

# The Effect of Carbon Emissions on Company Profitability

Alexandra Ștefan and Mădălina Preda

The Bucharest University of Economic Studies, Romania

[stefan5alexandra21@stud.ase.ro](mailto:stefan5alexandra21@stud.ase.ro)

[predamadalina17@stud.ase.ro](mailto:predamadalina17@stud.ase.ro)

**Abstract:** Sustainability factors and in particular environmental factors have become increasingly important in recent years for companies, governments and public agencies, but also for many other stakeholders, gaining ground at the expense of financial factors. Non-financial reporting is an area of major interest for companies and researchers, but financial aspects and the quality of financial reporting remain relevant, influencing corporate decisions, including the adoption of short, medium, and long-term sustainability strategies. The two elements, financial and non-financial, mutually influence each other: the adoption of sustainable strategies entails additional costs, leading to lower profits in the short term; while the adoption of sustainability strategies can be beneficial for the profitability of companies in the long term. Thus, this paper aims to study the influence that the dissemination of information on carbon emissions has on the profitability of companies and to confirm or deny the synergy between environmental regulations and the economic development of companies. Moreover, another dimension in which we will approach the research involves analyzing the position in which the carbon disclosures rank in comparison with the ESG score. The study is carried out by using quantitative research methods on a sample of companies in the European Union, and the data used in the research are extracted from the LSEG Data & Analytics (Refinitiv) database and are explained in the paper. The contribution of our study is represented by the simultaneous analysis of the influence that carbon emissions and sustainability performance (ESG score) have on companies' profitability and by bringing together emerging and developed economies in the same study. In order to achieve the research objective, we consider similar research in the literature. We believe that the topic addressed in this paper is topical and may be relevant for future academic research on the case of carbon emissions in relation to corporate profitability.

**Keywords:** Carbon emissions, Profitability, Dissemination, Environment

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## 1. Introduction

In the context of climate change and the need for regulatory compliance and truthful disclosure to investors and other stakeholders, carbon disclosure has become a key practice for companies globally. Reporting greenhouse gas emissions, and therefore CO<sub>2</sub>, reflects the extent to which companies comply with environmental regulations and their commitment to sustainability. At the European Union (EU) level, the legal framework that requires companies to publish data on carbon emissions and other risks is the Corporate Sustainability Reporting Directive (CSRD) and the adoption of the European Sustainability Reporting Standards (ESRS).

The adoption of sustainability strategies and compliance with sustainability directives and regulations have significant implications for companies' profitability in the short, medium and long term. Thus, the costs associated with reducing emissions and complying with legislation can negatively influence short-term profitability. On the other hand, transparency in the dissemination of sustainability information can help to enhance reputation and attract investors interested in sustainable practices. The literature analyzes from multiple perspectives the relationship between carbon emissions and financial performance indicators such as Return on Assets (ROA), Return on Equity (ROE) (Wang et al., 2022; Gallego-Alvarez et al., 2014; Miah et al., 2021; Lewandowski, 2017).

Thus, analyzing the impact of carbon disclosure on the profitability of companies is a topical issue of interest to multiple stakeholders and is essential for understanding the correlations between sustainability strategies, compliance and economic effects on companies. This paper aims to analyze the influence that the level of carbon emissions, as measured by CO<sub>2</sub> Equivalent Total Emissions (tons), has on companies' performance, as expressed by the ROA profitability indicator. In parallel, the analysis also takes into account companies' sustainability performance as measured by the ESG score and its influence on financial performance (ROA), but it is not the main pillar of our study.

The results of our study show that the relationship between the ESG score and companies' profitability, measured through the financial indicator ROA, is positive and significant, but in terms of the link between carbon emissions and companies' profitability (ROA), the regression model is not significant.

Even if the results lack statistical significance, this paper contributes to the literature by concomitantly analyzing the influence that both carbon emissions and sustainability performance (ESG score) have on

companies' profitability expressed by the financial indicator ROA, which is a relatively limited approach in existing empirical studies, according to the studies we have carried out. While many papers separately investigate the influence of carbon emissions (Lewandowski, 2017; Miah et al., 2021; Wang et al., 2022) or ESG score (Aydogmus et al., 2022; Almeyda and Darmansyah, 2019; Treepongkaruna and Suttipun, 2024) on companies' profitability, few studies simultaneously investigate the effect of both factors on companies' financial performance (Gabr and ElBannan, 2024). What differentiates our study from Gabr and ElBannan (2024) is that the present paper includes companies from developed and emerging countries, whereas the work of the aforementioned authors focuses on emerging economies.

We believe that our study provides a more comprehensive perspective on how companies integrate sustainability factors into their strategies, and our results show that a high ESG score is closely correlated with lower carbon emission levels. This integrated approach is relevant in the current context of increasingly stringent environmental transparency regulations (CSRD, CBAM - Carbon Border Adjustment Mechanism) and growing pressure from investors and other stakeholders who attach great importance to ESG criteria in order to inform (investment, partnership) decisions.

The paper is structured in several sections as follows: the first section is dedicated to the literature review; the second section presents the research methodology. The latter is followed by results and discussions, the third section, and the last section is dedicated to conclusions.

## **2. Literature Review**

The literature addresses sustainability factors and their relationship to globally operating companies from multiple perspectives. Thus, the increasing importance of environmental, social and governance (ESG) factors in both investment decisions and the focused attention of other stakeholders on these issues is driving a growing interest in studying how sustainability performance influences the profitability of companies.

Aydogmus et al. (2022) investigate the relationship between ESG performance and profitability on the 5000 largest listed companies in the Bloomberg database and emphasize that, although the adoption of ESG strategies involves significant upfront costs, they can generate long-term benefits. The authors conclude that there is a positive and significant correlation between firms' ESG performance and profitability.

Similarly, Almeyda and Darmansyah (2019) study the influence of ESG disclosure on the financial performance of listed companies in the real estate sector of the seven most developed countries globally (G7), and Treepongkaruna and Suttipun (2024) analyze the impact of ESG reporting on the profitability of companies in Thailand. The studies demonstrated a positive and significant relationship of ESG score on companies' profitability measured by financial indicators ROA (Return on Assets) and ROC (Return on Capital) (Almeyda and Darmansyah, 2019) and a positive relationship of ESG score on ROE (Return on Equity) but lack of it on ROA (Treepongkaruna and Suttipun, 2024). Thus, the literature suggests that investments related to the adoption of ESG measures can be considered as strategic investments with positive financial returns in the medium to long term.

There are also numerous studies regarding carbon emissions as a key indicator of companies' environmental performance. Several authors have approached this topic from different perspectives, but we have focused on identifying studies that focus on the relationship between carbon emissions and their effect on companies' profitability.

Naranjo Tuesta et al. (2020) study how carbon management influences the financial performance of EU companies as expressed by ROA, ROE and ROS (Return on Sales) indicators. Their study demonstrates that emission reduction strategies can have a positive impact on profitability, especially ROA. There are studies that address the issue of carbon emissions globally (Lewandowski, 2017; Gallego-Alvarez et al., 2014). The results show that companies promote sustainable behaviours to achieve higher financial performance, but do not show evidence on operational performance (Gallego-Alvarez et al., 2014), and that carbon emission reduction positively and statistically significantly affects the companies' return expressed using the ROS indicator, but negatively the Tobin's q indicator (Lewandowski, 2017).

Another study conducted at the international level, but focusing only on emerging economies, is conducted by Miah et al. (2021) and shows that carbon emissions are closely related to the reduction of profitability indicators such as ROE, Tobin's q, credit rating. It is noteworthy that companies operating in the financial sector have lower emissions than non-financial companies (Miah et al., 2021; Lewandowski, 2017).

Wang et al. (2022) show that listed companies in China are also concerned about reducing carbon emissions. They emphasized that the implementation of carbon emission reduction policies have contributed to increased corporate profitability and reduced the leverage of listed companies.

Therefore, based on the assumption that the adoption of sustainability strategies, which leads to higher ESG score and contributes to increase the profitability of companies, and on the other hand, the reduction of carbon emissions, which is also associated with the increase in profitability of companies, the hypotheses tested by us in parallel in the present study are as follows:

*H1. Reducing CO<sub>2</sub> emissions have a positive and significant influence on companies' profitability expressed by ROA*

*H2. The ESG score has a positive and significant influence on companies' profitability expressed by ROA*

The hypotheses can be supported by similar research in the literature reviewed. Table 1 summarizes the correspondence between existing studies and the hypotheses tested in this paper:

**Table 1: Correlation between research hypotheses and literature references**

No.	Research hypothesis	Literature references
H1	Reducing CO <sub>2</sub> emissions have a positive and significant influence on companies' profitability expressed by ROA	Gallego-Alvarez et al. (2014) Miah et al. (2021) Wang et al. (2022)
H2	The ESG score has a positive and significant influence on companies' profitability expressed by ROA	Almeyda și Darmansyah (2019) Aydogmus et al. (2022) Treepongkaruna și Suttipun (2024)

### 3. Research Methodology

In order to carry out the research, we conducted a quantitative analysis based on an econometric model consistent with similar research in the field (Wang et al., 2022; Aydogmus et al., 2022) using panel data. The data were extracted from the LSEG Data & Analytics database (Refinitiv), and the sample includes companies listed on stock exchanges operating in Europe, reference currency EUR, for the analyzed period 2021-2023. The indicators selected to support the research topic are the following: ESG Score, Total Assets, Net Income After Taxes, CO<sub>2</sub> Equivalent Emissions Total, Total Liabilities, Average Total Assets, Total Current Assets, Total Current Liabilities. The selection based on the filters listed above generated an initial sample of 11203 companies. Since we wanted to identify a group of companies subject to the same carbon reporting regulation, the study aims to analyze only EU companies subject to the Carbon Border Adjustment Mechanism (CBAM) and the Corporate Sustainability Reporting Directive (CSRD). Therefore, out of the initial sample of 11203 companies, 4158 non-EU companies were removed. The next step was to eliminate all references that did not disclose information for each selected indicator in each year under analysis. The final sample consists of 751 companies from 20 EU member countries for the period 2021-2023, representing a total of 2253 observations.

**Table 2: Sample data**

	Sample
Period	2021-2023
Number of companies	751
Number of countries	20
Total number of observations	2253
<u>Number of observations by region</u>	
Eastern Europe	57
Northern Europe	822
Southern Europe	402
Western Europe	972

The analyzed period starts with the year before the publication of the Directive and we want to highlight companies' CO<sub>2</sub> reporting trends in this context: before and after the publication of the Directive.

The study is based on a regression model with two independent variables and a single dependent variable. The dependent variable of both approaches is the financial indicator ROA and is calculated by the authors by relating the Net Income After Taxes indicator to Total Assets, extracted from LSEG Data & Analytics (Refinitiv). ROA is a profitability indicator, indicating the return on assets, and its use is supported by numerous similar studies (Almeyda and Darmansyah, 2019; Aydogmus et al, 2022; Treepongkaruna and Suttipun, 2024; Gallego-Alvarez et al., 2014; Wang et al., 2022; Naranjo Tuesta et al., 2020).

The independent variables of the study are ESG Score and CO<sub>2</sub> Equivalent Emissions Total. These correspond to the LSEG Data & Analytics (Refinitiv) database calculation methodology. The emissions category is one of the three components of the environmental pillar (Emission, Innovation, Resource use) and measures 0.15% of the total ESG Score and 35% of the total environmental pillar, respectively.

**Table 3: Emissions dimension in ESG score (LSEG Data & Analytics)**

Pillar	Pillar weights	Category	Category weights
Environmental	0,44	Emission	0,15
		Innovation	0,15
		Resource use	0,13
Social	0,31		
Governance	0,26		

The control variables applied in the study are also supported by works in the field (Aydogmus et al., 2022; Wang et al., 2022) and are Company size, Asset liability ratio and Current ratio. The calculation of the dependent variable ROA and the control variables was performed by the authors using Microsoft Excel spreadsheet program and based on the indicators extracted from the LSEG Data & Analytics database (Refinitiv).

**Table 4: Summary of variables**

Variable	Description/formula
Dependent variable	
ROA	Net Income / Total Assets
Independent variable	
ESG Score	LSEG data
CO <sub>2</sub> Equivalent Emissions Total	LSEG data
Control variable	
Company size	Ln(Total Assets)
Asset-liability ratio	Total Liabilities / Total Assets
Current ratio	Total Current Assets / Total Current Liabilities

Table 5 summarizes the analysis of all variables used in the study for the 751 companies and the period 2021-2023.

**Table 5: Descriptive statistics**

Description	Variable	N	Range	Minimum	Maximum	Mean	Std. Deviation
ESG	Independent	2253	88.3128	4.8880	93.2008	58.3785	16.3496
CO <sub>2</sub>	Independent	2253	982 000.0000	0.0000	982 000.0000	90 222.5862	158 649.4554
Companysize	Control	2253	10.1328	2.4065	12.5393	7.7143	1.6058
Assetliabilityratio	Control	2253	1.5643	0.0057	1.5700	0.5974	0.1876
Currentratio	Control	2253	36.2199	0.0154	36.2353	1.6379	1.7354

Description	Variable	N	Range	Minimum	Maximum	Mean	Std. Deviation
ROA	Dependent	2253	1.5077	-1.0006	0.5071	0.0341	0.0786
Valid N (listwise)		2253					

The average obtained by the dependent variable ROA is only 3.4%, registering a minimum of -100.06% and a maximum of 50.71%. We consider it worth mentioning that both values at the sample bounds were obtained in the year 2021. From the total of 2253 observations, the ROA indicator registers positive values for 1835 observations, i.e. 81.45% of the sample, and 418 negative values representing the difference of 18.55% of the total companies. The independent variables present only positive or null values.

The following regression model was constructed in order to support the research hypotheses:

$D \text{ variable}(it) = \alpha + \beta_1 I \text{ variable}(it) + \beta_2 \text{ Control}(it) + \varepsilon(it)$ , where:

- $D \text{ variable}(it)$  is the dependent variable (ROA);
- $I \text{ variable}(it)$  is the independent variable (ESG Score/ CO<sub>2</sub> Equivalent Emissions Total);
- $\text{Control}(it)$  is represented by the control variables (Company size, Asset-liability ratio și Current ratio);
- $\varepsilon(it)$  is the error term.

Therefore, each of the two research hypotheses was assigned a regression model to measure the influence of the independent variable (ESG Score and CO<sub>2</sub> Equivalent Emissions Total) on the dependent variable ROA.

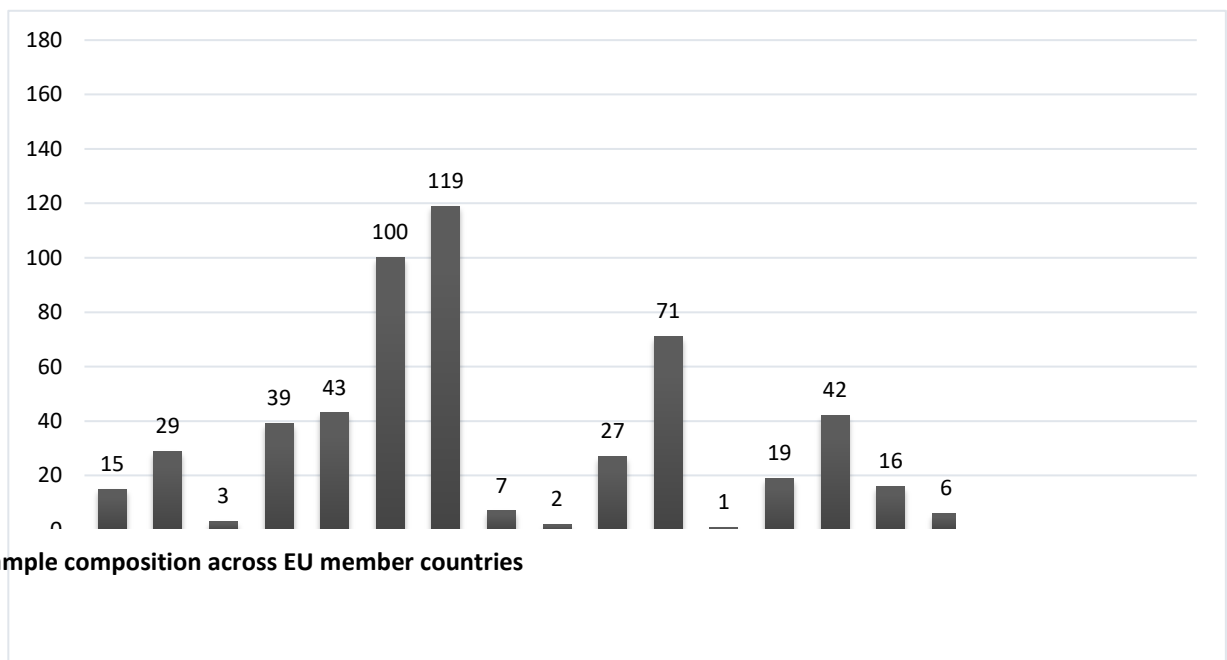
**Table 6: Regression models of the study**

Variable	H1 (Model 1)	H2 (Model 2)
Dependent	ROA	ROA
Independent	CO <sub>2</sub> Equivalent Emissions Total	ESG Score
Control	Company size	Company size
Control	Asset liability ratio	Asset liability ratio
Control	Current ratio	Current ratio

Results were obtained by running regressions in SPSS (Statistical Package for the Social Sciences).

#### 4. Results and Discussions

Analyzing the composition of the sample across the EU countries, we can see that Sweden, Germany and France occupy the top three positions, with more than 100 companies each and a total of 383 companies, representing 50.99% of the sample. At the opposite pole are Lithuania, Romania, Hungary and Slovenia with a total of six companies in the sample, respectively a share of 0.79% in the sample.



**Figure 1: Sample composition across EU member countries**

Expanding on the analysis of the average ESG and carbon emissions scores across EU countries, the best performing countries in terms of sustainability scores are Hungary, the only country with a score above 70 units, followed by Portugal, France and Spain with scores above 65 units each. The 2021-2023 period is marked, moreover, by the continuous increase of the ESG score by two units, from 57.1 units in 2021 to 59.1 units in 2023.

Portugal and Cyprus have the highest CO<sub>2</sub> emissions over the period, with more than 200000 tons per year, but a downward trend is observed. The same trend is adopted by most of the countries in the sample and can be supported by the overall decreasing averages at EU level per year, which is a consequence of the realization of the need for sustainability investments as well as the development of EU legislation on sustainability and in particular on carbon emissions (CSRD, CBAM).

These significant differences can be explained by factors such as clear legislation, incentives provided by the competent bodies and monitoring of the implementation of ESG strategies being more pronounced in some EU countries, as well as the existence of more industrialized and fossil fuel dependent economies and the low level of technology to promote clean energy in terms of carbon emissions.

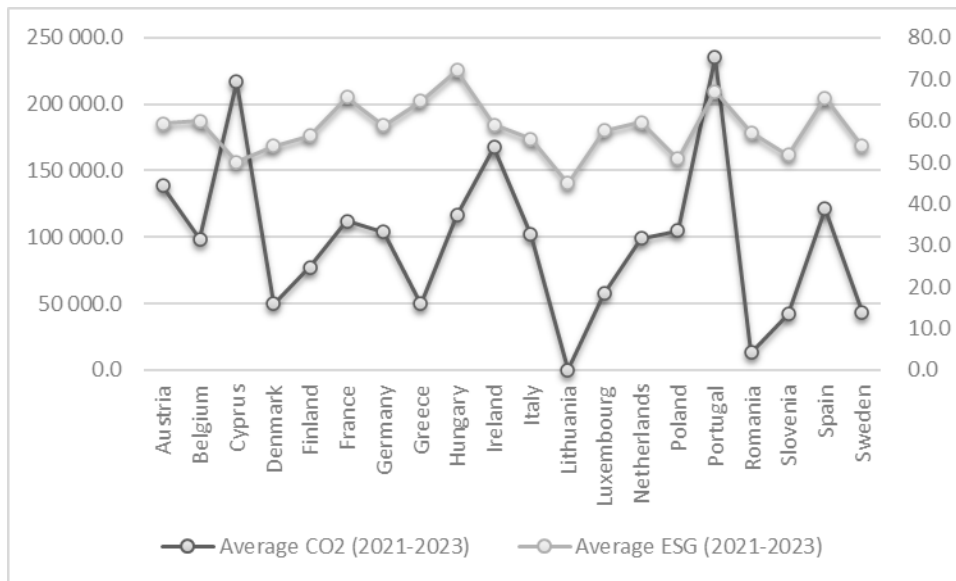


Figure 2: Global averages of ESG scores and CO<sub>2</sub> emissions across EU countries

#### 4.1 Theoretical Implications

In order to answer the research hypotheses stated earlier in the paper, the regressions were run on the basis of the models presented, using the SPSS statistical program, which is compatible with the present research due to the not very complex databases under analysis.

The results obtained are presented in Tables 7-10.

The results obtained in the study make a relevant contribution to the literature on the relationship between sustainability and the financial performance of companies. Model 1 tested the influence of carbon emission reduction on company profitability (ROA), and the R<sup>2</sup> coefficient obtained shows that only 9.5% of the variation in ROA can be explained by the change in CO<sub>2</sub> emissions. By performing the F-test, together with the Significance F, which registers a value below the 0.05 threshold, the model is statistically significant and can be used to analyze the dependence between the two variables. The ROA indicator value is 0.091 when total CO<sub>2</sub> equivalent emissions are equal to 0, and the coefficient for CO<sub>2</sub> emissions is not statistically significant (p = 0.151), which means that we cannot support a direct relationship between carbon emission reduction and profitability.

Table 7: Regression results to support H1

Dependent Variable:		ROA				
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1.318 <sup>a</sup>	4	0.330	58.902	0.000	0.095
Intercept	0.458	1	0.458	81.799	0.000	0.035
CO <sub>2</sub>	0.012	1	0.012	2.064	0.151	0.001
Companysize	0.079	1	0.079	14.152	0.000	0.006
Assetliabilityratio	1.248	1	1.248	223.051	0.000	0.090
Currentratio	0.130	1	0.130	23.292	0.000	0.010
Error	12.578	2248	0.006			
Total	16.512	2253				
Corrected Total	13.897	2252				

a. R Squared = .095 (Adjusted R Squared = .093)

Table 8: Parameter estimates (H1)

Dependent Variable:		ROA					
Parameter	B	Std. Error	t	Sig.	95% Confidence Interval		Partial Eta Squared
					Lower Bound	Upper Bound	
Intercept	0.091	0.010	9.044	0.000	0.071	0.111	0.035
CO <sub>2</sub>	0.000	0.000	1.437	0.151	0.000	0.000	0.001
Companysize	0.004	0.001	3.762	0.000	0.002	0.006	0.006
Assetliabilityratio	-0.138	0.009	-14.935	0.000	-0.156	-0.120	0.090
Currentratio	-0.005	0.001	-4.826	0.000	-0.007	-0.003	0.010

The results obtained contradict similar studies in the literature, such as those by Naranjo Tuesta et al. (2020), who analyzed the relationship between carbon management and the financial performance of European companies, expressed by the ROA, ROE and ROS indicators. Their study was conducted for the period 2006-2017 on 497 companies, and the results indicate that reducing CO<sub>2</sub> emissions is useful for improving the profitability of companies, especially those in non-polluting sectors.

Gallego-Alvarez et al. (2014) subject 89 international companies to a similar analysis for the period 2006-2009, and their results show that reducing emissions has a positive impact on financial performance.

In this regard, our study offers a critical perspective, suggesting that the relationship between carbon emissions and profitability may depend on numerous contextual factors, such as region, industry, period analyzed, and reporting framework.

Model 2 tested the influence of the ESG score on company profitability expressed in ROA. The R<sup>2</sup> coefficient shows that 9.7% of the variation in ROA is explained by the evolution of the ESG score, suggesting a modest effect and a slightly higher contribution than in Model 1.

The validity of the regression model is achieved by obtaining a Significant F value below 0.05, and the validity of the coefficient results from obtaining a p value of 0.013.

The ROA indicator value is 0.083 when the ESG score is equal to 0.

The ESG coefficient registers a value of almost zero, 0.0003, which represents a weak positive evolution of the ROA indicator in relation to the increase of the ESG score by 1 unit.

However, the significance of the regression model and the positive correlation between the study variables can be supported by similar works in the literature. Thus, our results are consistent with those of Aydogmus et al. (2022), whose relationship between ESG score and profitability expressed by ROA was positive and significant, as well as with the study by Almeyda and Darmansyah (2019), whose conclusion highlighted a positive and significant relationship between performance and ESG score.

Table 9: Regression results to support H2

Dependent Variable: ROA						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1.341 <sup>a</sup>	4	0.335	60.035	0.000	0.097
Intercept	0.402	1	0.402	71.973	0.000	0.031
ESG	0.034	1	0.034	6.168	0.013	0.003
Companysize	0.036	1	0.036	6.426	0.011	0.003
Assetliabilityratio	1.247	1	1.247	223.264	0.000	0.090
Currentratio	0.129	1	0.129	23.039	0.000	0.010
Error	12.555	2248	0.006			
Total	16.512	2253				
Corrected Total	13.897	2252				

a. R Squared = .097 (Adjusted R Squared = .095)

Table 10: Parameter estimates (H2)

Dependent Variable: ROA							
Parameter	B	Std. Error	t	Sig.	95% Confidence Interval		Partial Eta Squared
					Lower Bound	Upper Bound	
Intercept	0.083	0.010	8.484	0.000	0.064	0.103	0.031
ESG	0.000	0.000	2.484	0.013	0.000	0.001	0.003
Companysize	0.003	0.001	2.535	0.011	0.001	0.005	0.003
Assetliabilityratio	-0.137	0.009	-14.942	0.000	-0.156	-0.119	0.090
Currentratio	-0.005	0.001	-4.800	0.000	-0.007	-0.003	0.010

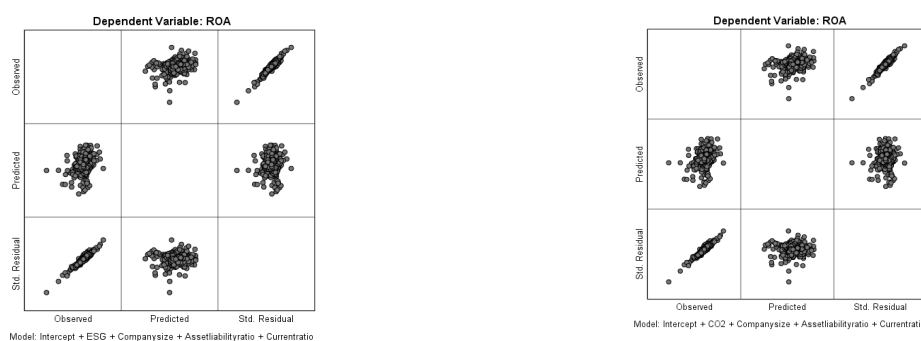
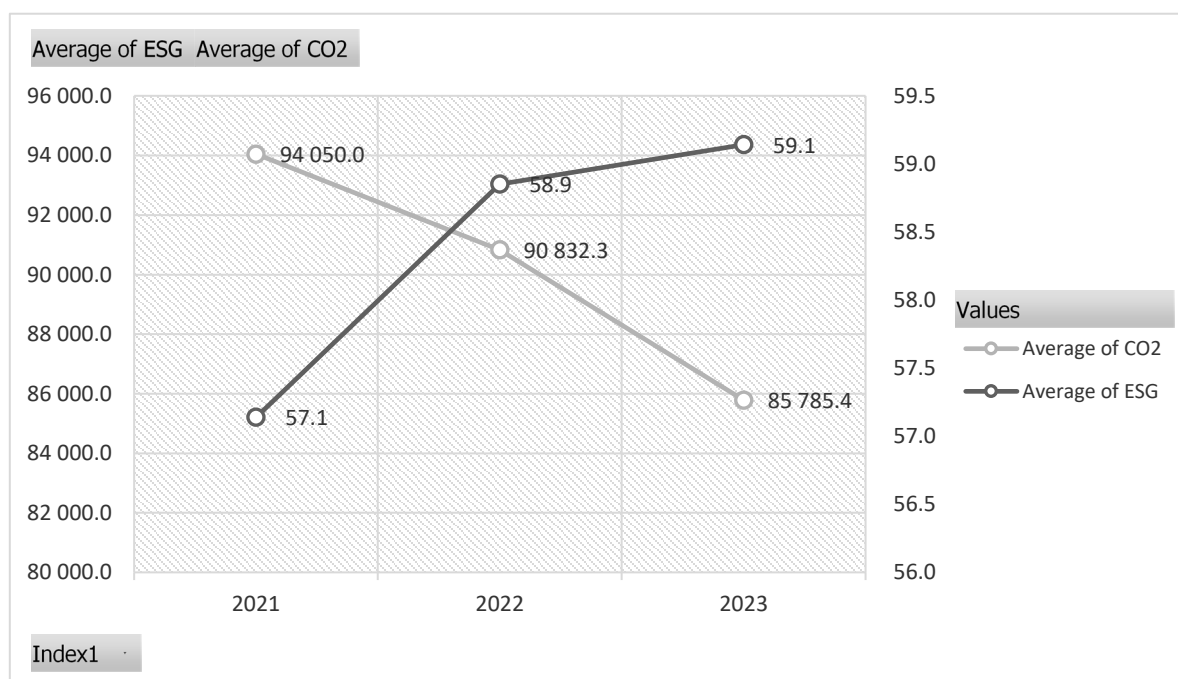


Figure 3: Illustrating regression results to support research hypotheses

Although the statistical results do not fully validate the scope of our research, Figure 4 illustrates the evolution of the average ESG score, as well as carbon emissions, over the period under analysis, 2021-2023. It is evident that the ESG score increases from 57.1 in 2021 to 59.1 in 2023, while carbon emissions decrease from 94050.0 t in 2021 to 85785.4 t in 2023.



**Figure 4: Evolution of the global averages of the ESG Score and CO<sub>2</sub> Equivalent Emissions Total, period 2021-2023**

We believe that the results reinforce the validity of the positive relationship between ESG scores and financial performance.

As stated above, our study partially validates the literature, supporting the importance of ESG performance, but providing contradictory results regarding the link between carbon emissions and profitability. We believe that this contribution is theoretically relevant, as it analyzes the influence on companies' financial performance from two perspectives. The first model addresses the relationship between one of the components of the environmental pillar (carbon emissions) and profitability, while the second model uses overall ESG performance.

#### 4.2 Practical Implications

The results highlight the importance of ESG factors in relation to company profitability and offer several implications for various stakeholders, such as managers, investors, or regulators.

For companies, the results suggest that improving ESG scores can have positive effects on financial returns. This may encourage companies to set sustainability goals not only to strengthen their reputation and comply with regulations, but also to maximize financial performance.

Sustainability criteria (ESG) can be considered decision-making factors for investors in that sustainable investments can generate financial returns. In terms of regulatory factors, the results of the study may suggest the need to strengthen environmental policies, particularly in relation to carbon emissions, and initiatives such as the CSRD (Corporate Sustainability Reporting Directive) are essential in integrating sustainability at the company level.

#### 4.3 Limitations and Future Research

The present research has limitations, which are mentioned below. First, the database used (LSEG Data & Analytics) may construct ESG scores and carbon emissions information based on a different methodology than other databases used in other studies, which may affect data comparability.

Another limitation of the research may be the econometric models applied, which may not take into account all the significant variables of the study, such as the sector of activity or other specific indicators.

As directions for future research, we believe that the analysis could be developed to include two categories of companies: financial and non-financial companies, for greater validity of the results, as they may address

different strategies in terms of sustainability. Also, an analysis conducted over a significantly longer period of time may capture the effects of sustainability policies and financial performance over time.

## 5. Conclusions

A review of the literature reveals a growing interest in the topics covered in this paper, namely non-financial disclosure, ESG score and carbon emissions.

The testing of the research hypotheses involved the application of regression models on a sample of companies of the size presented. The results obtained did not validate both hypotheses tested: the existence of a positive and significant relationship between the ESG score and the profitability of companies expressed by ROA has been demonstrated and can be supported by other studies in the recent literature (Aydogmus et al., 2022; Almeyda and Darmansyah, 2019; Treepongkaruna and Suttipun, 2024). Thus, *H2. The ESG score has a positive and significant influence on companies' profitability expressed by ROA* was validated in the study.

Regression model 1, which tested the influence of carbon emission reduction on profitability was found to have no statistical significance, therefore *H1. Reducing CO<sub>2</sub> emissions have a positive and significant influence on companies' profitability expressed by ROA* cannot be supported. In the literature surveyed, we identified works by other authors that validate the hypothesis stated above, such as Wang et al. (2022), Gallego-Alvarez et al. (2014) or Miah et al. (2021).

Lewandowski (2017) finds that a positive association between carbon performance and financial performance is a motivation for companies to adopt carbon reduction strategies.

We believe that our results support the importance of promoting policies that encourage transparency and performance of ESG factors and are of interest to companies, policy makers and investors alike. Supporting non-financial reporting (such as CSRD) and integrating ESG aspects into company policies can contribute to a more sustainable and competitive economy. The result on carbon emissions may suggest that there is a need for stronger policies to link polluting behavior to financial performance. Moreover, for investors, the results provide a strong argument for integrating sustainability factors to inform investment decisions.

The study contributes to the literature by concomitantly analyzing the influence that carbon emissions as well as sustainability performance (ESG score) have on the profitability of companies expressed by the financial ROA indicator, being a relatively limited approach (Gabr and ElBannan, 2024), and by bringing together emerging and developed economies in the same study.

With respect to the limitations of the research, we consider that one of them is the choice of the database for the information extracted on carbon emissions and ESG scores. Another limitation of the research may be the econometric models applied, which may not account for all significant variables of the study.

As future research directions, we believe that the analysis can be developed to include two categories of companies: financial and non-financial companies, for greater validity of the results.

## Acknowledgements

This paper was co-financed by The Bucharest University of Economic Studies during the PhD Program.

**Ethics Declaration:** As authors, we declare that the research complies with ethical principles and rules.

**AI Declaration:** As authors, we declare that no AI tools were used in the research.

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