecting the estimated associations. The study also relies on specific indicators for measuring key concepts like SES, EM, and RQI (). While standard indices from reputable sources (WDI, IMF) were used, the choice of indicators can influence results, and alternative measures might yield different findings (). Finally, the relationships explored exist within a dynamic context; the interplay between trade, environmental policy, and emissions is constantly evolving, and findings based on data up to 2023 might change as new policies are implemented or global conditions shift.

Acknowledging these limitations, particularly the constraints imposed by the sample size and potential parameter instability, is crucial for appropriately contextualizing the study's descriptive findings and the propositions derived from them.

5.4 Recommendations and Implications

Based on the descriptive findings and the exploratory nature of this study, this section outlines tentative considerations for policy and theory, acknowledges the need for further investigation, and provides specific recommendations for future research directions. It is crucial to emphasize that due to the study's limitations, particularly the small sample size and potential parameter instability, the following implications are suggestive rather than conclusive.

5.4.3 Tentative Policy Considerations

The observed negative associations between environmental policy stringency (SES), enforcement mechanisms (EM), regulatory quality (RQI), and CO₂ emissions within the sample (), while not demonstrating causality, suggest that policymakers engaged in designing and implementing trade agreements might consider the potential importance of incorporating ambitious and well-enforced environmental standards, supported by strong national governance frameworks. The consistent pattern observed across these 12 diverse countries, although not generalizable, points towards these factors as potentially relevant levers for environmental sustainability that warrant further investigation. Similarly, the persistent positive association observed between GDP growth and CO₂ emissions () highlights the ongoing challenge of decoupling economic development from environmental impact, suggesting that environmental provisions within trade agreements may need to be complemented by robust domestic policies promoting green transitions.

5.4.4 Potential Theoretical Implications

The descriptive findings offer preliminary observations potentially relevant to established theoretical frameworks. The positive GDP-CO₂ association observed () aligns with the initial phase of the Environmental Kuznets Curve hypothesis. The negative associations found for SES and EM () in this sample provide context for the Pollution Haven Hypothesis debate, suggesting

that for these countries, any emission-inducing relocation effects did not appear to outweigh the observed negative association between standards and emissions, although this requires rigorous testing. These observations do not confirm or refute existing theories but highlight the need for further research exploring these dynamics with larger datasets.

5.4.5 Suggestions for Future Research

The exploratory nature of this study and its limitations lead directly to recommendations for future research, primarily focused on validating the patterns observed here:

1. **Test the Developed Propositions:** The most critical direction for future research is to formally test the propositions developed in Section 5.2 using larger, more representative datasets. Expanding the sample to include significantly more countries over longer time periods would allow for robust econometric analysis, hypothesis testing, and the potential to draw more generalizable conclusions about the causal impact of SES, EM, GDP, RQI, TO, and FDI on CO₂ emissions within the context of trade agreements.
2. **Address Parameter Instability:** Future studies should explicitly investigate and address the potential parameter instability indicated by the CUSUMQ test in this research (). Techniques such as testing for structural breaks, incorporating dummy variables for significant global events (e.g., the 2008 financial crisis, major climate agreement milestones), or employing time-varying parameter models (like TVP-ARDL) could provide insights into how these relationships may have evolved over time.
3. **Refine Variable Measurement:** Research using alternative or more nuanced indicators for key concepts like environmental policy stringency, enforcement capacity, and regulatory quality could test the robustness of the associations observed here (). Exploring different measurement approaches for trade openness and FDI might also reveal relationships not captured by the aggregate indicators used in this study.
4. **Expand the Model:** Incorporating additional relevant variables—such as indicators of technological innovation, renewable energy adoption, sector-specific trade data, political

stability, or specific types of environmental provisions within agreements—could provide a more comprehensive understanding of the factors influencing CO2 emissions.

5. **Explore Non-Linearities and Heterogeneity:** Investigating potential non-linear relationships (e.g., threshold effects related to GDP or stringency levels) or exploring country-specific heterogeneity using appropriate panel data techniques could offer deeper insights than the linear model primarily employed here (). Complementary qualitative case studies could also enrich understanding of context-specific mechanisms.

By pursuing these avenues, future research can build upon the exploratory groundwork laid by this thesis, rigorously test the proposed relationships, and contribute more definitively to the understanding of how international trade agreements can effectively support environmental sustainability goals.

References

- Abman, R., Lundberg, C., & Ruta, M. (2024). The Effectiveness of Environmental Provisions in Regional Trade Agreements. *Journal of the European Economic Association*. <https://doi.org/10.1093/jeea/jvae023>
- Abreo, C., Bustillo, R., & Rodriguez, C. (2021). The role of institutional quality in the international trade of a Latin American country: evidence from Colombian export performance. *Journal of Economic Structures*, 10(1). <https://doi.org/10.1186/s40008-021-00253-5>
- Ahmed, Z., Ahmad, M., Rjoub, H., Kalugina, O. A., & Hussain, N. (2021). Economic growth, renewable energy consumption, and ecological footprint: Exploring the role of environmental regulations and democracy in sustainable development. *Sustainable Development*, 30(4). <https://doi.org/10.1002/sd.2251>
- Ali, E. B., Anufriev, V. P., & Amfo, B. (2021). Green economy implementation in Ghana as a road map for a sustainable development drive: A review. *Scientific African*, 12. <https://doi.org/10.1016/j.sciaf.2021.e00756>
- Auty, R. M. (1993). *Sustaining Development in Mineral Economies: the Resource Curse Thesis*. Routledge.
- Awosusi, A. A., Mata, M. N., Ahmed, Z., Coelho, M. F., Altuntaş, M., Martins, J. M., Martins, J. N., & Onifade, S. T. (2022). How Do Renewable Energy, Economic Growth and Natural Resources Rent Affect Environmental Sustainability in a Globalized Economy? Evidence From Colombia Based on the Gradual Shift Causality Approach. *Frontiers in Energy Research*, 9. <https://doi.org/10.3389/fenrg.2021.739721>
- Azam, A., Rafiq, M., Shafique, M., & Yuan, J. (2021). An empirical analysis of the non-linear effects of natural gas, nuclear energy, renewable energy and ICT-Trade in leading CO2 emitter countries: Policy towards CO2 mitigation and economic sustainability. *Journal of*

- Environmental Management*, 286, 112232.
<https://doi.org/10.1016/j.jenvman.2021.112232>
- Campos, R. G., Timini, J., & Vidal, E. (2021). Structural gravity and trade agreements: Does the measurement of domestic trade matter? *Economics Letters*, 208, 110080.
<https://doi.org/10.1016/j.econlet.2021.110080>
- Carrère, C., Olarreaga, M., & Raess, D. (2021). Labor clauses in trade agreements: Hidden protectionism? *The Review of International Organizations*, 17.
<https://doi.org/10.1007/s11558-021-09423-3>
- Coenen, J., Bager, S., Meyfroidt, P., Newig, J., & Challies, E. (2020). Environmental Governance of China's Belt and Road Initiative. *Environmental Policy and Governance*, 31(1), 3–17.
- Corrocher, N., & Mancusi, M. L. (2021). International collaborations in green energy technologies: What is the role of distance in environmental policy stringency? *Energy Policy*, 156, 112470. <https://doi.org/10.1016/j.enpol.2021.112470>
- Demiral, M., Akça, E. E., & Tekin, I. (2021). Predictors of global carbon dioxide emissions: Do stringent environmental policies matter? *Environment, Development and Sustainability*.
<https://doi.org/10.1007/s10668-021-01444-7>
- Di Ubaldo, M., & Gasiorek, M. (2022). Non-trade provisions in trade agreements and FDI. *European Journal of Political Economy*, 102208.
<https://doi.org/10.1016/j.ejpoleco.2022.102208>
- Dou, Y., Zhao, J., Malik, M. N., & Dong, K. (2021a). Assessing the impact of trade openness on CO2 emissions: Evidence from China-Japan-ROK FTA countries. *Journal of Environmental Management*, 296, 113241. <https://doi.org/10.1016/j.jenvman.2021.113241>
- Dou, Y., Zhao, J., Malik, M. N., & Dong, K. (2021b). Assessing the impact of trade openness on CO2 emissions: Evidence from China-Japan-ROK FTA countries. *Journal of Environmental Management*, 296, 113241. <https://doi.org/10.1016/j.jenvman.2021.113241>

- Duong, M., Holmes, M. J., & Strutt, A. (2020). The impact of free trade agreements on FDI inflows: the case of Vietnam. *Journal of the Asia Pacific Economy*, 26(3), 1–23. <https://doi.org/10.1080/13547860.2020.1765717>
- Farooq, S., Ozturk, I., 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>
- Hendry, D. F., & Nielsen, B. (2012). *Econometric Modeling*. Princeton University Press.
- Hoekman, B., & Sabel, C. (2021). Plurilateral Cooperation as an Alternative to Trade Agreements: Innovating One Domain at a Time. *Global Policy*, 12(S3), 49–60. <https://doi.org/10.1111/1758-5899.12923>
- Jahanger, A., Yu, Y., Hossain, M. R., Murshed, M., Balsalobre-Lorente, D., & Khan, U. (2022). Going away or going green in NAFTA nations? Linking natural resources, energy utilization, and environmental sustainability through the lens of the EKC hypothesis. *Resources Policy*, 103091. <https://doi.org/10.1016/j.resourpol.2022.103091>
- Kalantaripor, M., & Najafi Alamdarlo, H. (2021). Spatial Effects of Energy Consumption and Green GDP in Regional Agreements. *Sustainability*, 13(18), 10078. <https://doi.org/10.3390/su131810078>
- Khalid, U., Okafor, L. E., & Burzynska, K. (2021). Do Regional Trade Agreements Enhance International Tourism Flows? Evidence from a Cross-Country Analysis. *Journal of Travel Research*, 004728752110283. <https://doi.org/10.1177/00472875211028321>
- Khan, H., Weili, L., & Khan, I. (2021). Environmental innovation, trade openness and quality institutions: an integrated investigation about environmental sustainability. *Environment, Development and Sustainability*. <https://doi.org/10.1007/s10668-021-01590-y>

- Khan, I., & Hou, F. (2021). The Impact of Socio-economic and Environmental Sustainability on CO2 Emissions: A Novel Framework for Thirty IEA Countries. *Social Indicators Research*. <https://doi.org/10.1007/s11205-021-02629-3>
- Lavenex, S., Serrano, O., & Büthe, T. (2021). Power transitions and the rise of the regulatory state: Global market governance in flux. *Regulation & Governance*. <https://doi.org/10.1111/rego.12400>
- Levinson, A. (2008). Pollution Haven Hypothesis. *The New Palgrave Dictionary of Economics*, 1–5. https://doi.org/10.1057/978-1-349-95121-5_2693-1
- Luo, Y., Salman, M., & Lu, Z. (2021). Heterogeneous impacts of environmental regulations and foreign direct investment on green innovation across different regions in China. *Science of the Total Environment*, 759, 143744. <https://doi.org/10.1016/j.scitotenv.2020.143744>
- Mahalik, M. K., Pal, S., Le, T., & Mishra, S. (2023). Does environmental policy stringency improve nature's health in BRICS economies? Implications for sustainable development. *Environmental Science and Pollution Research*. <https://doi.org/10.1007/s11356-023-31134-y>
- Mamasoliev, S. (2024). INTERNATIONAL BUSINESS LAW AND US MARKET EXPANSION. *INTERDISCIPLINE INNOVATION and SCIENTIFIC RESEARCH CONFERENCE*, 2(24), 92–101. <https://doi.org/10.5281/zenodo.12052306>
- Méndez, E., & Patten, D. V. (2022). *Voting on a Trade Agreement: Firm Networks and Attitudes Toward Openness*. <https://doi.org/10.3386/w30058>
- Morin, J.-F., & Rochette, M. (2017). Transatlantic convergence of preferential trade agreements environmental clauses. *Business and Politics*, 19(4), 621–658. <https://doi.org/10.1017/bap.2017.23>

Mulder, C., Conti, E., & Mancinelli, G. (2021). Carbon budget and national gross domestic product in the framework of the Paris Climate Agreement. *Ecological Indicators*, 130, 108066. <https://doi.org/10.1016/j.ecolind.2021.108066>

Murshed, M., Rahman, Md. A., Alam, M. S., Ahmad, P., & Dagar, V. (2021a). The nexus between environmental regulations, economic growth, and environmental sustainability: linking environmental patents to ecological footprint reduction in South Asia. *Environmental Science and Pollution Research*, 28(36), 49967–49988. <https://doi.org/10.1007/s11356-021-13381-z>

Murshed, M., Rahman, Md. A., Alam, M. S., Ahmad, P., & Dagar, V. (2021b). The nexus between environmental regulations, economic growth, and environmental sustainability: linking environmental patents to ecological footprint reduction in South Asia. *Environmental Science and Pollution Research*, 28(36), 49967–49988. <https://doi.org/10.1007/s11356-021-13381-z>

Omeihe, K., Simba, A., Gustafsson, V., & Omeihe, I. (2021). Trade associations and trust in weak institutional contexts: exploring SME relationships in Nigeria. *International Review of Entrepreneurship*, 18(4), 583–610. <https://irep.ntu.ac.uk/id/eprint/42975/>

PHILLIPS, P. C. B., & PERRON, P. (1988). Testing for a unit root in time series regression. *Biometrika*, 75(2), 335–346. <https://doi.org/10.1093/biomet/75.2.335>

Qiu, S., Wang, Z., & Geng, S. (2021). How do environmental regulation and foreign investment behavior affect green productivity growth in the industrial sector? An empirical test based on Chinese provincial panel data. *Journal of Environmental Management*, 287, 112282. <https://doi.org/10.1016/j.jenvman.2021.112282>

Raff, Z., & Earnhart, D. (2022). Employment and environmental protection: The role of regulatory stringency. *Journal of Environmental Management*, 321, 115896. <https://doi.org/10.1016/j.jenvman.2022.115896>

Safdar, S., Khan, A., & Andlib, Z. (2022). Impact of good governance and natural resource rent on economic and environmental sustainability: an empirical analysis for South Asian

- economies. *Environmental Science and Pollution Research*.
<https://doi.org/10.1007/s11356-022-21401-9>
- Santeramo, F. G., & Lamonaca, E. (2022). Standards and regulatory cooperation in regional trade agreements: What the effects on trade? *Applied Economic Perspectives and Policy*.
<https://doi.org/10.1002/aepp.13276>
- Saunders, M., Lewis, P., & Thornhill, A. (2019). *Research Methods for Business Students* (8th ed.). Pearson Education Limited.
- Su, C.-W., Xie, Y., Shahab, S., Faisal, Ch. M. N., Hafeez, M., & Qamri, G. M. (2021). Towards Achieving Sustainable Development: Role of Technology Innovation, Technology Adoption and CO2 Emission for BRICS. *International Journal of Environmental Research and Public Health*, 18(1), 277. <https://doi.org/10.3390/ijerph18010277>
- Tian, K., Zhang, Y., Li, Y., Ming, X., Jiang, S., Duan, H., Yang, C., & Wang, S. (2022). Regional trade agreement burdens global carbon emissions mitigation. *Nature Communications*, 13(1), 408. <https://doi.org/10.1038/s41467-022-28004-5>
- Wang, Q., Wang, X., Li, R., & Jiang, X. (2024). Reinvestigating the environmental Kuznets curve (EKC) of carbon emissions and ecological footprint in 147 countries: a matter of trade protectionism. *Humanities and Social Sciences Communications*, 11(1).
<https://doi.org/10.1057/s41599-024-02639-9>
- Wang, Q., Zhang, F., & Li, R. (2023). Free trade and carbon emissions revisited: The asymmetric impacts of trade diversification and trade openness. *Sustainable Development*, 32(1).
<https://doi.org/10.1002/sd.2703>
- Wolde-Rufael, Y., & Mulat-Weldemeskel, E. (2021). Do environmental taxes and environmental stringency policies reduce CO2 emissions? Evidence from 7 emerging economies. *Environmental Science and Pollution Research*, 28(18), 22392–22408.
<https://doi.org/10.1007/s11356-020-11475-8>

Xiaoman, W., Majeed, A., Vasbieva, D. G., Yameogo, C. E. W., & Hussain, N. (2021). Natural resources abundance, economic globalization, and carbon emissions: Advancing sustainable development agenda. *Sustainable Development*, 29(5). <https://doi.org/10.1002/sd.2192>

Zikmund, W. G. (2017). *Business research methods*. South-Western Cengage Learn