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Graduate School of Management

**Bachelor's Thesis**

# THE IMPACT OF GREEN PARTNERSHIPS AND INTERNATIONALIZATION ON THE ENVIRONMENTAL PERFORMANCE OF METALLURGICAL COMPANIES

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**Content**

## INTRODUCTION

The relevance of this research lies in the fact that in the modern industrial ecosystem, which is dynamically evolving, and which is known for its raising attention to ecological consciousness, the role of green partnerships in supporting the environmental performance of metallurgical companies as leading producers of harmful CO2 emissions gains a significant importance. This research aims to investigate this principal aspect by offering insightful data to a wide array of stakeholders.

The analysis of green partnerships addresses global need to solve environmental problems, such as pollution, climate change and irrational use of resources, and highlights the need to introduce joint efforts into dealing.with the issue. All of the mentioned problems are especially relevant for metallurgical sector, which is famous for its significant negative environmental impact.

The research in the field of reasons for green partnerships of metallurgical companies positively affecting the environment is especially important, taking into account governments all over the world tightening climate regulations. The activation of the Paris agreement and governments' commitment to UN Global Compact further underlines the need for accepting industrial strategies, which align with global efforts to keep global warming below 2 degrees Celsius above pre-industrial level[1]. Furthermore, it is difficult to overestimate the social value of the environmental performance indicator, which includes many of indeed important metrics. Nowadays metallurgical companies gain more and more attention from the public and eco-conscious groups, demanding meticulous control over the environmental performance. Violations might harm the companies' reputations and legal appearance.

Thus, green partnerships not only can serve as a possible plan for companies to increase their environmental performance and improve overall corporate image, but also are able to contribute to the global goal of creating sustainable industrial framework, which highlights the particular importance of this topic for research. In addition, the results of the study may be applicable to other industries with similar specifics, providing a framework and useful insights for further study of the topic of green partnerships, which is not yet widely discussed. For example, companies belonging to energy intensive industries can use the results of this study as a starting point for further research.

Considering that the phenomenon of green partnerships as a factor influencing the effectiveness of the company's environmental activity has not been studied so widely, the focus on the

[1] The Paris Agreement. What is the Paris Agreement? – UNFCCC. Retrieved from: https://unfccc.int/process-and-meetings/the-paris-agreement [Online Resource]

metallurgical industry is a significant step forward in the study of this topic. Especially taking into account the role of the metallurgical industry as one of the most active environmental pollutants.

The goal of this research is to evaluate the impact of green partnerships and internationalization on the environmental performance of metallurgical companies.

To achieve the identified goal of the research paper, several objectives were formulated:

- To study the theoretical basis of corporate social responsibility and ESG, as well as green partnerships' and internationalization concepts;
- To study aspects of the ESG agenda and internationalization specific to the metallurgical industry;
- To conduct the analysis of previously completed theoretical and empirical papers, formulate the hypotheses;
- To collect and process the data and create an empirical model;
- To evaluate the impact of green partnerships and internationalization on the environmental performance of metallurgical companies by testing the econometric model;
- To analyze the outcomes of the study, formulate conclusions and recommendations for potential stakeholders.

The object of the study are metallurgical companies, disclosing information on their ESG-related practices.

The subject of the study is the impact of green partnerships and internationalization on the environmental performance of these metallurgical companies.

Research methodology includes econometric modeling using regression analysis using the Python programming language.

The research paper includes three chapters. Chapter 1 provides a comprehensive overview of the metallurgical industry, emphasizing its economic significance and environmental challenges. It defines corporate social responsibility (CSR) and explores its relevance to the industry. The chapter introduces the Environmental, Social, and Governance (ESG) framework and its specific application within the metallurgical sector. It discusses the relationship between internationalization and ESG performance and examines the concept and classification of green partnerships. The chapter concludes by presenting the hypotheses formulated based on the literature review.

Chapter 2 details the research methodology. It describes the data collection process and the characteristics of the data sample. The chapter defines the dependent, independent, and control variables used in the study and provides an overview of the econometric model employed. It presents basic descriptive statistics of the data sample and describes the tests conducted for multicollinearity among the independent variables.

Chapter 3 presents the results of the econometric model used to analyze the impact of green partnerships and internationalization on the environmental performance of metallurgical companies. It details the outcomes of the model, including statistical significance and the strength of the relationships identified. The discussion section interprets these results, explaining why certain hypotheses could be accepted or rejected and what the findings mean for the industry. This chapter contextualizes the results within the broader literature and industry practices, providing insights and recommendations based on the study's findings.

The conclusion summarizes the key findings, reinforces the importance of green partnerships and internationalization for improving environmental performance, and suggests practical recommendations for industry stakeholders and policymakers.

# CHAPTER 1. THEORETICAL BACKGROUND

## 1.1. Industry overview

Metallurgical Industry has a central role in manufacturing across the globe, starting from extraction and processing to the stage of refining a metal from its ore and finally shaping that metal into a product. It is then subdivided into some of the key sub-sectors, including the largest production and most energy-demanded of all: production of iron and steel, non-ferrous metal production (like aluminum, copper, and nickel), and metal forming and finishing. It plays an essential role in supplying the essential raw material to many other sectors, such as construction, automotives, and electronics. It is, however, the largest CO2 emitter among industries, being supported by an enormous need for energy in the extraction and processing of metals, often based on fossil fuel. The iron and steel sector is responsible for 7,2% of worldwide greenhouse gas emissions (Figure 1).

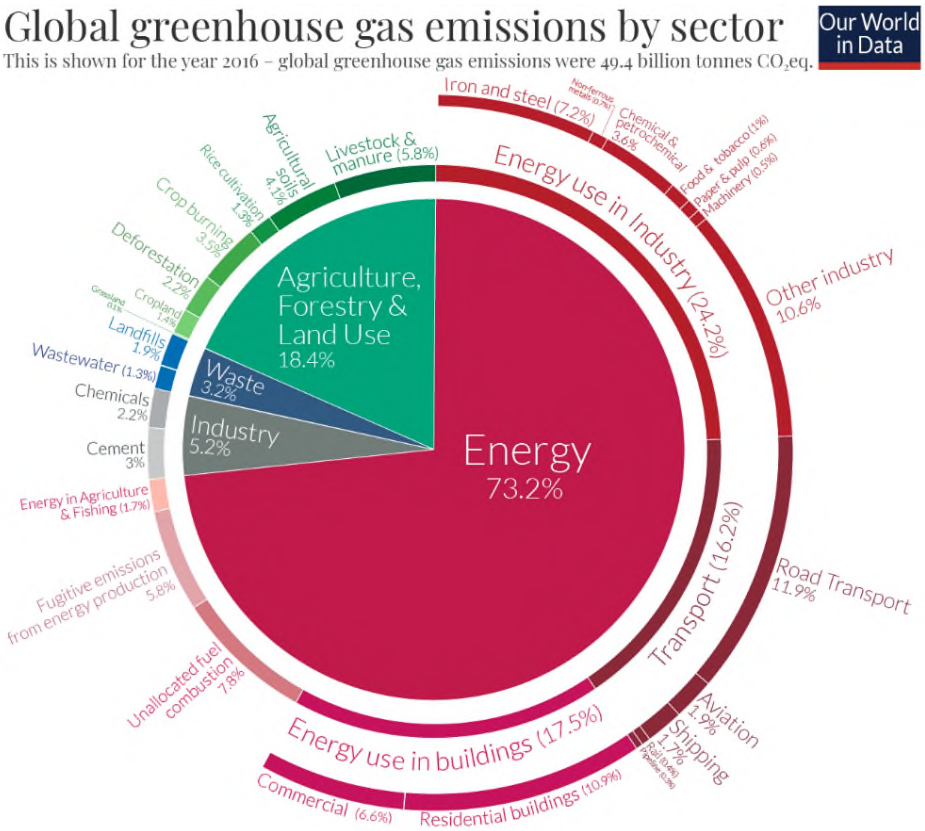


***Figure 1.*** *Global greenhouse gas emissions by sector, 2016*

***Source:*** *Our World in Data, 2016*[2]

Amidst growing concerns for the environment, the industry is realizing innovations not only for energy efficiency and recycling but also for incorporating renewable sources of energy to

[2] Hannah Ritchie (2020) – "Sector by sector: where do global greenhouse gas emissions come from?" – OurWorldInData. Retrieved from: https://ourworldindata.org/ghg-emissions-by-sector [Online Resource]

decrease the carbon footprints, which allows for better sustainability. The industry produces 11% of global carbon dioxide emissions[3]. Even though total emissions have increased during the last 10 years, largely that has been so because of the drastically increased demand. Serious cuts in emissions are essential to get on track with Net Zero scenario under which the emissions are shorter by quarter by 2030. The intensity of the iron and steel sector in the NZE Scenario is illustrated in the (Figure 2). Short-term cuts in emissions may become achievable through serious improvements in energy efficiency[4].

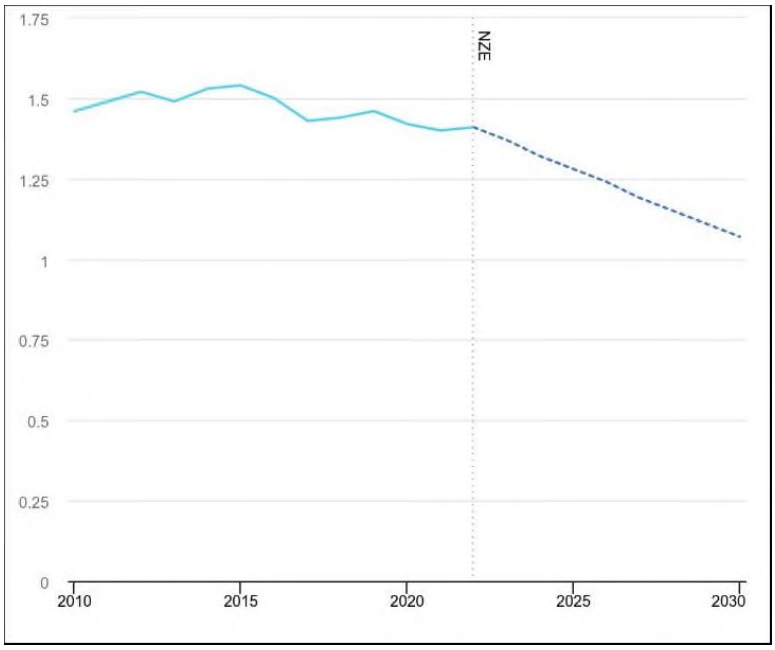


***Figure 2.*** *Direct CO2 intensity of the iron and steel sector in the Net Zero Scenario, 2010-2030*

***Source:*** *IEA, 2023*[5]

## 1.2. Corporate Social Responsibility: terms and concepts

Corporate social responsibility is an imperative feature of cutting-edge business practices, advocating for a business model that aims to achieve beneficial co-existence with the society and environment, rather than focusing solely on profit generation. Historically, CSR has evolved from mere philanthropy to core enterprise strategy that complements sustainability and stakeholders. The foundational idea states that companies ought to perform in methods, which might be useful

[3] Ali Hasanbeigi – "Steel Climate Impact: An International Benchmarking of Energy and CO2 Intensities" – Global Efficiency Intelligence. Retrieved from: https://www.globalefficiencyintel.com/steel-climate-impact-international-benchmarking-energy-co2-intensities#:~:text=The%20iron%20and%20steel%20industry,global%20steel%20production%20in%202020 [Online Resource]

[4] Direct CO2 intensity of the iron and steel sector in the Net Zero Scenario, 2010-2030 – IEA, Paris. Retrieved from: https://www.iea.org/data-and-statistics/charts/direct-co2-intensity-of-the-iron-and-steel-sector-in-the-net-zero-scenario-2010-2030 [Online Resource]

[5] Ibid.

to society and the environment, integrating ethical, social, and environmental concerns into their strategic frameworks [Carroll, 1991].

Carroll's Pyramid of CSR formulates responsibilities in economic, legal, ethical, and philanthropic layers, meaning that enterprises have to try to meet expectations of society as well as profitability [Carroll, 1991]. Scientific work of [Porter and Kramer, 2006] further develops the idea and makes a suggestion of creating shared value – not only for the shareholder, but for the society as well. The authors later defined the concept as a set of principles and practices, which is able to "strengthen a company's competitiveness while improving the economic and social conditions of the communities in which it operates" [Porter M. and Kramer M., 2011].

Crane, Matten, and Spence [Crane et al., 2008] emphasized the fact that ethical leadership is very important in embedding corporate social responsibility into corporate culture, which is vital for promotion of true CSR practices that align with more general social values. Such practices are very important for promoting a company's image, operational efficiency, and regulatory conformity, at the end contributing to a sustainable long-term success of the business.

The CSR practices' integration is often reflected through a company's dedication to ESG principle criteria. These standards are used as benchmarks to estimate company's commitment to corporate social responsibility, showing a comprehensive overall view of the firm's devotion to sustainable practices. The concentration on ESG highlights the mutual dependence between success in business and societal health, supporting a business model, which prefers long-term sustainability over short-term achievements.

### 1.3. ESG concept

The ESG (Environmental, Social, and Governance) framework is a strategic enlargement that puts sustainability in the center of company's operation. The development of ESG idea emphasizes a shift of a paradigm in corporate governance, paying attention to financial performance in addition to the value of environmental guidance, social accountability, and ethical leadership. This switch shows a growing acknowledgement between stakeholders that sustainable business is inseparable to long-term profit and reliable risk management.

The ESG framework performs as a metric system to assess a company's attempts to address environmental risks, social liabilities, and governance practices, which are ethical and clear. Through this framework, companies are estimated to what extent they are able to mitigate environmental risks, promote social wellbeing, and support strong governance structures. The concept allows us to come up with a quantitative description for company's sustainability activity and overall development.

The critical discussions around CSR and the Environmental, Social, and Governance framework underscore the importance of various ESG ratings and rankings in evaluating corporate

sustainability efforts. These ratings are based on databases, like Thomson Reuters (the one primarily used for this research), and are believed to contain the most robust collection of data, including reports on companies, industries, and geographies. This is an important instrument for cross-comparison and benchmarking, enabling to study the correlating between actions to the environment and financial and governance outcomes.

### 1.3.1. ESG concept in metallurgical industry

Researches on the impact of ESG in the metallurgical industry show that dedication to the standards can seriously increase corporate efficiency and innovation in the company. For example, a 2018 study "Exploring Social Origins in the Construction of ESG Measures Working Paper" clearly showed a positive correlation between high ESG ratings and company's financial performance as well as market value and profitability [Eccles et al., 2018]. Besides, firms with high ESG ratings typically show lower volatility in earnings and more stable investments, which are difficult to overestimate for long-term planning[6].

For example, in the metallurgical industry, ArcelorMittal alongside with other companies has taken substantial steps forward to integrating ESG in their operation. In the year 2020, ArcelorMittal has started a project "XCarb" aimed at putting together its reduced and zero-carbon products and activities, striving to get to carbon neutrality by 2050. At the end of 2020, the firm has decreased its carbon emissions by 9% comparing to 2018, showing a significant commitment to its ESG goals[7].

Likewise, the firm Vale S.A. has been very active in its ESG attempts, focusing on reduction of emission and investments in renewable energy sources. Vale's commitment to decrease both direct and indirect emissions by 33% by year 2030 from its 2017 level and to achieve net-zero emissions level by year 2050 is a significant evidence of its seriousness in terms of commitment to environmental problems. In year 2021, about 20% of the consumed energy by the company were from renewable sources, which demonstrates company's commitment to ESG[8].

[6] "How has integrating ESG considerations into the investment process affected performance?" – MSCI. Retrieved from: https://www.msci.com/esg-101-what-is-esg/esg-and-performance [Online Resource]

[7] ArcelorMittal, 2021 Annual Report – Retrieved from: https://corporate.arcelormittal.com/media/xm4blr5z/annual-report-combined-2021.pdf [Online Resource]

[8] Vale, 2021 Sustainability Report – Retrieved from: https://vale.com/documents/d/guest/2021-annual-report-pt-vale-indonesia-tbk [Online Resource]

### 1.4. Internationalization and ESG performance

The term ‘internationalization’ refers to a process of a company expanding its activity outside home country, entering international markets. This process covers a range of activities, including exports, foreign direct investment, joint ventures, strategic alliances and the establishment of subsidiaries in foreign countries.

There are several major reasons for a company to go international. First of all, new markets provide access to a wider customer base, which is potentially a great opportunity for sales growth. Moreover, internationalization helps to diversify risks across different markets, mitigating possible negative effects. Another reason to internationalize the business is connected with competitive advantage, gained by an early mover in a new market, which is especially critical in a situation when company is able to apply its expertise to a new market (alongside with obtaining valuable insights into new market strategies). Besides, one of the possible internationalization drivers is the desire to overcome the difficulties and limitations that the company has faced in the home market[9].

In addition to the undeniable advantages of business internationalization, it also involves a variety of risks, which should be considered. Not only companies face numerous challenges when entering a new market in order to gain a foothold in it, they are also obliged to take into account possible difficulties associated with changes in the culture, regulatory regime, a competitive market environment or limited resources of the host country[10].

Numerous studies have been devoted to the search for the relationship between the internationalization of the company (and its foreign activity in general) with the effectiveness of environmental performance in the recent years. However, there is still no consensus on the topic [Ahmadova et al., 2022]. On the one hand, the researchers [Kennely et al., 2003], who focused on US-based multinational enterprises, identify a positive direct relationship between the degree of internationalization and firm environmental performance. The paper also highlights the idea that companies with a higher degree of internationalization are more proactive in their environmental performance throughout time. Which means that a certain time lag between internationalization and environmental performance measurements may lead to stronger correlation results. Similar conclusions are reached by the authors [Ermolaeva et al., 2023], who argue that internationalization, as well as strict climate regulations in the country of origin of the company, have a positive effect on the environmental performance of metallurgical companies.

[9] Miron, T. (2022, February 14). 5 good reasons to expand internationally - Prime Target. Prime Target. https://primetarget.tech/5-good-reasons-to-expand-internationally/

[10] Sascha Kraus, Tina C. Ambos, Felix Eggers, Beate Cesinger, Distance and perceptions of risk in internationalization decisions, Journal of Business Research, Volume 68, Issue 7, 2015, Pages 1501-1505, ISSN 0148-2963, https://www.sciencedirect.com/science/article/pii/S0148296315000557

The study of Chinese multinational corporations from the authors [Zhang et al., 2022] found that higher levels of internationalization can also lead to increased degrees of greenwashing. Greenwashing refers to the act in which an organization decides to selectively publicize positive information about environmental activities and at the same time concealing damaging information in the operations in order to obtain the stakeholders' acceptance. Regarding this aspect, it was identified that companies facing home country legitimacy pressures (both from the regulators and the public) have a growing inclination towards greenwashing as their level of internationalization increases.

It is important to mention the fact that the effect of internationalization on the environmental performance is rather complex and context-bound with company-specific factors playing an important role in defining this relationship. So, the relationship may be moderated in line with environmental regulations, governmental policies, public pressures, and particular industry specific conditions.

The internationalization of companies in the metallurgical industry is taking place quite actively for the reasons indicated earlier in the text. Here are some examples of metallurgic companies, who seek to extract advantages from their internationalized position, and their internationalization efforts:

- ArcelorMittal: With headquartered in Luxembourg, is the world's leading steel and mining company, operating in over 60 countries. It has expanded its footprint globally through acquisitions and establishing joint ventures[11];
- Tata Steel: Based in India, the company has a strong presence in Europe and Southeast Asia. It acquired Corus Group in 2007, making it one of the largest steel producers in Europe[12];
- ThyssenKrupp: German company has a strong global presence, with operations in Europe, the Americas, and Asia. It is involved in steel production and processing, as well as engineering services[13].

## 1.5. The concept of green partnership

The concept of a green partnership is gaining attention from the scientific and business community as a promising strategic asset for various beneficial purposes, which is capable of creating both economic and social value.

Given that the green partnership is a specific case of the concept of strategic partnerships, in this work, as in similar studies, the adapted definition of strategic partnership given by [Gulati,

[11] Home page | ArcelorMittal. (n.d.). https://corporate.arcelormittal.com/
[12] Tata steel. (n.d.). Steel supplier & manufacturer in India | Tata Steel. Tata Steel. https://www.tatasteel.com/
[13] thyssenkrupp. (n.d.). Thyssenkrupp. https://www.thyssenkrupp.com/

1998], adjusted for the environmental context, is used. Thus, an eco-friendly strategic partnership can be defined as a voluntary agreement between two or more organizations for the purpose of exchanging or developing environmentally friendly products, technologies or services to achieve strategic environmental goals together. These partnerships typically involve the development and implementation of innovative technologies that reduce ecological footprints, such as carbon capture and storage and advanced recycling processes [Hart, 1995]. The pooling of these complex and often expensive resources can transform traditional constraints into new opportunities for competitiveness, propelling industries toward greener technologies. [Sadovnikova et al., 2017]

The resource-based theory suggests that firms can gain competitive advantages by acquiring and utilizing resources that are valuable, rare, inimitable, and non-substitutable [Barney, 1991]. The rationale for using resource-based theory regarding green partnerships lies in the fact that these collaborative endeavors often extend across multiple sectors, uniting diverse competencies and resource bases necessary to foster innovation, enhance environmental performance, and ensure the sustainability of industrial practices.

At the same time, many researches lean towards the stakeholder theory perspective, according to which green partnerships also serve to reconcile the often-divergent interests of various stakeholders, including investors, local communities, regulatory bodies, and NGOs [Freeman, 1984]. This alignment enhances a company's legitimacy and trust within the community, solidifying its market position and supporting sustainable growth.

Summing up the information above and previous research on the topic, several green partnerships characteristics have been identified:

1) Resource Sharing: Collaborative utilization of unique, complementary resources that are too costly or complex for individual firms to develop alone [Barney, 1991];
2) Innovativeness: Development and implementation of new environmental technologies or processes that are critical for reducing the environmental impact of industrial activities [Hart, 1995];
3) Stakeholder Integration: An inclusive approach that enhances company legitimacy and trust across a broad spectrum of societal stakeholders [Freeman, 1984];
4) Sustainability Focus: Commitment to long-term ecological health and viability, promoting environmental stewardship;
5) Economic and Environmental Synergy: Initiatives that improve resource efficiency or reduce operational costs through sustainable practices, thereby enhancing economic returns while promoting environmental benefits [Porter and van der Linde, 1995].

Examples of successful green partnerships in the metallurgical industry include for example, Nucor Corporation's collaboration with JFE Steel of Japan to enhance environmentally

friendly technology in steel production. The alliance aimed at implementing advanced high-strength steel technologies. These technologies not only reduce emissions but also improve operational efficiency by producing lighter, more fuel-efficient vehicles[14].

Another exemplar is POSCO's entry into multiple green partnerships focusing on the development of lithium for electric vehicle batteries and the recycling of steel materials. These initiatives reduce the environmental costs associated with raw material extraction and align POSCO strategically within the global supply chain that favors sustainability[15].

In summary, the exploration of green partnerships within the metallurgical industry underscores their crucial role in advancing sustainable development. These collaborations not only foster the integration of diverse stakeholder interests into strategic management frameworks but also enhance companies' technological bases and innovative capacities. The experiences of firms like Nucor and POSCO highlight the profound impacts of strategic alliances, suggesting that further exploration and investment in green partnerships are imperative. The synergy between these collaborations and sustainable industrial practices promises not only to advance global environmental goals but also to strengthen competitive advantages underpinned by CSR and stakeholder theory principles.

### 1.6. Research design

The research paper contains the results of a two-stage analysis: first of all, the studied information about green partnerships was gathered and organized in such a way that it was possible to create a classification by describing the special features of the groups; secondly, statistical regression analysis was conducted on the basis of the data obtained.

[14] JFE Steel Corporation. (2016). JFE Steel Corporation. – Retrieved from: https://www.jfe-steel.co.jp/en/release/2016/160609.html [Online Resource]

[15] Sustainable Financing Framework (2023). – Retrieved from: Poscp https://www.posco.co.kr/homepage/docs/kor7/jsp/resources/file/esg/POSCO_Sustainable_Financing_Framework.pdf [Online Resource]

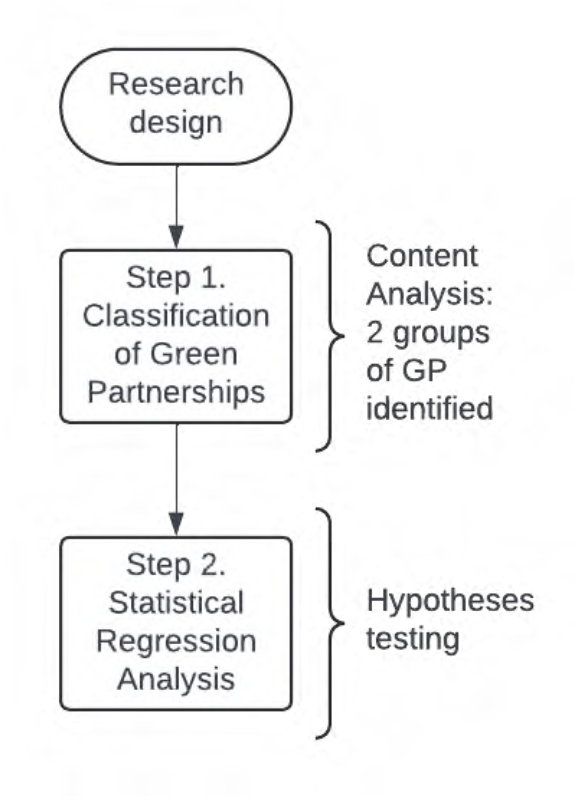


***Figure 3.*** *Research design methodology*

***Source:*** *Compiled by the author*

### 1.6.1. Classification of green partnerships

During data collection and analysis, qualitative and quantitative information was gathered and processed on 78 companies of metallurgical industry that, according to Thomson Reuters data for 2020, had some form of environmental partnership. Further in-depth research was needed to identify the nature of these partnerships, which were prior only 'marked' by binary variable for each company as having (1) or not (0) any form of activity that falls under the characteristics of a green partnership. The data was collected manually, special attention was paid to the essence of the partnership - what exactly the green partnership is, what events it includes; who are its participants and how many of them there are, whether the partnership is international and when it was founded.

As a result, two major groups of partnerships were distinguished. In the first group there were 45 companies, which either only sponsored NGO's, without putting any tangible effort, or these companies were only formally registered in partnerships, but did not actually operate within these organizations and conducted extensive environmental activity of their own. The partnerships of this group can roughly be called 'Nominal'. The second group of 33 companies was, on the contrary, actively and openly involved in green partnerships with multiple members, such as other metallurgical companies, government entities and NGOs. The second-group partnerships, based on these distinctive features, were called 'Active'.

Despite rather diverse activities of these partnerships, several main areas of activity can be identified. Thus, a large number of partnerships are aimed at interacting with local communities, and supporting them. Apart from that, another common activity implies developing environmental technologies that increase efficiency and minimize the harmful impact of the industry on the environment. The full list of 'Active' partnerships and corresponding partnership data is included in Appendix [Appendix 1].

Thus, both groups are of significant interest for this study, since at the moment there is no clear understanding of whether the degree of involvement of the company in green partnership activities affects the results of the overall environmental activity of the organization.

### 1.6.2. Content analysis

The content analysis method involves examination of textual data to identify trends, patterns, and categories. This method can be useful for identifying types of green partnerships as follows:

1) Data Classification: Content analysis is suitable for the examination of large volumes of textual data, such as company reports and press releases, helping to classify mentions of various types of green partnerships (nominal, active, etc.);
2) Trend Identification: Analyzing texts helps to identify recurring themes and terms, which is important for understanding the key characteristics and differences between different types of partnerships;
3) Objectivity and Systematic Approach: Using quantitative methods for text analysis reduces subjectivity in interpretations and increases the reliability of results. Creating clear rules for text coding ensures consistency and accuracy in data analysis[16].

As mentioned in the previous paragraph, during the analysis of numerous reports revealing the ESG activity of companies in the metallurgical sector, as well as news resources, two significant groups of partnerships were identified: 'Nominal' and 'Active'. As mentioned earlier, we refer to 'Nominal' partnerships as to collaborations where companies either only sponsor non-governmental organizations (NGOs) without making any tangible efforts or are formally registered in partnerships but do not actively participate in the organizations. These companies might conduct extensive environmental activities independently but do not engage deeply within the partnership frameworks. Thus, their involvement is largely in name only and lacks substantive action or collaboration.

[16] Content Analysis – Retrieved from: Columbia Mailman School of Public Health https://www.publichealth.columbia.edu/research/population-health-methods/content-analysis#:~:text=Courses-,Overview,words%2C%20themes%2C%20or%20concepts [Online Resource]

One example of a company, which is involved in a 'Nominal' green partnership is Arconic Corp. The company has the so-called Arconic Foundation, which is a financial initiative, supporting several non-profit organizations that focus on education, environmental sustainability, and social equity. This includes partnerships with groups that have a significant impact and reputation, ensuring that these collaborations are effective and far-reaching[17]. Arconic is committed to developing products and solutions that enhance sustainability. The company's environmental management system adheres to ISO 14001 standards, and it integrates climate change and energy management into its risk management processes. Arconic has made strides in reducing its carbon footprint across operations and supply chains and focuses on achieving certifications like the Aluminum Stewardship Initiative (ASI) for responsible production and stewardship of aluminum[18]. Despite the fact that the company undertakes activities in the ESG field, including steps to minimize environmental harm, the company's activities cannot be attributed to an active partnership, since, although nominally it represents interaction with other participants, it does not have an active form according to characteristics discussed earlier.

At the same time, we refer to 'Active' partnerships that are characterized by the active and open involvement of companies in green partnerships with multiple members, including other metallurgical companies, government entities, and NGOs. Companies in these partnerships are not just formally registered but are also actively participating and collaborating within the partnership frameworks. They engage in substantial joint environmental activities and contribute meaningfully to the collective goals of the partnership.

An example of a company with an 'Active' green partnership is a company Ero Copper Corp. The company has engaged in environmental initiatives, as outlined in their 2022 Sustainability Report, though the specific details about partnerships were not directly mentioned in the sources available[19]. However, they have a notable partnership with Vale Base Metals, a part of the Vale Base Metals business, where Ero Copper entered into a binding term sheet to advance its Furnas copper project located in the Carajás Mineral Province in Pará State, Brazil. This agreement indicates Ero Copper earning a 60% interest in the project upon completion of various exploration, engineering, and development milestones. This partnership is not only about advancing the project but also aligns with a vision for sustainable mine development, suggesting environmental considerations are part of their collaborative efforts[20].

[17] Partnerships - Arconic - Arconic Portal. (n.d.). Arconic. https://www.arconic.com/our-partners

[18] Environmental - Arconic - Arconic portal. (n.d.). Arconic. https://www.arconic.com/environmental/

[19] Ero Copper Corp. | Ero Copper Publishes 2022 Sustainability Report. (n.d.). Ero Copper Corp. https://ero-copper.com/news/ero-copper-publishes-2022-sustainability-report/

[20] Investing News Network. (2023, October 30). Ero Copper Agrees with Vale Base Metals to Enter into Earn-in Agreement for a 60% Interest in the Furnas Copper Project. INN. https://investingnews.com/ero-copper-agrees-with-vale-base-metals-to-enter-into-earn-in-agreement-for-a-60-interest-in-the-furnas-copper-project/

These definitions highlight the key differences in the level of engagement and collaboration between nominal and active partnerships. Nominal partnerships lack substantial participation, while active partnerships involve significant and proactive engagement in environmental activities.

### 1.7. Hypotheses statement

Having gained a greater understanding of the types of partnerships and their main differences, as well as having studied the relevant literature considering the possible relationship between green partnerships and environmental activism of companies, the following hypotheses were developed.

The strategic inclusion of green partnerships in the metallurgical industry is posited to enhance environmental performance significantly. Under the Resource-Based View (RBV), these partnerships are seen as unique resources that provide competitive advantages through shared innovative technologies and processes critical for environmental sustainability [Barney, 1991]. Hart's Natural Resource-Based View (NRBV) further suggests that such strategic resources not only mitigate risks and reduce costs but also enhance competencies leading to superior environmental performance [Hart, 1995]. Empirical support for this hypothesis can be drawn from [Russo et al., 1997], who found that firms with proactive environmental strategies, often facilitated by partnerships, show better resource efficiency and waste management. Additionally, [Wagner, 2001] identified a positive correlation between collaborative environmental strategies and improved sustainability metrics across firms, emphasizing that partnerships specifically contribute to these outcomes. Therefore, the participation of metallurgical companies in green partnerships is expected to positively correlate with environmental performance, illustrating the practical application of RBV and NRBV in real-world settings. The first hypothesis was identified:

**H1:** The participation of the metallurgical company in the green partnership positively correlates with environmental performance.

Taking into account the fact that we do not fully know the direction and strength of the influence of the type of partnership and the level of involvement of its participants on the results of the company's activities in terms of environmental impact, it was decided to also consider both groups of partnerships separately. We assume that an active partnership involving a significant investment of resources will have a positive impact on the value of dependent variable, because judging by the content analysis carried out during the work, such partnerships have a significant impact on both the general idea of the company and the well-being of stakeholders. At the same time, nominal partnerships seem to have rather an ostentatious effect and are not aimed at significant changes. Therefore, we can suppose that such partnerships will correlate negatively with the

company's performance in the ESG field, similar to previous studies that raise the question of significant greenwashing risks.

**H1.A.** The participation of the metallurgical company in the ‘nominal’ green partnership negatively correlates with environmental performance.

**H1.B.** The participation of the metallurgical company in the ‘active’ green partnership positively correlates with environmental performance.

Internationalization has been theorized to enhance a firm's environmental performance through the Eclectic Paradigm, which suggests that international operations facilitate strategic resource optimization and capability development [Dunning, 1988]. This paradigm is supported by the evidence that firms operating internationally are likely to adopt stringent environmental practices to comply with diverse and often more rigorous regulatory standards they encounter in various markets [Christmann and Taylor, 2006]. [Kolk and Pinkse, 2008] further substantiate this by noting that multinational enterprises (MNEs) are more inclined to implement advanced environmental technologies compared to domestic-only firms, driven by the global need to meet varied environmental regulations [Kolk and Pinkse, 2008]. The exposure to international markets, therefore, compels metallurgical firms to adopt and integrate advanced environmental technologies and practices, leading to significant improvements in their overall environmental footprints. In addition, some authors even link the internationalization of a company with its level of eco-innovation. Eco-innovation, in turn, can enhance a company's environmental performance through measures such as energy conservation and emission reduction [Liu M., et al., 2024] Thus, internationalization is predicted to positively correlate with environmental performance, affirming the Eclectic Paradigm's applicability to the environmental scope of global business operations. The second hypothesis was identifies:

**H2:** Internationalization of the company positively correlates with environmental performance.

The relationship between green partnerships and environmental performance in the metallurgical sector can be moderated by internationalization, as outlined by Vernon’s Interactionist Perspective. This perspective suggests that the characteristics of resources and capabilities, including their geographical and cultural dispersion, influence the benefits derived from such international operations and collaborations [Vernon, 1979]. [Luo, 2000] provides insight into this interaction, noting that the synergy between international market knowledge and local operational capabilities enhances a firm’s responsiveness and innovation in environmental practices. Further-

more, [Zeng et al., 2010] observed that international partnerships aid in the transfer of best practices and innovative technologies for recycling and waste reduction, crucial for environmental performance improvements in industries such as construction and manufacturing. Hence, internationalization is likely to positively moderate the relationship between green partnerships and environmental performance, enhancing the efficacy of such collaborations through increased resource utility, innovation, and sustainable practice adoption more effectively than domestic partnerships alone. The third hypothesis was identified:

**H3:** The internationalization of the green partnership enhances positive correlation between green partnership and environmental performance of a company.

Summarizing the hypotheses discussed above, a table [Table 1] has been formed reflecting the expected results of testing hypotheses

**Table 1.** Formulation of hypotheses

| Hypotheses | Expected results |
|---|---|
| **H1:** The participation of the metallurgical company in the green partnership correlates with environmental performance. | Positive correlation |
| **H1.A:** The participation of the metallurgical company in the 'nominal' green partnership correlates with environmental performance. | Negative correlation |
| **H1.B:** The participation of the metallurgical company in the 'active' green partnership correlates with environmental performance. | Positive correlation |
| **H2:** Internationalization of the company correlates with environmental performance. | Positive correlation |
| **H3:** The internationalization of the green partnership enhances positive correlation between green partnership and environmental performance of a company. | Positive correlation |

**Source:** Compiled by the author

## CHAPTER 2. METHODOLOGY OF THE RESEARCH

### 2.1. Data collection

The data provided by the Thomson Reuters agency database was used as the main source of data required to build the econometric model. The database provided the information on existing partnerships, as well as data for some of the control and dependent variables, and the independent variable.

The partnership details were filled in manually with additional information derived from the companies' annual reports, investor presentations, and sustainability reports, as well as companies' official websites.

### 2.2. Characteristics of the data sample

Out of 230 companies of initial sample, Thomson Reuters ranked 78 metallurgical companies as ones that had an environmental partnership. Further analysis identified 45 of them as 'nominal partnerships, while the other 33 are regarded as 'active'. The complete list of companies involved in green partnerships of different kind is included in appendix (Appendix 1).

The study covers the data for 4 years: from 2017 to 2020. About 65% of the companies originate from developed countries (Figure 4). The distribution of companies by country of origin can be seen in (Figure 5).

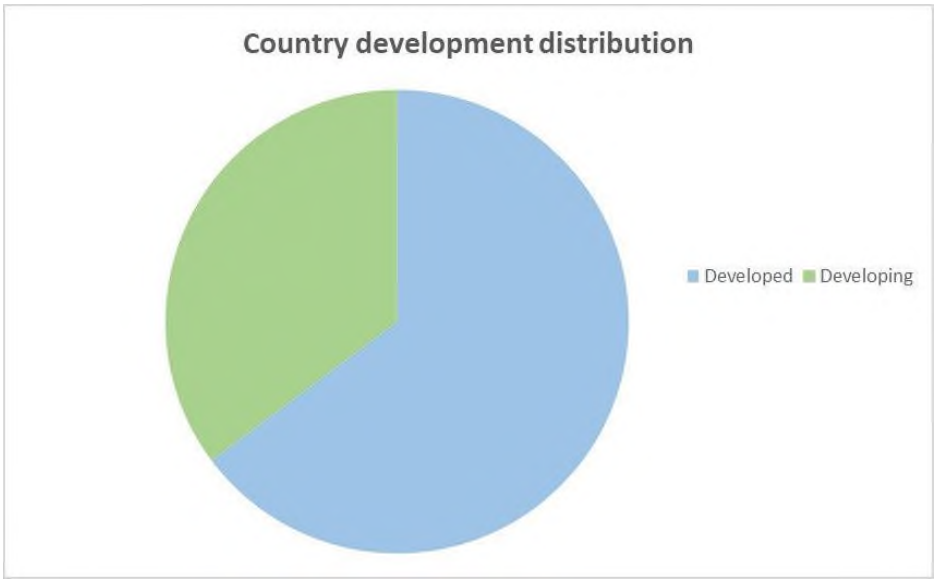


***Figure 4.*** *Country development distribution of the sample dataset*

***Source:*** *Author's calculations*

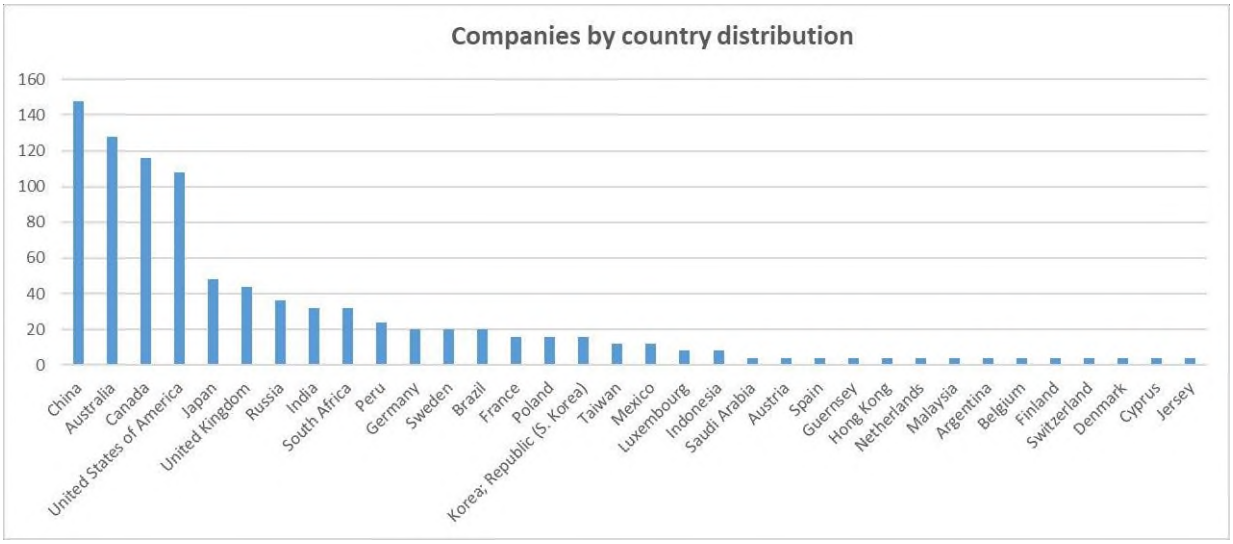


***Figure 5.*** *Companies by country distribution of the sample dataset*

***Source:*** *Author's calculations*

## 2.3. Description of variables

### 2.3.4. Dependent variables

The variable "Environmental pillar score", which is the E component in Thomson Reuters ESG-rating, is a qualitative variable which is calculated from 1 to 100. This environmental rating is aimed at evaluating company's environmental performance and is derived from a total of 70 KPIs: 53 of them are Boolean, and 17 are metric indicators. The metric is calculated by assessing company's usage and reduction of resources, emissions and their reduction, environmental activism and initiative, and both product and process innovation[21].

The variable considers both company's main operations and the ones in its supply chain, which makes it a universal indicator to evaluate environmental performance of a company.

### 2.3.5. Independent variables

**Total Foreign Sales**

Total Foreign Sales is the share of goods or services sold by a business outside of its native market in international marketplaces. It is a crucial economic metric that shows how globally oriented a business is and how well-positioned it is to enter foreign markets. Within the framework of the study, total foreign sales can be seen as a measure of a company's internationalization, which could potentially impact its environmental policies and how it interacts with the environment in other nations.

[21] Thomson Reuters Corporate Responsibility Ratings (TRCRR) - Rating and Ranking Rules and Methodologies Retrieved from: https://www.thomsonreuters.com/content/dam/openweb/documents/pdf/tr-com-financial/methodology/corporate-responsibility-ratings.pdf (Online resource)

**Green Partnership**

This variable shows the participance of the metallurgical company in a green partnership according to Thomson Reuters. It is a binary variable: 1 – a company is considered to be a part of a GP; 0 – a company doesn't participate in any form of green partnerships.

**Green Partnership 'Active'**

A binary variable, where 1 defines a company, which is actively engaged into green partnership, and 0 – a company, which partnership doesn't fall under that category.

**Green Partnership 'Nominal'**

A binary variable, 1 is assigned for companies that are included in the Thomson Reuters list of companies with green partnerships, whose partnerships, however, do not meet the author's requirements for 'active' partnerships.

**Green Partnership Internationalization**

This variable represents the presence of international activities inside the partnership. As a characteristics of internationalization of a partnership cross country activities are considered.

### 2.3.6. Control independent variables

**Total assets**

The value of all the assets owned by the company is shown by Total Assets. This variable may serve as an indicator of the company's size and scope. Bigger businesses might be more equipped to adopt sustainable environmental practices because they have more resources, but they might also have a bigger negative influence on the environment. Bigger businesses might be able to invest more in environmental projects because they have greater means to do so (Boffo et al., 2020). This could result in improved environmental performance. The variable was left in its original form for descriptive statistics, and later in the model it was prologarized.

**Energy Transition Index**

115 nations' readiness to energy transformation is benchmarked by the Energy transformation Index (ETI). The index is calculated by World Economic Forum and OECD. The current energy system performance and the environment that supports the energy transition make up the two components of the ETI framework. System performance evaluates how well an energy system is doing in a nation in relation to three main delivery priorities: firstly, the capacity to promote economic expansion and development; secondly, the security, dependability, and accessibility of

energy; thirdly, the sustainability of the environment across the energy value chain[22]. In the research the ETI variable represents the Energy Transition Index of the home country of the company.

**Development of environment-related technologies**

This variable represents the percentage of investments made by the company in the environment-related technologies out of all number of investments in technologies.

**Number of members of green partnership**

This variable is represented quantitatively by the number of partners involved in the enterprise together with the metallurgical company in question. The data was collected manually from different sources such as websites of the companies, annual reports, sustainability reports and presentations for investors made by the companies themselves.

**Carbon pricing**

Carbon pricing represents the presence of government issued price for carbon for industrial entities. It is a binary variable.

The above variables with their designations and descriptions are given in the table [Table 2].

**Table 2.** Variables description

| Indicator | Variable | Description |
|---|---|---|
| **Dependent** | | |
| Environmental pillar score | $EPS_{it}$ | Evaluates an organization's ability to manage the environment and how its operations affect it |
| **Independent** | | |
| Total Foreign Sales | $TFS_{it}$ | Represents the share of revenue that a business makes from its operations in foreign markets – internationalization metric |
| The fact of establishing a green partnership | $GP_{it}$ | According to Thomson Reuters database: 1 – since the year of foundation, 0 – until the partnership has been organized, dummy variable |
| Green Partnership 'Active' | $GP\_Active_{it}$ | Similar to the GP variable for partnerships classified by the |

[22] Fostering Effective Energy Transition (2021) Retrieved from: edition https://es.weforum.org/publications/fostering-effective-energy-transition-2021/in-full/appendix-methodology/ (Online resource)

| | | |
|---|---|---|
| | | author as 'Active', dummy variable |
| Green Partnership 'Nominal' | $GP\_Nom_{it}$ | Similar to the GP variable for partnerships classified by the author as 'Nominal', dummy variable |
| Green Partnership Internationalization | $GP\_Inter_{it}$ | The fact of internationalization of the partnership: 1 – for cross-country partnerships, 0 – for domestic ones, dummy variable |
| **Control independent** | | |
| Total assets | $TA_{it}$ | Permits the company to estimate its size (logged variable for the model) |
| Energy Transition Index | $ETI_{it}$ | Evaluates a company's home-country progress toward converting to environmentally friendly, and more sustainable energy framework |
| Development of environment-related technologies | Environment-related_tech_dev,%_all_$tech_{it}$ | The percentage of investments made by the company in the environment related technologies out of all number of investments in technologies |
| Number of members of green partnership | $No\_Members\_GP_{it}$ | Number of partners involved in the partnership with the company |
| Carbon pricing | $CO2\_Pricing_{it}$ | Represents the presence of government issued price for carbon for industrial entities, dummy variable |

**Source:** Compiled by the author

### 2.4 Description of the model

Based on the variables above, a regression model was constructed. The regression equation has the following form:

$$EPS_{it} = \beta_0 + \beta_1 \times GP_{it} + \beta_2 \times TA_{it} + \beta_3 \times TFS_{it} + \beta_4 \times Environment\_related\_tech\_dev,\%_{it} + \beta_5 \times CO2\_Pricing_{it} + \varepsilon_{it} \quad (1)$$

$$i = 1, \ldots, N, t = 2017, \ldots, 2020.$$

### 2.5 Descriptive statistics

The results of descriptive statistics are presented in the table [Table 3]. Dummy variables were omitted for this part of modeling.

**Table 3.** Descriptive statistics

| | n | mean | St. dev. | Min | Max |
|---|---|---|---|---|---|
| $EPS_{it}$ | 872.00 | 46.34 | 27.15 | 0.50 | 94.41 |
| $TFS_{it}$ | 920.00 | 0.43 | 0.36 | 0 | 1 |
| $ETI_{it}$ | 920.00 | 62.55 | 7.13 | 47.00 | 79.50 |
| Environment-related_tech_dev,%_all_$tech_{it}$ | 883.00 | 11.47 | 4.34 | 1.50 | 25.83 |
| No_Members_$GP_{it}$ | 920.00 | 0.68 | 6.33 | 0 | 130.00 |
| Log_$TA_{it}$ | 918.00 | 21.76 | 1.65 | 16.35 | 25.44 |

**Source:** Compiled by the author

Adding the number of members in the green partnership led to insignificant results, for this reason the variable was excluded from the final model at the testing stage to increase the quality of the model: an increase in R2 from 0.38 to 0.48. The variable was also tested for a nonlinear correlation (U-shaped), which was not significant as well.

### 2.6 Multicollinearity test

Multicollinearity occurs when two or more predictors in a model are highly correlated, which can distort the results and reduce the reliability of the coefficient estimates. The factors do not have a strong correlation, as the chart below (Figure 6) demonstrates. Consequently, there is no justification for eliminating any of the suggested factors from the examination.

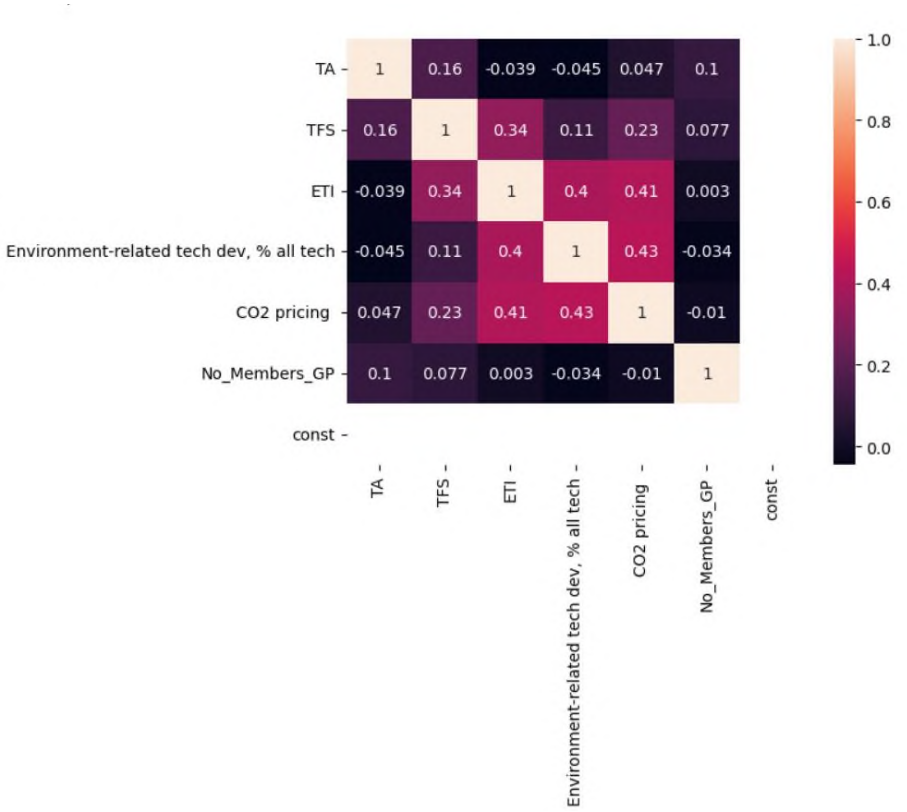


***Figure 6.*** *Multicollinearity testing results, heat map*

The Variance Inflation Factor (VIF) test was conducted as an additional test for multicollinearity among the independent variables in the econometric model. The results are presented in the table [Table 4].

**Table 4.** VIF test results

| Feature | VIF |
|---|---|
| TA | 1,0514 |
| TFS | 1,1717 |
| ETI | 1,3975 |
| Environment-related tech dev, % all tech | 1,3347 |
| CO2 pricing | 1,3458 |
| GP | 1,1439 |

**Source:** Author's calculations

These VIF values are all below 10, indicating that multicollinearity is not a concern in this model. Generally, a VIF value above 10 suggests high multicollinearity, which could undermine the statistical significance of the independent variables. The low VIF values in the model of this research suggest that the independent variables are sufficiently independent of each other, allowing for more accurate and reliable regression analysis.

## CHAPTER 3. MODEL RESULTS AND DISCUSSION OF THE RESULTS

### 3.1. Model results

To test the first hypothesis Point-Biserial Correlation was used. The distinctive feature of this test is that it is applicable when one variable is binary and the other is continuous, the point-biserial correlation coefficient can measure the strength and direction of the relationship between them.

The results are the following:

1) H1: The participation of the metallurgical company in the green partnership positively correlates with environmental performance.

   Point-Biserial Correlation: 0.45, P-value: 7.65e-47.

   The graph in [Figure 7] represents the density distribution of the independent variable. There is a reason to accept the first hypothesis, regarding the fact that participation in the green partnership statistically significantly correlates with the dependent variable.

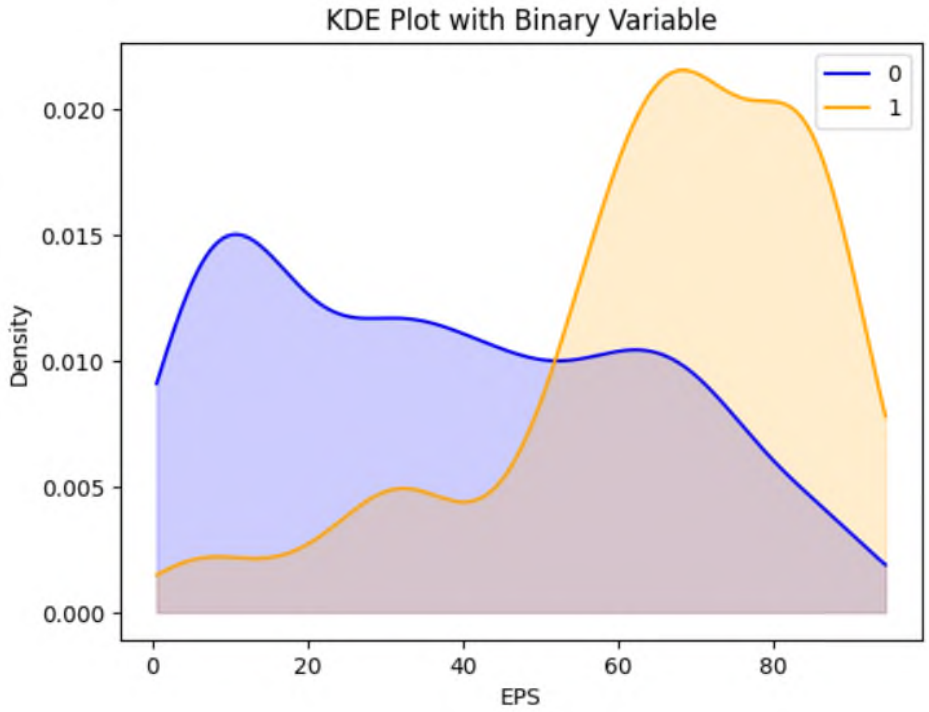


***Figure 7.*** *KDE Plot H1 for 78 Partnerships*

2) H1.A: The participation of the metallurgical company in the 'Nominal' green partnership correlates with environmental performance.

   Point-Biserial Correlation: 0.33, P-value: 1.20e-23.

   The graph in [Figure 8] represents the density distribution of the independent variable. The second hypothesis cannot be accepted due to the fact that a statistically significant correlation between the variables was found.

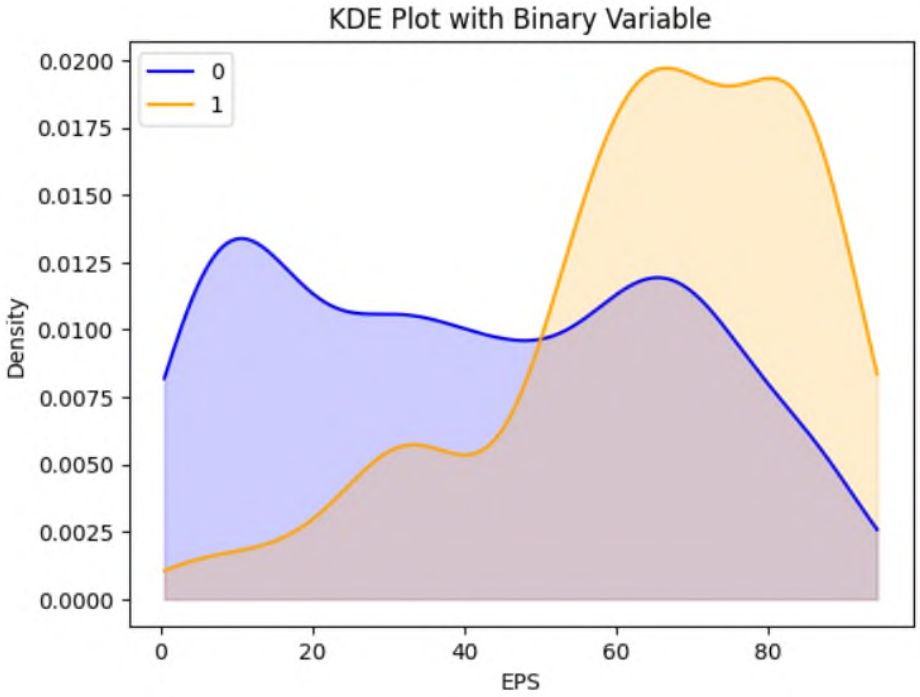


***Figure 8.*** *KDE Plot H1 for 45 'Nominal' Partnerships*

3) H1.B: The participation of the metallurgical company in the 'Active' green partnership correlates with environmental performance.

   Point-Biserial Correlation': 0.25, P-value: 3.88e-14.

   The graph in [Figure 9] represents the density distribution of the independent variable. The first hypothesis is accepted as a statistically significant correlation between the participation of a company in an 'active' green partnership with the dependent variable had been found.

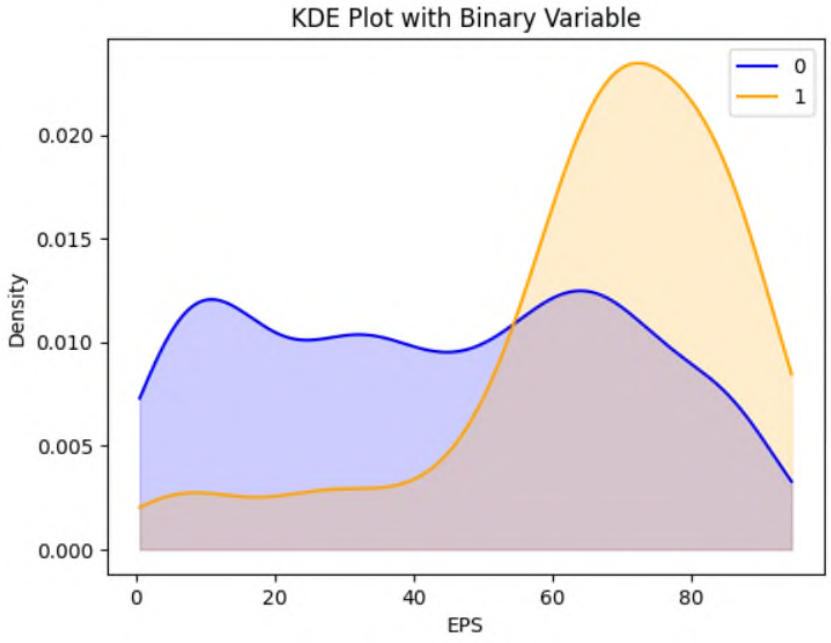


***Figure 9.*** *KDE Plot H1 for 33 'Active' Partnerships*

During the testing of the main research model, the results presented in [Table 5] were obtained.

**Table 5.** Model results

| | Parameter | Std. Err. | T-stat | P-value | Lower CI | Upper CI |
|---|---|---|---|---|---|---|
| **GP** | 19.992 | 1.7019 | 11.747 | 0.0000 | 16.651 | 23.333 |
| **TA** | 6.56e-10 | 5.20e-11 | 12.61 | 0.0000 | 5.544e-10 | 7.588e-10 |
| **TFS** | 19.51 | 2.35 | 8.27 | 0.0000 | 14.88 | 24.14 |
| **ETI** | -0.42 | 0.13 | -3.24 | 0.0012 | -0.68 | -0.16 |
| **Environment-related tech dev, % all tech** | 0.48 | 0.21 | 2.30 | 0.2214 | 0.07 | 0.89 |
| **CO2 pricing** | 6.01 | 1.96 | 3.06 | 0.0023 | 2.15 | 9.87 |

Control variables, including *TFS (Total Foreign Sales)* variable, are significant. The only insignificant control variable was Environment-related tech dev, % all tech.

The relationship with the dependent variable is positive in all cases except for *ETI*, where company's *Energy Transition Index* seems to correlate negatively with the *Environmental Pillar Score*.

To assess the impact of internationalization on the company's environmental performance, a Pearson test was conducted with the following results: statistic = 0. 3158; P-Value = 1.2038e-21. Which means that the variable has a statistically significant positive effect on the *Environmental Pillar Score* of the company.

The fact that internationalization, presumably significantly enhances the effectiveness of environmental partnerships, has been tested as follows using the moderation effect:

```
data_main['Modified feature'] = data_main['GP'] * data_main['GP_Inter']
```

Point-Biserial Correlation: 0.15,

P-value: 2.57e-06.

The graph in [Figure 10] represents the density distribution of the independent variable.

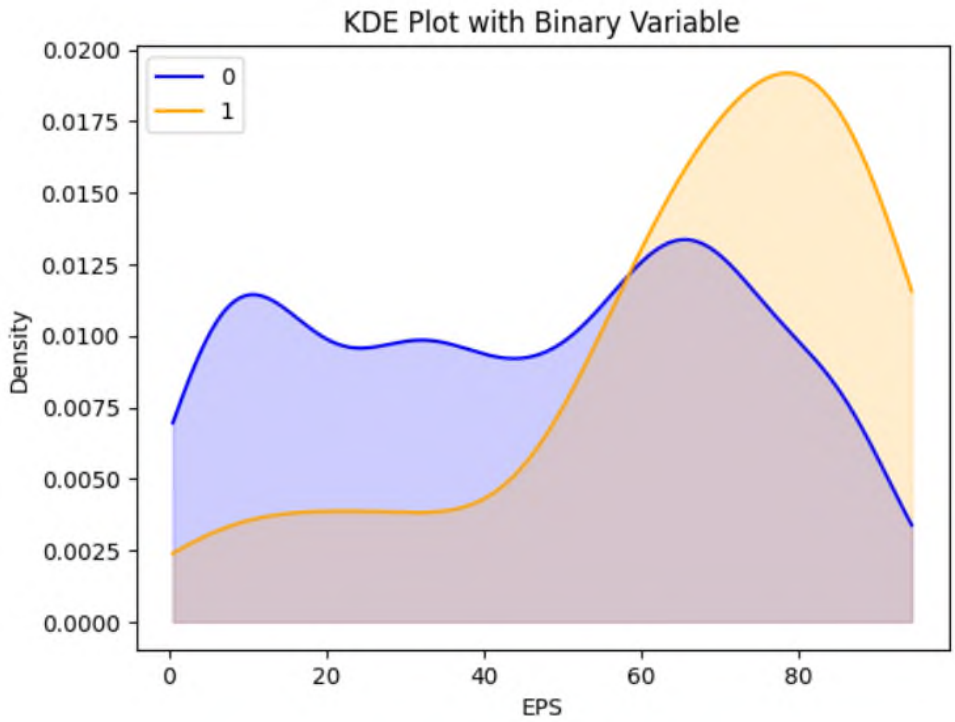


***Figure 10.*** *KDE Plot for internationalization moderation effect*

Hypotheses testing results are presented in [Table 6].

**Table 6.** Hypotheses testing results

| Hypotheses | Testing results |
|---|---|
| **H1:** The participation of the metallurgical company in the green partnership positively correlates with environmental performance. | **H1:** Accepted |
| **H1.A:** The participation of the metallurgical company in the 'nominal' green partnership negatively correlates with environmental performance. | **H1.A:** Rejected |
| **H1.B:** The participation of the metallurgical company in the 'active' green partnership positively correlates with environmental performance. | **H1.B:** Accepted |
| **H2:** Internationalization of the company positively correlates with environmental performance. | **H2:** Accepted |
| **H3:** The internationalization of the green partnership enhances positive correlation between green partnership and environmental performance of a company. | **H3:** Accepted |

### 3.2. Discussion of the results

The acceptance of the first hypothesis (H1) indicates that green partnerships facilitate knowledge sharing, resource pooling, and joint problem-solving, enhancing environmental performance. For instance, [Darnall et al., 2008] came to similar conclusions that firms involved in environmental partnerships showed significant improvements in their environmental performance due to collaborative efforts and shared best practices. Metallurgical companies benefit from green partnerships by sharing environmental best practices, gaining access to advanced technologies, and enhancing their regulatory compliance. This collaborative approach helps companies reduce emissions, manage waste more effectively, and improve overall sustainability.

The sub-hypothesis (H1.A) regarding the negative effect on company's environmental performance of participation in 'nominal' green partnerships was rejected. As suggested by [Simpson et al., 2007] even nominal participation in green partnerships can enhance environmental performance by providing a platform for basic information exchange and compliance encouragement. This participation can help companies align with environmental standards, albeit at a lower intensity. Similarly, the second sub-hypothesis (H1.B) was accepted, which proves the positive effect of 'active' green partnerships positively correlates with environmental performance. The research by [Ramanthan et al., 2002] demonstrated that firms engaging actively in green partnerships often implement more rigorous environmental practices and innovate more effectively, resulting in better environmental outcomes.

Hypothesis (H2): Internationalization positively correlates with environmental performance was also accepted, which can be explained by the fact that internationalization exposes firms to stringent environmental standards and best practices from different markets, which can enhance their environmental performance. [Christmann et al., 2001] in their research highlight that multinational companies often adopt superior environmental practices due to global competition and diverse regulatory pressures.

The last hypothesis (H3) has also shown to be accepted. A statistically significant correlation has been found in the fact of participation in international green partnership and company's environmental performance. International green partnerships allow firms to leverage global expertise, leading to improved environmental performance. A study by [Lemos et al., 2006] highlights how international collaborations provide access to cutting-edge technologies and practices, which significantly enhance environmental sustainability efforts.

It's important to separately mention the control variables, which were not included in the hypotheses, nevertheless, they have demonstrated their statistical significance and also explain the results of regression analysis.

Total Assets variable (TA) positively correlates with the dependent variable, which means that one should take the size of a company into consideration when discussing company's environmental performance. It is justified by the fact that larger companies have more resources to invest in ESG initiatives, including those, which mitigate harmful environmental effects. The point also matches the resource based theory. For example, authors [King et al., 2001] found that there is a significant positive correlation between environmental management and firm performance, including total assets. Similar conclusions can be observed in the work [Gao et al., 2011].

Besides, Carbon pricing (CO2_Pricing) has positive correlation with the dependent variable. According to the results, existing government issued price for carbon for industrial entities motivates metallurgical companies to improve their environmental performance. Considering that the existence of carbon prices is one of the signs for a rigor and advanced climate policy of the company's country of origin, thus, in stricter regulation, metallurgical companies manage to achieve better results in their environmental activities. According to the study [Itzhak et. al., 2021], companies with headquarters in countries with stringent environmental regulations tend to have lower overall carbon dioxide emissions. For example, moving from a country with weak regulations, such as China, to one with stronger regulations, like Germany, was associated with a 44% reduction in global emissions. This shows that stricter policies at home can effectively lower a company's total pollution footprint.

The question why does the energy transition index have a negative impact on environmental performance is a subject to further research. However, we can suppose that with high ETI scores, the effectiveness of environmental policies depends significantly on how they are implemented and enforced. Weak implementation, loopholes, or inconsistent enforcement can undermine the potential positive impacts of these policies. Companies may exploit these weaknesses, leading to suboptimal environmental performance despite a high ETI.

## CONCLUSION

The topic of green partnerships and internationalization in the metallurgical industry is highly relevant due to the sector's significant environmental impact. Metallurgical companies act as major contributors to global carbon emissions and resource consumption. Addressing environmental performance through collaborative green initiatives and expanding global operations can lead to substantial improvements in sustainability. This research provides insights into effective strategies for reducing the environmental footprint of metallurgical companies, aligning with global efforts to combat climate change and promote sustainable industrial practices.

The paper provides valuable insights into how green partnership participation and internationalization influence sustainability practices within the industry. The findings indicate that:

Participation in green partnerships, both actively and passively, significantly enhances environmental performance. This is possible due to the collaborative sharing of best practices, access to advanced technologies, and improved regulatory compliance. Companies that expand internationally show improved environmental performance. Exposure to diverse regulatory environments and competitive pressures compels these companies to adopt superior environmental practices. The participation in international green partnerships provides the most substantial improvements in environmental performance. Access to global expertise and resources enables companies to address environmental challenges more effectively.

These conclusions underscore the importance of active engagement in green partnerships and international expansion for metallurgical companies aiming to enhance their environmental performance. Companies should prioritize meaningful collaboration and embrace global best practices to drive sustainable growth and compliance with environmental standards. This study contributes to the broader understanding of sustainability strategies in the metallurgical sector, highlighting the positive impacts of internationalization and green partnerships on corporate environmental responsibility.

Talking about managerial/practical implications, the following recommendations could be provided based on the described results:

1. For Metallurgical Companies, who are interested in mitigating harmful effects caused to the environment by their activities:
    a. To engage actively in collaborative environmental initiatives, such as Green Partnerships, to access advanced technologies and best practices;
    b. To leverage internationalization to adopt superior environmental standards and practices from diverse regulatory environments;
    c. To invest in sustainable technologies and processes to reduce emissions and improve resource efficiency.

2. For Stakeholders, such as investors, regulators, local communities, etc.:
    a. To encourage partnerships between companies and environmental organizations to enhance collective environmental performance;
    b. To develop stringent environmental regulations that promote sustainable practices within the metallurgical industry;
    c. To provide financial and policy incentives for companies to adopt green technologies and practices, promoting a sustainable industry-wide transformation.

This research has several limitations that should be acknowledged. Firstly, the data sample is constrained to companies that disclose their ESG practices publicly, which might introduce a selection bias. Companies that are more transparent about their environmental efforts might already be more inclined towards better performance, thus skewing the results. Secondly, the study relies on the Thomson Reuters database for identifying green partnerships and environmental performance metrics. This dependence on a single data source may affect the comprehensiveness and accuracy of the findings. Additionally, the binary classification of green partnerships into 'active' and 'nominal' may oversimplify the complexity and nuances of these collaborations. Lastly, the research timeframe, limited to four years, might not capture long-term trends and the full impact of green partnerships and internationalization on environmental performance.

Future research could address these limitations by expanding the scope to include a broader range of industries. This would help determine whether the observed effects of green partnerships and internationalization on environmental performance are consistent across different sectors. Additionally, incorporating multiple data sources and databases could provide a more comprehensive and accurate picture of companies' ESG activities and performance. Future studies might also consider a more granular classification of green partnerships, taking into account various degrees of engagement and types of activities. Longitudinal studies spanning a longer timeframe could better capture the long-term impacts and trends related to green partnerships and internationalization. Finally, qualitative research methods, such as case studies and interviews with industry stakeholders, could provide deeper insights into the mechanisms through which green partnerships and internationalization influence environmental performance. These approaches would help validate and enrich the quantitative findings, offering a more holistic understanding of the topic.

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## APPENDIX

### Appendix 1. Active environmental partnerships list

**Appendix 1.** List of companies with environmental partnership

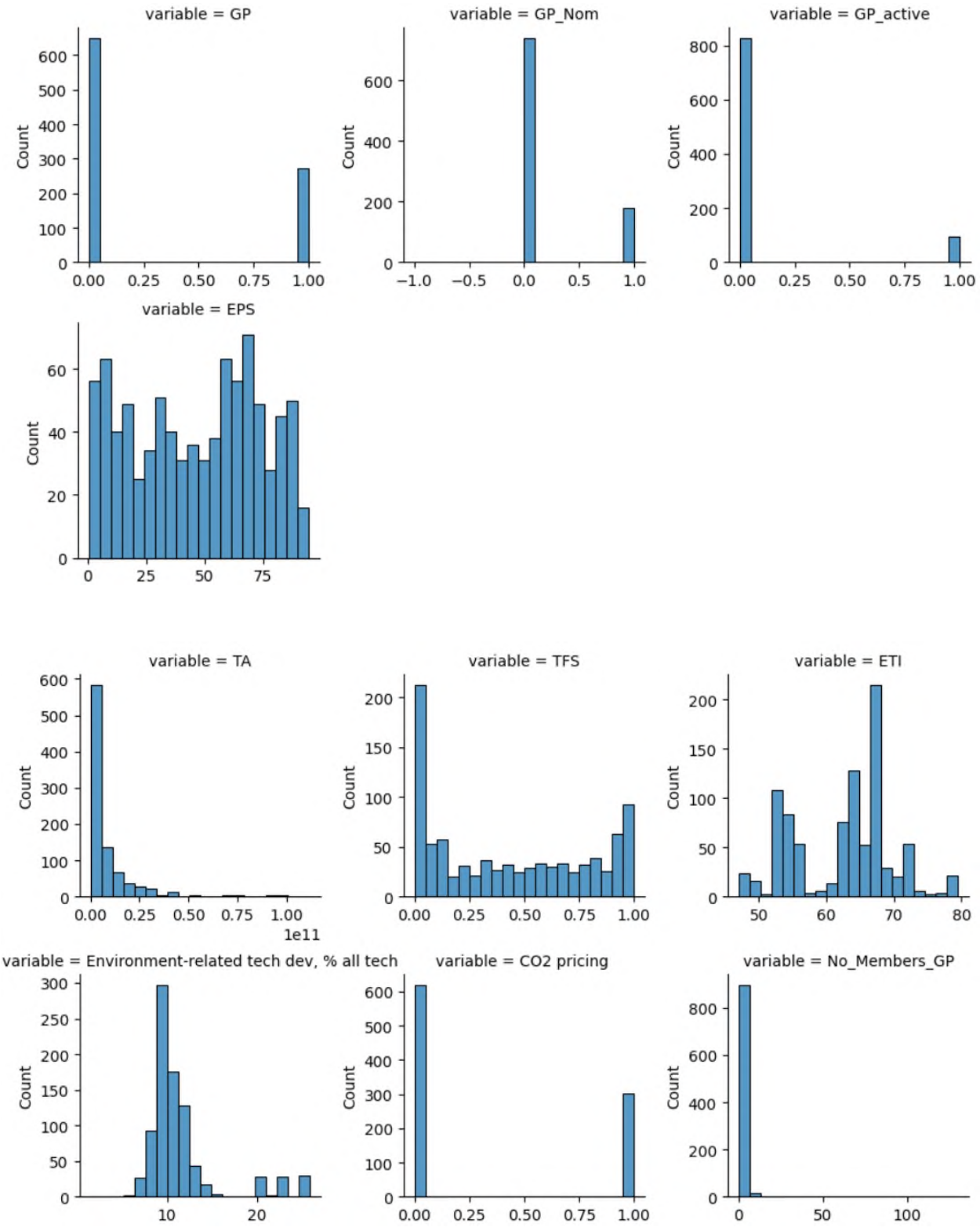
| Company name | Target | Members | Number of members | Patrnership internazionalization | Year of creation |
|---|---|---|---|---|---|
| Alcoa Corp | Global bauxite mining and alumina refining with an emphasis on environmental sustainability | Alumina Limited and Alcoa | 2 | 1 | 1994 |
| Alumina Ltd | Global bauxite mining and alumina refining with an emphasis on environmental sustainability | Alumina Limited and Alcoa | 2 | 1 | 1994 |
| Anglo American PLC | A joint venture with EDF to advance their decarbonization efforts, particularly in South Africa. Partnership on sustainable copper products | EDF Renewables, Aurubis AG | 3 | 1 | 2014 |
| AngloGold Ashanti Ltd | An agreement to construct and operate wind and solar generation capacity. Electricity generated will be fed into the power supply for the mine site | Pacific Energy | 2 | 0 | 2016 |
| Antofagasta PLC | Develop a real-time TSF monitoring system for Chile, enhancing safety and environmental stewardship | Fundación Chile, governmental bodies, Antofagasta PLC, other mining companies | 23 | 0 | 2018 |
| BHP Group Ltd | Focus on biodiversity enhancement and ecosystem management | Curtin University, IBN Services, and Greening Australia, BHP Group Ltd | 4 | 0 | 2018 |
| BlueScope Steel Ltd | To explore low-carbon steelmaking, focusing on clean hydrogen in steel production | BlueScope Steel Ltd and Rio Tinto | 2 | 0 | 2020 |
| Centerra Gold Inc | Reclamation Training and Skills Development Pilot Program designed to empower local communities by providing | Chu Cho Environmental | 2 | 1 | 2018 |

| | | | | | |
|---|---|---|---|---|---|
| | training in reclamation activities. | | | | |
| Ero Copper Corp | Advancing the Furnas copper project with sustainable development in Brazil | Ero Copper Corp and Vale Base Metals | 2 | 1 | 2017 |
| Fortescue Metals Group Ltd | Designing and engineering an industrial-scale prototype plant for hydrogen-based, net-zero emission hot metal production | Fortescue Metals Group Ltd, Primetals Technologies, and voestalpine | 3 | 1 | 2019 |
| Freeport-McMoRan Inc | Supporting a clean watershed in Colorado through the reclamation of the former Keystone mine site | Freeport-McMoRan Inc, Trout Unlimited, and the Division of Reclamation, Mining, and Safety. | 3 | 0 | 2019 |
| First Quantum Minerals Ltd | This joint venture aims to leverage both companies' resources and expertise to advance one of the largest undeveloped copper deposits globally, emphasizing responsible and sustainable mining practices | Rio Tinto | 2 | 0 | 2013 |
| GMK Noril'skiy Nikel' PAO | Utilizing decommissioned nuclear-powered submarines for material transport along the Northern Sea Route, aiming to tackle logistical challenges with an eye on environmental implications | Nornickel and the St. Petersburg Research Institute of the Arctic and Antarctic | 2 | 1 | 2000 |
| Harmony Gold Mining Company Ltd | Advancing the Wafi-Golpu copper-gold project, focusing on infrastructure and social development in Papua New Guinea | Harmony Gold, Newcrest Mining, and Papua New Guinea government | 3 | 1 | 2019 |
| Hyundai Steel Co | Supporting the Sustainable Development Goals (SDGs) for sustainable and inclusive growth | Hyundai Steel Co. and the World Bank Group | 2 | 1 | 2019 |
| Hunan Valin Steel Co Ltd | This collaboration primarily focuses on the automotive steel market, leveraging ArcelorMittal's leadership in | Hunan Valin Steel Co Ltd, ArcelorMittal | 2 | 1 | 2015 |

| | | | | | |
|---|---|---|---|---|---|
| | automotive steel in Europe and North America. | | | | |
| Kaiser Aluminum Corp | Recycling aluminum alloys used in commercial aircraft production | Kaiser Aluminum and Boeing | 2 | 0 | 2014 |
| Kinross Gold Corp | Conservation of aquatic ecosystems and promotion of sustainable environmental policies | Kinross Gold Corp, Trout Unlimited, and the University of Guelph | 3 | 0 | 2016 |
| Lundin Mining Corp | Extending the Candelaria mine's operational life with a focus on sustainable development and supporting communities through the Lundin Foundation | Lundin Mining Corp and the Lundin Foundation | 2 | 0 | 2016 |
| Maanshan Iron & Steel Co Ltd | Green and low-carbon development, "Dual Carbon" goals, Yangtze River Protection. | Maanshan Iron & Steel, China Baowu Steel Group Corp. Ltd., and six other entities in Ouyeel Industrial Products Co. Ltd. | 8 | 0 | 2020 |
| New Gold Inc | Fostering long-term positive impacts for Indigenous communities and integrating Indigenous knowledge and respect for traditional lands in mining operations. | New Gold Inc, various First Nations, and the Métis Nation of Ontario | 10 | 0 | 2019 |
| Newcrest Mining Ltd | Enhancing environmental sustainability and operational efficiency through digital innovation. | Newcrest Mining Ltd and Microsoft | 2 | 1 | 2020 |
| Newmont Corporation | Enhancing Indigenous community engagement through Free, Prior and Informed Consent. | Newmont Corporation, various companies, NGOs, and RESOLVE. | 7 | 1 | 2012 |
| Nexa Resources Peru SAA | Achieving superior financial returns with positive social and environmental impacts. | Nexa Resources and Votorantim group | 2 | 1 | 2004 |
| Nippon Steel Corp | Zero-carbon business operations through biocarbon investment and floating solar power generation. | Nippon Steel and its subsidiary Nippon Steel Trading Americas, Inc., Aymium, and partners in Floating Solar GK. | 16 | 1 | 2020 |

| | | | | | |
|---|---|---|---|---|---|
| OK Rusal MKPAO | Advancing sustainable practices and innovations in aluminum production. | RUSAL and other entities in the aluminum industry | 130 | 0 | 2019 |
| Rio Tinto PLC | Setting industry standards on biodiversity, ecosystem services, and responsible sourcing and production in the aluminium value chain | Rio Tinto, Nespresso, Flora & Fauna International, and other ASI members | 8 | 1 | 2012 |
| SSAB AB | Revolutionizing steelmaking by replacing coking coal with fossil-free hydrogen to reduce CO2 emissions. | SSAB AB, LKAB, and Vattenfall. | 3 | 1 | 2017 |
| Steel Authority of India Ltd | Enhancing operational efficiency and environmental sustainability in power generation and supply | SAIL, NTPC Ltd. (NSPCL), and DVC (BPSCL) | 3 | 0 | 2001 |
| Tata Steel Ltd | Enhancing sustainability in steel production and reducing carbon footprint through ResponsibleSteel membership and collaboration with BHP | Tata Steel, ResponsibleSteel members, and BHP | 9 | 1 | 2020 |
| thyssenkrupp AG | Developing green ammonia production using renewable energy. | thyssenkrupp Uhde, DL E&C, CARBONCO, Copenhagen Infrastructure Partners. | 4 | 1 | 2020 |
| United States Steel Corp | Enhancing sustainability in the steel industry | U.S. Steel and ResponsibleSteel™ members | 12 | 1 | 2020 |
| voestalpine AG | Covering a third of the facility's energy needs with solar power to reduce CO2 emissions | voestalpine AG and partners in the Netherlands | 8 | 0 | 2014 |

## Appendix 2. Histograms of the distribution of variables




**Appendix 2.** Histograms for variables