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The Influence of Carbon Management on the Financial Performance of European Companies

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Abstract: This document shows the relationship between carbon management and the financial performance of the European Union's best market capitalization companies. Different measures are used to understand it by adopting a quantitative approach. After analyzing the validity and reliability of the construct, the study empirically tests its hypotheses by performing a multiple regression analysis with a sample of 497 companies. The study identified how factors related to carbon management could affect the financial performance of European organizations. Furthermore, it recognizes that carbon management affects profitability, in particular, ROA (Return on Assets). The study highlights the differences between companies that are considered sensitive and those that are not, as the management of emission reductions and performance impacts are handled differently.

Keywords: carbon management; carbon performance; financial performance; emission reduction; carbon management system

1. Introduction

Indexes such as the Dow Jones Sustainability Europe Index [1], in its latest report, state that the carbon intensity of each index evaluated increased in 2017, except for the S&P Asia 50, which reduced its carbon intensity by 26%. The S&P Dow Jones carbon indexes are a barometer for carbon intensity in current financial markets and their relationship with the direction of the economy. The Carbon Disclosure Project (CDP), together with ISS-Climate [2], joined forces to create the new "Climetrics" methodology. Thus, European investment funds aligned with the Paris Agreement (limiting global warming to below 2 °C is the objective established at the Climate Change Conference held in Paris - COP21 of 2015) [3] to provide an unaffected rating (ranging from 1 to 5) to help companies understand their exposure to climate change risks, providing a holistic assessment of climate-related risks and opportunities.

In 1998, an initiative was launched to develop accounting standards and encourage companies to report on their greenhouse gas (GHG) emissions worldwide. In this way, "the greenhouse gas protocol" [4] promoted by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) was created with a coalition of 170 international companies. Given the negative effect on the growth of the economy in these countries, it could be assumed that, in turn, this would have an impact on organizations (especially those that are considered to be more sensitive or with high levels of pollution).

According to the OECD, improving air quality can yield significant economic benefits [5]. Therefore, companies must set clear objectives when it comes to reducing their carbon footprint and

control processes in ways that do not affect or contribute to climate change. However, this can cause a dichotomy between economic growth and environmental impact [6,7].

Previous studies have addressed this problem at a more general level by linking economic performance and environmental performance [8–13]. However, they do not manage a single conclusion regarding this relationship. They suggest that the timespan of the study (observation of data) may bias the analysis of environmental management's effects over economic management and profitability. Some authors [14,15] claim these relationships depend on the sensitivity of the industry, which is considered more polluting because of its economic activity. Another type of study focuses on the relationship between carbon management (regarding carbon performance aspects that, in turn, are associated with a reduction in CO₂ emissions (carbon mitigation) [16]) and economic performance (the economy's performance will be understood as the profitability or profits generated by the company in a certain period) [17–19], and also fails to provide a consensus on how the variation in emissions, or carbon management, affects corporate performance. Moreover, the results are equally diverse and depend on the sample and analysis scenario.

Therefore, in the absence of a consensus and with different results for the relationships studied, one contribution of this work is to provide more elements for the academic and social debates concerning the relationship of carbon management and its impact on the economic performance of European organizations. Moreover, it particularly recognizes whether the sensitivity of industries influences this relationship [15,20,21]. Similarly, the presence of management control systems or the like in this relationship has been observed to a lesser extent within this type of work. Therefore, we explore how management control systems focused on emission reductions can affect companies' performance and whether this varies together with the industry sensitivity.

On the one hand, carbon management refers to those measures that gather information on carbon dioxide emissions by an entity and, in turn, reviews the internal systems that organizations follow to try and control such emissions. In this particular regard, it is necessary to understand that the relationship will be approached from the Carbon Management Accounting—CMA—perspective (environmental management system (EMA) techniques applied to carbon [22]), which allows us to evaluate the activities that a company engages in to reduce emissions and assess economic impacts on the company [17].

On the other hand, financial performance is related not only to profits but also to the long-term stability of the entity and having sound solvency and liquidity levels. In turn, operational activities have a particular impact on the organization's financial performance and, therefore, on regulatory compliance matters such as reducing emissions, which must be considered as they are becoming increasingly critical in organizational management. Organizations set themselves different objectives, both financially and operationally, which should be considered in the strategic approach to determine the firms' behavior and performance [23]. The financial or economic indicators that highlight management activities over time are analyzed under the concept of financial performance.

This document aims to show the relationship between carbon management and the financial performance of European companies, and particularly to address EMA issues concerning the impact of that relationship. We decided to study companies in the European Union, because this territory generates large amounts of emissions worldwide and, therefore, becomes a region of interest for the study. To that end, the existing correlation is first identified and then, through multivariate studies using panel data, which factors related to carbon management and emission control impact the financial performance of organizations are identified.

Given the studies mentioned above, together with other research, we aim to contribute empirical work to the discussion in this field of knowledge. By analyzing different carbon management and organizational profitability measures, we determine how emission management can impact the results of companies, which is essential in economic, environmental, and financial terms. Another contribution of this document is to explore the influence of carbon management systems on the relationship between emissions management and profitability.

This document consists of five sections, including this introduction. In the second section, we describe the relationship between carbon management and financial performance in previous works or literature reviews to support the hypothesis. The next one presents the research method, emphasizing the model and the variables used. Then, we present the results and findings in the fourth section. The document concludes with a discussion of the results and limitations in the study.

2. Literature Review and Hypotheses

Accounting research has recently been discussed and the relationship between environmental behavior and corporate performance has been analyzed. However, in the last two decades, there has been increasing interest in issues related to carbon emissions, greenhouse gas emissions, and the impact of CO₂. Nevertheless, studies initially showed their results only in terms of the relationship without delving deeper below the surface. Works like those of Freedman and Jaggi [24] investigate the long-term relationship between pollution and economic performance. This type of research was novel for its time and offered a way to explore the effects of environmental management and economic management measures in organizations, thus becoming a reference work for our research.

Other works such as Bartolomeo et al. [25] asserted that environmental management accounting should provide a more comprehensive view of the long-term implications of sustainability. Schaltegger and Csutora [19] have stated that, thus far, studies about carbon accounting are incipient and most are theoretical, and therefore reinforcing this type of research becomes a necessity. Works like Gibassier and Schaltegger's [17] recognize that different methods of carbon management accounting require specific knowledge of organizations' internal information systems, which is not always available. This poses challenges in researching business practices, developing information programs, and designing management systems that facilitate environmental improvement and are effective in reducing CO₂ emissions and decision-making. Although several developments were documented for use, additional research is needed on business practices and software development to develop specific accounting methods and systems that help increase awareness, identify reduction potentials, and support decision-making and the effective implementation of reduction measures.

There are various elements to consider when talking about carbon management and how companies control emissions. Here, we refer in particular to management accounting methods, especially those related to CMA that require specific knowledge and information systems that are not always available in organizations today [17]. CMA are affected by internal and contextual (external) factors since they were designed and used by organizations. In a way, these constitute quantitative records of a particular unit established according to the company's operations and communicated within and beyond the company [26].

Theoretical and academic discussions are growing in this area. However, the works are not conclusive, but they show how social concern for companies' ethical, social, and environmental issues has gained particular relevance in recent years. In this vein, this research, which analyzes the impact of carbon management on corporate performance in the long term and the involvement of the management control variable in the study, allows contributing to these discussions.

Hypothesis

There is a blind spot in regard to the changes and impact of carbon management on the financial performance of a company [19]. It is essential to increase or establish strategies to be environmentally competitive, thus differentiating between the short and long-term impact of climate change management on corporate performance [27].

Past studies did not reach a consensus regarding the relationship between carbon management and CO₂ emission reductions with financial performance. Horváthová [10] uses a variety of emissions in his study, and the results show that companies that reduce their emissions improve long-term financial performance markedly (an aspect that is expected to contrast with this research focusing on CO₂ emissions). Gallego et al. [28] state that, when analyzing the effects of GHG emissions' variation

on the company's performance over several years, reductions have a positive effect on financial performance. On the contrary, Lewandowski [18] expressed that, per his study, there is no significant relationship between carbon management and financial performance. Brzobohatý and Janský [29] asserted that the more CO₂ a company emits, the lower its revenue and associated costs. At the same time, they describe that the impact on the profits of a company that reduces its emissions are not always that clear. Freedman and Jaggi's [24] work did not find sufficient evidence to reject their hypothesis about the non-association of performance with pollution. Nevertheless, they state that this could be seen as something positive from the environmental (social) point of view, since not finding any impact on the company's economic management could lead to reduced emission levels beyond regulatory compliance.

These works contemplate different emission measures, but they are close to ours in terms of the relationship they show with profitability. Although there is no consensus on the results present in the relationships studied, these authors state that the sectoral differences, study time, and the impact on the economic and financial performance of reducing emissions must be taken into account. Therefore, the first working hypothesis is to recognize whether or not carbon management has an impact on European organizations' financial performance and whether these changes depend on the type of sector in which the companies operate. That is, following De Villers, to recognize whether the sensitivity of industries influences relationships and results [14,15,30]. Therefore, the question driving the first scenario is: does carbon management affect European organizations' financial performance depending on their industry's sensitivity?

Hypothesis 1 (H1). *There is a relationship between carbon management and financial performance in sensitive and non-sensitive organizations.*

The Greenhouse Gas Protocol [4] encourages standard practices in carbon accounting at the organizational level. Such standards promote common corporate carbon accounting practices and are considered a tool for management accounting and reporting [31]. Zvezdov and Schaltegger [32] state that carbon management accounting allows the efficient use of resources and an effective reduction in carbon emissions.

Solovida and Latan [33] affirm in their studies that a company should base its environmental performance indicators on its environmental strategy so that an appropriate environmental strategy will determine the success of the company's environmental performance. Likewise, companies certified in ISO 14001 that have implemented an environmental management system (EMA) choose to use these systems as a tool to achieve their strategic objectives. Tang and Luo [16] show that Australian companies that have carbon management systems achieve better results in carbon mitigation and suggest that this must be personalized and aligned with the corporate strategy for an optimal result.

Obtaining certification for an environmental control system provides an environmental performance overview that, coupled with carbon emissions in a company, is capable of highlighting environmental management practices and their impact on economic management. Therefore, the basis for the second hypothesis is to recognize that managing carbon performance is not only environmentally effective but also economically desirable.

Hypothesis 2 (H2). *Companies with environmental management systems perform better financially than those without one.*

3. Materials and Methods

3.1. Sample Selection

The environmental information is disclosed voluntarily. Although there are incentive mechanisms for organizations to provide this type of report more frequently, the data are often not comparable; either the information reported is incomplete or it is not adequate to conduct more in-depth studies. To avoid this problem and to conduct a more conclusive study, information from the Eikon database ("Thomson

Reuters Eikon is a great tool to retrieve market data, news, and economic information pertaining to the wealth of countries and nations. The software is user-friendly and comes with a convenient excel add-in, allowing for the simple extraction of historical and real-time market data”[34]) was used to extract both the financial and environmental data published from 2006 to 2017—i.e., two databases were used to determine the impact of carbon management on profitability. Firstly, to obtain the firm’s profitability and financial data, we used the Thomson Reuter’s in World Scope and DataStream. Secondly, environmental data from ESG-Asset4 (Thomson offers users the possibility of combining and analysing ESG data using state-of-the-art applications for in-depth analysis through its Asset4 database, which contains data related to the environmental, social, and government pillars [35]) were used. The European Union will serve as a reference, given that the bloc has the second-highest emission levels after the United States [36] or the third, according to the latest report of the Global Carbon Project [37] and limited to the 500 companies with the best market capitalization (the financial sector was excluded due to the accounting and financial peculiarities that they possess).

3.2. Data Collection

The initial search was conducted in groups, and those companies that belong to the European Union and whose equity was in common shares were selected. All the sectors were selected, except those belonging to the financial sector, based on previous work and to prevent biasing the results [18,38,39].

There are several filters to collect the data, and we employed them by taking only primary-quote companies. In market capitalization, the search was filtered for those higher than or equal to 2000 million. This initial search yielded 629 companies.

Adjustments were made in both databases, so the correct data to apply to the model would be left in the database. Within the criteria to discard the financial data, the legal system for countries was identified. Similarly, those companies that reported a #error were also discarded. Other cases where companies were excluded from the study include companies with data for less than three consecutive years (since variation measures are used, information on at least two years is required. We were a little more rigorous with the filtering, and the research group decided that we would handle the information to avoid enforcement for three consecutive years). Within the criteria for the deletion of Asset4 data, companies that did not have RIC (RIC—Reuters Instrument Code. “RIC is used to describe the unique code used to identify Thomson Reuters data. It generally represents either a particular financial instrument (e.g., AAPL.O) or a group of related instruments (e.g., 0#.DJI)”[40]) or where a #error appeared were also discarded. Additional grounds for discarding a company included companies without sufficient information on their CO₂ emissions, or without emission scores, as well as data without a specific year.

Both databases were migrated and unified based on the RIC identifier. The data with matches in both databases—that is, in both the financial database and the environmental database—were kept. Robust data were used to reduce variance and relevant changes to address heteroscedasticity issues (as Hoechle [41] states, the Vce (robust) or robust command permit carrying out the estimation even with heteroscedasticity issues). After merging and adjusting, we ended up with unbalanced panel data from 2006 to 2017, with approximately 4775 observations corresponding to 497 firms. The panel is unbalanced due to missing observations, so the final sample was made up by firms that provided information on financial performance and carbon management for the entire period under analysis. The sample is separated in relation to the “Sensitive” variable considering the behavior in relation to the number of observations or participating companies. This is due to the amount of information that each firm reports on the variables analyzed in each scenario.

Table 1 shows the distribution by country and sector for the companies studied. Thus, approximately 26% of the companies belong to the United Kingdom, followed by French (14.5%) and German (13.1%) firms. With regards to the sectors (to perform this assignment, the Eikon characteristics were taken as a reference for each firm. Then, the reallocation was made based on the sensitivity of the sector) in the sample, 24% belong to the industrial sector and 21% to cyclical

consumption companies. Countries with the lowest share in the study were Cyprus, the Czech Republic, and Hungary, with less than 0.5% participation. Within the sectors, telecommunications, energy, and technology services sectors have the least intervention in the composition of the sample. The data also includes observations distributed by sensitivity (contamination levels) and by country.

Table 1. Distribution by country and sector.

Country	Firm	Obs	% Country	Nonsensitive	Sensitive	Sector	Firm	% Sector
Austria	12	124	2.4%	57	67	Energy	32	6%
Belgium	13	126	2.6%	80	46	Basic Materials	60	12%
Cyprus	1	7	0.2%	0	7	Industrials	117	24%
Czech Republic	2	21	0.4%	10	11	Consumer Cyclical	105	21%
Denmark	17	158	3.4%	121	37	Consumer Non-Cyclical	43	9%
Finland	17	178	3.4%	112	66	Healthcare	49	10%
France	72	709	14.5%	568	141	Technology	32	6%
Germany	65	588	13.1%	381	207	Telecommunications Services	23	5%
Greece	5	48	1.0%	26	22	Utilities	36	7%
Hungary	2	18	0.4%	0	18	Total	497	100%
Ireland	26	236	5.2%	145	91			
Italy	24	231	4.8%	126	105			
Luxembourg	8	47	1.6%	18	29			
Netherlands	31	261	6.2%	177	84			
Portugal	14	110	2.8%	36	74			
Spain	25	258	5.0%	123	135			
Sweden	36	345	7.2%	258	87			
United Kingdom	127	1310	25.6%	976	334			
Total	497	4775	100.0%	3214	1561			

3.3. Empirical Models

Two models will be prepared to capture the effect of the variables relating to carbon management (CM) that affect financial performance (FP) in European organizations. Equation (1) is related to the first hypothesis. In this equation, the dependent variable related to FP will be measured in three different ways—namely, return on asset (ROA), return on equity (ROE), and return on sales (ROS)—indicating aspects of profitability. CM shall use three measures: an external one (the SCORE) that is expected to have a positive relationship with profitability, and two internal measures, emissions variation (VEMI) and carbon performance (PCC), which are determined based on the tons of CO₂ emitted by European companies. A negative relationship is expected, where the higher the number of emissions, the lower the profitability of the companies.

$$\mathcal{FP}_{it} = \beta_0 + \beta_1 \text{SCORE}_{it} + \beta_2 \text{VEMI}_{i(t-1)} + \beta_3 \text{PCC}_{it} + \sum_{i=4}^n \beta_4 \text{CONTROLS}_{it} + \mu_{it}. \quad (1)$$

As mentioned above, the use of panel data allows us to evaluate the company's performance over time by analyzing observations over several consecutive years for the same sampled companies. When using panel data, as stated by Wooldridge [42], there is a compound error related to the unobserved factors that affect the dependent variable, which remains constant over time. Furthermore, an idiosyncratic error shifts both over time and through the units, since each company has a different cultural and legal context in which it carries out its activities, which the explanatory variables fail to capture.

To test hypothesis two (H2), Equation (2) follows, which aims to understand the interaction between different aspects of the environmental management systems with emissions control in order to assess their impact on financial performance (FP). Here, the profitability variable, the most affected, will be taken as a dependent measure from the estimates in Equation (1). The three variables related to CM will be kept, and CERTIFICATE (dichotomous variable related to environmental certifications)

will be considered a variable of explanatory interest, wherefore efforts should focus on reviewing the interaction with the variation in emissions. The parameters were consistently estimated (and the standard error) in the model to lead to valid inferences.

$$\mathcal{FP}_{it} = \beta_0 + \beta_1 \text{SCORE}_{it} + \beta_2 \text{VEMI}_{i(t-1)} + \beta_3 \text{PCC}_{it} + \beta_4 \text{CERTIFICATE}_{it} + \beta_5 (\text{CERTIFICATE} \times \text{VEMI})_{it} + \sum_{i=6}^n \beta_6 \text{CONTROLS}_{it} + \mu_{it}. \quad (2)$$

3.4. Variables

Three profitability measures will be taken from the dependent variables—i.e., ROA, ROE, and ROS—to analyze the impact of carbon management on European companies in each case. In a similar vein, three reference measures were used to list the different aspects of carbon management: (i) one associated with internal management, given by environmental carbon performance (PCC); (ii) another as an external performance measure in which an entity rates its management of emissions (SCORE); and (iii) an emissions variation measure (VEMI). Works such as Busch and Lewandowski's [43] support the use of these main variables, both dependent and independent, which allow the carbon as well as financial performance to be linked together (See Table A1).

3.4.1. Dependent Variable: Financial Performance.

This research analyses the impact of CO₂ emissions on corporate performance. As different authors have stated, studying financial performance requires market-based or accounting-based measures like return on assets and equity. These may be used under the understanding that they can be affected in different ways and recognizing that political, regulatory, and market aspects are influenced directly or indirectly [44]. For this work, the dependent variable will take the value of accounting indicators such as ROA (return on assets) and ROE (return on equity) to analyze profitability [27,28,45], and we will also use the ROS (return on sales) variable as another indicator of profitability [8,18,24]

3.4.2. Independent Variable: Carbon Management Measures

As expressed by Fujii et al. [8], reducing CO₂ emissions reduces production costs, for example, through the conservation of fossil fuel energy, which contributes to greater profitability. Horváthová [10] states that companies can benefit from reducing pollution; however, this should be reviewed for more than one accounting period. Therefore, to analyze the aspects relating to carbon management, three measures were taken in account: SCORE, a Thomson measure that indicates the commitment and effectiveness of a company in reducing environmental emissions in production and operational processes [46,47]; an environmental performance measure, PCC, linking the consumption of emissions with the company's sales [18,19,27]; and the last measure is related to the company's emission levels per year, EMISSION, and it indicates CO₂ consumption levels in tons for each organization. The latter serves as a reference for the VEMI variable analyzed, which is the variation in emission levels from one year to the previous one [18,29,48].

3.4.3. Scenario Variable

Following Villier's work, we split the sample by scenarios between companies belonging to a sensitive sector—that is, a business activity that includes companies that are prone to generating more pollution—and those belonging to a non-sensitive sector or business activity [14,15,30]. This separation helps us understand how carbon management influences companies' financial performance based on their pollution levels. Indeed, this aspect is a fundamental and relevant contribution from this work.

3.4.4. Control Variables

Control variables such as GRI (Global Reporting Initiative); variation in property, plant, and equipment (VPPE); the growth of the company against sales (GROWTH); the market share—industry

relationship (SHARE); the company's leverage (LEV); other characteristics of the company such as size (SIZE) and operational expenses (OPEX); and the type of legislation of each country, whether common law or civil law, and in that process it was defined as common law (COMMON).

3.4.5. Itinerant Variable: Measure Related to Carbon Management Accounting

The variable CERTIFICATE contains those companies holding an environmental certification such as ISO 14001 and those that follow an environmental management system (EMS), which will interact with the EMISSION variable to understand the former's impact on profitability. In short, we aim to compare if a management system's existence impacts the performance of organizations against those organizations that have not implemented one.

4. Results

4.1. Descriptive and Correlations

The results present the aspects related to carbon management and the performance of the companies studied in the period 2006–2017. Tables 2 and 3 presents the statistics for both scenarios, based on the Sensitive variable (the Sensitive variable is not involved because it is dichotomous, and it is the variable that defines the scenarios of the model. The Year variable is related to the years of the data obtained and will serve as a model control.) (Table 2—sensitive; Table 3—non-sensitive). The financial variables ROA and ROE, on average, are higher in non-sensitive industries, while the variable ROS is, on average, higher in sensitive industries. The variables with carbon measures such as Score, Emission, and Pcc are larger in average terms in the sensitive industries. Furthermore, the Vemi variable, on average, is higher for non-sensitive industries.

It is also noted that more data is observed for non-sensitive industries than for sensitive industries. Similarly, it is possible to say that certified companies in the sample are related to pollution-sensitive industries. Concerning the control variables, it is known that the companies present similar characteristics, especially regarding company size (SIZE), when they have the best market capitalization. A difference is observed between the SHARE variable because the market–industry relationship is more significant for sensitive companies.

Tables 2 and 3 also present the simple correlation between the dependent and explanatory variables showing the significant measures between them. The data shows the degree of association between two variables—in this case, between those related to carbon management and profitability. At a general level, it can be said that there is a negative and significant linear correlation with the carbon management variables and the profitability variables, especially in non-sensitive industries. In the sample related to sensitive companies, the ROA variable has a negative and significant relationship with Emission and PCC. Likewise, the ROS variable is negatively and significantly related to emission. For the sample of non-sensitive companies, it is shown that the most impacted variable is ROA, as it has a negative and significant linear relationship with the Score, Emission, Vemi, and PCC variables. Likewise, the ROE and ROS variables are negatively and significantly related to Emission and PCC. The correlation matrix fails to show strong multicollinearity between the explanatory variables. Indeed, the PIV test shows an average of 2.22 for the pollution scenario and 2.59 for the non-sensitive scenario.

Table 2. Descriptive statistics. Pearson correlation—sensitive.

Variable	Obs	Mean	Std. Dev.	Min	Max	ROA	ROE	ROS
ROA	1560	0.080	0.061	−0.006	0.246	1		
ROE	1560	0.209	0.165	−0.061	0.682		1	
ROS	1560	0.134	0.107	−0.008	0.343			1
SCORE	1561	68.732	23.282	17.600	97.600	−0.0459 <i>0.0702</i>	0.0586 <i>0.0206</i>	−0.0338 <i>0.1821</i>
EMISSION	1561	14.290	2.274	9.096	17.141	−0.1387 <i>0.0000</i>	<i>0.0205</i> <i>0.4193</i>	−0.1614 <i>0.0000</i>
VEMI	1405	0.069	0.165	0.000	0.704	−0.0234 <i>0.3808</i>	0.0062 <i>0.8178</i>	0.0322 <i>0.2282</i>
PCC	1561	0.544	0.506	0.006	1.457	−0.1453 <i>0.0000</i>	−0.0452 <i>0.074</i>	−0.0165 <i>0.5154</i>
GRI	1093	0.963	0.188	0.000	1.000	−0.1629 <i>0.0000</i>	−0.1376 <i>0.0000</i>	−0.0957 <i>0.0015</i>
VPPE	1405	0.053	0.125	−0.178	0.344	0.1510 <i>0.0000</i>	0.1134 <i>0.0000</i>	0.1660 <i>0.0000</i>
GROWTH	1405	0.048	0.136	−0.183	0.317	0.2026 <i>0.0000</i>	0.1518 <i>0.0000</i>	0.1557 <i>0.0000</i>
SIZE	1561	16.088	1.313	13.609	18.275	−0.2156 <i>0.0000</i>	0.0008 <i>0.9747</i>	−0.0346 <i>0.1716</i>
LEV	1561	0.568	0.151	0.291	0.863	−0.2173 <i>0.0000</i>	0.3052 <i>0.0000</i>	−0.0694 <i>0.0061</i>
SHARE	1561	2.704	3.961	−0.752	12.846	0.2135 <i>0.0000</i>	0.2660 <i>0.0000</i>	0.1985 <i>0.0000</i>
COMMON	1561	0.277	0.448	0	1	0.0959 <i>0.0001</i>	0.1071 <i>0.0000</i>	0.0997 <i>0.0001</i>
CERTIFICATE	1561	0.848	0.359	0	1	−0.0252 <i>0.3196</i>	0.0828 <i>0.0011</i>	−0.0735 <i>0.0037</i>
YEAR	1561	2012.061	3.286	2006.000	2017.000			

$p < 0.01$ numbers in bold and italics; $p < 0.05$ numbers in italics.

Table 3. Descriptive statistics. Pearson correlation—non-sensitive.

Variable	Obs	Mean	Std. Dev.	Min	Max	ROA	ROE	ROS
ROA	3195	0.098	0.063	−0.006	0.246	1		
ROE	3195	0.265	0.183	−0.061	0.682		1	
ROS	3195	0.124	0.086	−0.008	0.343			1
SCORE	3214	67.879	23.825	17.600	97.600	−0.0618 <i>0.0005</i>	−0.0188 <i>0.2873</i>	−0.0366 <i>0.0384</i>
EMISSION	3214	12.090	1.849	9.096	17.141	−0.3323 <i>0.0000</i>	−0.0874 <i>0.00000</i>	−0.3172 <i>0.00000</i>
VEMI	2871	0.078	0.176	0.000	0.704	−0.0517 <i>0.0057</i>	−0.0284 <i>0.1293</i>	−0.0259 <i>0.1658</i>
PCC	3214	0.097	0.233	0.006	1.457	−0.1080 <i>0.0000</i>	−0.0892 <i>0.0000</i>	−0.0507 <i>0.0041</i>
GRI	1720	0.918	0.274	0.000	1.000	−0.1124 <i>0.0000</i>	−0.0610 <i>0.0117</i>	−0.0445 <i>0.0654</i>
VPPE	2870	0.045	0.127	−0.178	0.344	0.1276 <i>0.0000</i>	0.1065 <i>0.0000</i>	0.1362 <i>0.0000</i>
GROWTH	2871	0.052	0.117	−0.183	0.317	0.1713 <i>0.0000</i>	0.1456 <i>0.0000</i>	0.1704 <i>0.0000</i>
SIZE	3214	15.649	1.254	13.609	18.275	−0.4274 <i>0.0000</i>	−0.1239 <i>0.0000</i>	−0.1553 <i>0.0000</i>
LEV	3214	0.608	0.159	0.291	0.863	−0.2860 <i>0.0000</i>	0.2010 <i>0.0000</i>	−0.2152 <i>0.0000</i>
SHARE	3214	1.960	3.102	−0.752	12.846	0.1578 <i>0.0000</i>	0.1936 <i>0.0000</i>	0.2524 <i>0.0000</i>
COMMON	3214	0.349	0.477	0	1	0.1580 <i>0.0000</i>	0.1183 <i>0.0000</i>	0.0716 <i>0.0001</i>
CERTIFICATE	3214	0.680	0.467	0	1	−0.1870 <i>0.0000</i>	−0.0553 <i>0.0018</i>	−0.1221 <i>0.0000</i>
YEAR	3214	2012	3.280977	2006	2017			

$p < 0.01$ numbers in bold and italics; $p < 0.05$ numbers in italics.

4.2. Multivariate Analysis

4.2.1. Testing Hypothesis 1

Tables 4 and 5 present the empirical results of the relationship between carbon management and financial performance by separating the latter based on the sensitive variable. Several statistical assumptions are used to analyze the regression. Concerning normality, different tests, like Skewness and Shapiro–Wilk, found that the variables do not fit a normal distribution. Heteroscedasticity problems are solved by using reliable data and adjusting the variables to reduce the variance. The regression analysis of the panel data was performed from 2006 to 2017, using the fixed and random effects model in both scenarios. The values of the coefficients are presented in the first line and the value of the p -value in the lower part in parentheses, highlighting in bold the beta value of the variable when it is significant. Table 4 shows the results associated with the observations related to sensitivity—i.e., companies that belong to a polluting sector or that generate higher pollution rates due to their commercial activity. Table 5 shows the results of the data for companies that do not belong to a sensitive sector. Both effects were applied to minimize bias when selecting an estimate and have shown that there are significant results that explain the relationship between carbon management and the entity’s financial performance, regardless of the method applied. All the data analyzed are interpreted under the condition of “Ceteris Paribus” (there are individual behaviors within a market, but all other conditions remain the same).

Table 4. Sensitive industries model.

Variable	ROA				ROE				ROS			
	Fixed_s1		Random_s1		Fixed_s1		Random_s1		Fixed_s1		Random_s1	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
SCORE	0.01012 (0.178)	0.00748	0.0109 (0.106)	0.0068	−0.0023 (0.924)	0.0235	0.016 (0.421)	0.020	0.0081 (0.443)	0.0106	0.0080 (0.441)	0.0103
VEMI	−0.0021 (0.840)	0.0103	−0.0038 (0.709)	0.0102	0.0323 (0.411)	0.0393	0.022 (0.539)	0.035	−0.004 (0.807)	0.017	−0.003 (0.838)	0.016
PCC	−0.0141 (0.149)	0.0097	−0.0108 (0.052)	0.0055	−0.0610 (0.119)	0.0388	−0.033 (0.031)	0.015	−0.001 (0.939)	0.013	−0.001 (0.961)	0.010
GRI	−0.0228 (0.061)	0.0121	−0.0209 (0.064)	0.0113	−0.0325 (0.230)	0.0269	−0.043 (0.093)	0.026	−0.031 (0.066)	0.017	−0.028 (0.084)	0.016
VPPE	0.0246 (0.062)	0.0131	0.0203 (0.114)	0.0128	0.0712 (0.086)	0.0411	0.057 (0.161)	0.040	0.061 (0.001)	0.019	0.066 (0.000)	0.018
GROWTH	0.0691 (0.000)	0.0122	0.0646 (0.000)	0.0120	0.1674 (0.000)	0.0441	0.1527 (0.000)	0.0410	0.075 (0.001)	0.022	0.079 (0.000)	0.021
SIZE	−0.0233 (0.015)	0.0095	−0.0217 (0.000)	0.0034	−0.0421 (0.137)	0.0281	−0.047 (0.000)	0.009	0.007 (0.628)	0.014	−0.010 (0.112)	0.006
LEV	−0.1233 (0.001)	0.0353	−0.0674 (0.005)	0.0241	0.1586 (0.180)	0.1177	0.386 (0.000)	0.062	−0.157 (0.005)	0.056	−0.115 (0.011)	0.045
SHARE	0.0054 (0.000)	0.0006	0.0061 (0.000)	0.0006	0.0136 (0.000)	0.0021	0.016 (0.000)	0.002	0.007 (0.000)	0.001	0.008 (0.000)	0.001
COMMON			0.0053 (0.514)	0.0082			0.028 (0.200)	0.022			0.009 (0.619)	0.018
_cons	0.5338 (0.001)	0.1545	0.4653 (0.000)	0.0587	0.9367 (0.034)	0.4362	0.780 (0.000)	0.146	0.119 (0.614)	0.235	0.360 (0.000)	0.103
R2	0.3747		0.3670		0.2744		0.195		0.329		0.325	
Firm	132		132		132		132		132		132	
N	1032		1032		1032		1032		1032		1032	
Chi ²			258.36 (0.000)				339.74 (0.000)				158.31 (0.000)	
F	10.79 (0.000)				10.67 (0.000)				9.15 (0.000)			

$p < 0.1$ numbers in bold.

Table 4 shows that carbon management factors have a more significant impact on the return on assets (ROA) than on other measures of profitability, especially when random effects estimate the model. Where the sector is sensitive, companies indicate that their ROA is positively and significantly affected by the company’s SCORE, and this has a significant negative relationship with carbon performance (PCC). In the case of ROE, it is significantly and negatively related to PCC. The ROS variable is not affected by any of the measures related to carbon management. The positive relationship with SCORE indicates that the better the company is valued in terms of efficiency in emissions management,

the higher its ratio of profitability to ROA. The negative relationship with the performance of the carbon PCC indicates that when it increases, the ROA and ROE decrease, showing that the emissions generated or the level of sales must be taken care of so that when the relationship between emissions and sales increases, there is no reduction in the profitability of the organizations.

Table 5. Non-sensitive industries model.

Variable	ROA				ROE				ROS			
	Fixed_s0		Random_s0		Fixed_s0		Random_s0		Fixed_s0		Random_s0	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
SCORE	0.0195 (0.004)	0.0066	0.0170 (0.001)	0.0053	0.0473 (0.016)	0.0195	0.028 (0.063)	0.015	0.0149 (0.081)	0.0085	0.0122 (0.101)	0.0074
VEMI	-0.0113 (0.072)	0.0063	-0.0122 (0.040)	0.0060	-0.0311 (0.170)	0.0226	-0.035 (0.099)	0.021	-0.0062 (0.391)	0.0072	-0.0066 (0.335)	0.0068
PCC	-0.0217 (0.012)	0.0086	-0.0172 (0.038)	0.0083	-0.0368 (0.166)	0.0265	-0.041 (0.037)	0.020	0.0132 (0.476)	0.0185	0.0079 (0.605)	0.0152
GRI	-0.0093 (0.181)	0.0069	-0.0093 (0.122)	0.0060	-0.0149 (0.506)	0.0223	-0.015 (0.406)	0.018	-0.0065 (0.407)	0.0079	-0.0071 (0.311)	0.0070
VPPE	0.0141 (0.060)	0.0074	0.0167 (0.020)	0.0072	0.0254 (0.436)	0.0325	0.037 (0.242)	0.031	0.0248 (0.039)	0.0119	0.0253 (0.031)	0.0117
GROWTH	0.0434 (0.000)	0.0104	0.0401 (0.000)	0.0103	0.1568 (0.000)	0.0384	0.150 (0.000)	0.036	0.0279 (0.056)	0.0145	0.0334 (0.024)	0.0148
SIZE	-0.0331 (0.000)	0.0065	-0.0287 (0.000)	0.0028	-0.0668 (0.001)	0.0206	-0.063 (0.000)	0.008	-0.0046 (0.562)	0.0079	-0.0129 (0.001)	0.0039
LEV	-0.0849 (0.001)	0.0243	-0.0618 (0.001)	0.0183	0.3587 (0.000)	0.0904	0.370 (0.000)	0.058	-0.0976 (0.000)	0.0269	-0.0949 (0.000)	0.0226
SHARE	0.0061 (0.000)	0.0006	0.0067 (0.000)	0.0006	0.0206 (0.000)	0.0025	0.022 (0.000)	0.002	0.0090 (0.000)	0.0008	0.0092 (0.000)	0.0008
COMMON			0.0112 (0.083)	0.0065			0.040 (0.032)	0.019			0.0088 (0.350)	0.0094
_cons	0.6032 (0.000)	0.1072	0.5223 (0.000)	0.0441	0.9089 (0.009)	0.3442	0.919 (0.000)	0.118	0.188 (0.151)	0.131	0.330 (0.000)	0.064
R2	0.3026		0.2992		0.1923		0.191		0.303		0.301	
Firm	259		259		259		259		259		259	
N	1612		1612		1612		1612		1612		1612	
Chi ²			367.01 (0.000)				239.39 (0.000)				372.64 (0.000)	
F	12.65 (0.000)				9.06 (0.000)				17.91 (0.000)			

$p < 0.1$ numbers in bold.

Based on the p -values of the F and Chi2 statistics, it can be said that the variables included work to test the model's hypothesis, which is significant and representative in both forms of estimation (random and fixed). For the F statistic, it is 10.79 for the ROA, 10.67 for ROE, and 9.15 for ROS, which is significantly representative in all cases. Likewise, the Chi2 statistic is also statistically significant, as it is equivalent to 258.36 for the ROA, 339.74 for the ROE, and 158.31 for the ROS. Likewise, we can say that the model explains the relationship between the variables included, since the R2 is equal to 37.47% under fixed effects in the case of ROA and 36.70% under random effects. In ROE, the value of R2 under fixed effects is 27.44% and 19.50% under random effects. On the other hand, it is equal to 32.90% for the ROS in fixed effects and 32.50% in random effects.

Table 5 presents the model for companies that belong to a non-polluting sector. In this case, as in the previous scenario, carbon management has a more significant impact on asset performance (ROA), both for fixed and random effects, followed by ROE, while affecting at least one variable in the ROS. In general, PCC can be said to significantly and negatively affect the profitability in terms of ROA and ROE in this scenario. Under fixed effects, the variables related to carbon management have a significant impact on three measures (Score, Vemi, Pcc) for the ROA variable; the SCORE variable is the only one that positively and significantly affects the ROE and ROS in this type of estimate. In random effects, SCORE, VEMI, and PCC are significant for the ROA and ROE variables, and only the SCORE variable significantly and positively affects profitability in terms of ROS. Focusing on explaining ROA, which is the most impacted measure by carbon management in both estimates (fixed and random), SCORE positively and significantly affects profitability; that is, a higher score value increases the return on

assets—ROA. VEMI and PCC impact the ROA negatively and significantly, which means that higher emission levels reduce the profitability for VEMI and PCC.

Regarding GRI, it should be noted that the relationship is negative, since profitability is lower for those companies that report under these guidelines when compared to those that do not report under the same guidelines—that is, companies that report under GRI guidelines see their profitability decrease when compared to those that do not report under such guidelines. These results are significant and negative for the case of ROA and ROS in both estimations. Only in the case of random effects does GRI affect the Return on Equity (ROE). Like the above scenario, the models' R2 explains the relationship between the variables included in the model, representing approximately 30% for ROA and ROS and approximately 19% for ROE.

Upon the completion of the tests and as shown in Table 6, the variable related to profitability that is most affected in both scenarios is the ROA, then the ROE and the ROS. In terms of measures related to carbon management, the SCORE measure impacts profitability the most in a positive and significant way, while the PCC and VEMI variables negatively affect profitability measures when they are significant. Therefore, concerning scenario one (H1), it can be said that there is a relationship between carbon management and profitability. Therefore, the changes companies implement concerning their CO₂ emissions will affect the company's performance differently and in different proportions, as initially expected. In conclusion, if the variables related to the amount of CO₂ emissions that organizations emit increase, profitability will decrease. In contrast, if companies obtain a higher rating in their emission management practices, it will positively affect financial and economic profitability.

Table 6. Model variables results summarized.

Variable	SENSITIVE						NON-SENSITIVE						TOTAL	
	ROA		ROE		ROS		ROA		ROE		ROS			
	F1	R1	F1	R1	F1	R1	F0	R0	F0	R0	F0	R0		
SCORE		+						+	+	+	+	+	+	7
VEMI								-	-		-			3
PCC		-		-				-	-		-			5
			2		1			3	3	1	3	1	1	
ROA	2	3	3	8										
ROE	1	1	3	5										
ROS	1	1		2										
	4	5	6											

Total sum of the variables in both scenarios in bold.

Likewise, as can be seen in the previous results, non-sensitive industries show a more significant reaction to the interaction of the variables studied than companies considered to be more polluting (sensitive). Although sensitive industries would be expected to yield better results due to the regulatory, political, and social pressure they face in environmental terms, the results obtained are contrary to the literature [15,49]. Therefore, it could be said that non-sensitive industries show more significant aspects related to their managing of carbon emissions since they receive incentives to improve society's perception of them. They are also not held to a right image on account of the sector in which they are developing their economic activity [50,51].

4.2.2. Testing Hypothesis 2

To test hypothesis two (H2) and focus on the results obtained and synthesized in Table 6, we decided to analyze only the ROA measure, since it is the variable with the most significant impact on carbon management (although not presented in the results, estimates were made for the ROE and ROS

variables, but these did not show significant results, so it was decided not to include them in the body of the document). Therefore, this new model integrates the CERTIFICATE variable, which indicates whether a company has implemented a control system for their emissions and/or environmental management and seeks to identify whether or not having environment-related certifications affects the relationship between carbon management and financial performance. Table 7 presents the results of the model that integrates the CERTVEMI variable, which is itinerant; in this case, the variable of interest for the two scenarios (sensitive or non-sensitive) is estimated under the two methods (random or fixed effect).

Table 7. Presence of the itinerant variable.

Variable	ROA							
	Fixed_s1		Random_s1		Fixed_s0		Random_s0	
	Coef.	Std. Err.						
SCORE	0.00809 (0.322)	0.00814	0.0082 (0.276)	0.0075	0.0259 (0.002)	0.0081	0.0236 (0.000)	0.0063
VEMI	−0.0044 (0.697)	0.0114	−0.0058 (0.603)	0.0112	−0.0122 (0.064)	0.0065	−0.0127 (0.040)	0.0062
PCC	−0.0231 (0.024)	0.0101	−0.0204 (0.003)	0.0069	−0.0242 (0.010)	0.0093	−0.0226 (0.008)	0.0085
CERTIFICATE	0.0251 (0.097)	0.0150	0.0221 (0.075)	0.0124	0.0100 (0.473)	0.0139	0.0045 (0.651)	0.0100
CERTVEMI	0.0021 (0.030)	0.0010	0.0019 (0.017)	0.0008	0.0000 (0.078)	0.0000	0.0000 (0.838)	0.0000
GRI	−0.0221 (0.101)	0.0134	−0.0224 (0.060)	0.0119	−0.0134 (0.059)	0.0071	−0.0122 (0.052)	0.0063
VPPE	0.0572 (0.000)	0.0130	0.0536 (0.000)	0.0121	0.0327 (0.000)	0.0085	0.0344 (0.000)	0.0082
SIZE	−0.0123 (0.224)	0.0101	−0.0091 (0.017)	0.0038	−0.0265 (0.000)	0.0068	−0.0198 (0.000)	0.0028
LEV	−0.1478 (0.000)	0.0363	−0.1070 (0.000)	0.0261	−0.1189 (0.000)	0.0259	−0.0968 (0.000)	0.0196
COMMON			0.0125 (0.226)	0.0104			0.0143 (0.069)	0.0079
_cons	0.3788 (0.024)	0.1663	0.3020 (0.000)	0.0670	0.5079 (0.000)	0.1152	0.3940 (0.000)	0.0472
R2	0.2454		0.2423		0.1587		0.1557	
Firm	132		132		259		259	
N	1032		1032		1612		1612	
Chi ²			143.27 (0.000)				417.03 (0.000)	
F	5.96 (0.000)				8.67 (0.000)			

p < 0.1 numbers in bold.

In this case, it is interesting to see that the CERTIFICATE is significant and positive only for those companies that belong to a polluting sector. Similarly, when studying the variables CERTIFICATE and CERTVEMI, they are significant and positive for companies that are considered sensitive. This indicates that holding a certificate will positively affect a company's profitability. Therefore, companies belonging to a pollution-sensitive sector will have the advantage of an emission control system or will need to implement an environmental management system focused on carbon since this will benefit profitability directly—ROA.

Finally, upon reviewing the statistics in the model, the F statistic's values are 5.96 and 8.67, and the Chi² values are 143.27 and 417.03, which become a significant and concluding aspect that the results are reliable; thus, the variables under study are appropriate and therefore conclusive in the face of the relationships studied. Nevertheless, regarding H2, the significance of the variables under study are only given in non-sensitive industries.

4.3. Robustness Checks

This study's main objective is to show that there is a clear relationship between carbon management and financial and economic profitability in European companies. For this purpose, different carbon management-measuring and profitability variables were used to gain a complete view of the relationships present. Following Gallego et al. [28], we worked with panel data under random effects, since this provides more efficiency (the variation in the estimate is low) but is less consistent than the fixed effects model. In other words, random effects yield better results for the p -value because these estimators are more efficient. In this sense, the statistics were used to justify the choice of this model.

The model in equation (3) was calculated using two new measures, one that indicated the total variation in emissions from one year to another, that is, 2008 considers the 2007 variation, and 2009 considers that of 2008 and so on until we reach the 2017 variation corresponding to the 2016 data. This is totalized in the so-called variation in emissions (VAREM) and another variable under the same totalization method, which is based on the environmental performance variation as totalized in variation in carbon performance (VARPA). The logic behind these variables is to know whether they will affect profitability in future years; for example, the 2008 variation affects that of 2009–2010 and so on. Similarly, the CERTVA variable was included to learn whether a company's environmental certification had any impact on profitability when it was linked to gas emission variations (i.e., used as an itinerant variable or moderator variable in the model), since operating expenses (OPEX) were included as an additional control variable. In that way, the robust and integrated model with compound errors is:

$$\mathcal{FP}_{it} = \beta_0 + \beta_1 \text{VAREM}_{i(t-1)} + \beta_2 \text{VARPA}_{i(t-1)} + \beta_3 (\text{CERTIFICATE} \times \text{VAREM})_{i(t-1)} + \sum_{i=4}^n \beta_4 \text{CONTROLS}_{it} + \mu_{it}. \quad (3)$$

As presented in Table 8, carbon management does impact profitability, which is highly significant for the three parameters considered. A vital factor to consider is the measure related to environmental performance, since this impact is negative when there is a variation, maintaining the same effect as the previous model. The company should consider this measure, since it relates accurately to an indicator of the company's internal emissions management. It can also be seen that when environmental performance rises by one unit (ton/euro) in the previous period, the return on investment decreases by approximately €0.06 in the case of ROA and ROS, and profitability decreases by €0.18 *ceteris paribus* in the case of ROE. If the VARPA variable grows from one period to another, the profitability will decrease because the relationship between the environmental performance variation and the profitability studied is inverse.

The CERTVA variable is only significant and negative for the ROA in fixed-effects scenarios, which is why conclusions about the importance of holding an environmental certificate may not be drawn. It is also important to acknowledge that the companies whose country is governed by a common-law system will see their profitability positively affected. For all measures, it is equally significant that companies are based in countries without a civil code, and this positively affects profitability.

In general, the changes in the model reaffirm the relationship between carbon management and profitability in European Union-based companies. This is important to consider since the data helps assert that handling carbon emissions affects companies. This issue must be addressed in-depth and not only at the research level but also by companies and policymakers.

Table 8. Variation in gas emissions and environmental performance.

Variable	ROA_fe		ROA_re		ROE_fe		ROE_re		ROS_fe		ROS_re	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
VAREM	0.0622 ***	0.016	0.054 ***	0.016	0.1966 ***	0.04842	0.181 ***	0.047	0.0760 **	0.03018	0.077 **	0.03033
VARPA	−0.0631 ***	0.009	−0.060 ***	0.009	−0.1805 ***	0.02967	−0.177 ***	0.028	−0.0622 ***	0.01227	−0.064 ***	0.01198
CERTVA	−0.0291 ***	0.015	−0.012	0.015	−0.0702	0.04594	−0.062	0.045	−0.0305	0.02759	−0.031	0.02776
GRI	−0.0144 **	0.007	−0.011 *	0.006	−0.0142	0.0191	−0.014	0.015	−0.0154 *	0.00898	−0.015 **	0.00782
VPPE	0.0293 ***	0.008	0.029 ***	0.008	0.0883 ***	0.02927	0.092 ***	0.028	0.0558 ***	0.01243	0.056 ***	0.01192
LEV	−0.1511 ***	0.023	−0.113 ***	0.017	0.1316 *	0.07338	0.239 ***	0.047	−0.2071 ***	0.03285	−0.156 ***	0.02459
OPEX	7.43×10^{-10}	0.000	0.000 ***	0.000	2.04×10^{-9}	1.57×10^{-9}	0.000 *	0.000	0.000 ***	7.23×10^{-10}	0.000 ***	4.47×10^{-10}
SIZE	−0.0291 ***	0.007	−0.020 ***	0.003	−0.0452 **	0.02177	−0.031 ***	0.009	0.0196 **	0.00982	0.025 ***	0.00519
COMMON			0.017 **	0.007			0.059 ***	0.018			0.016 *	0.00909
SENTITIVE			−0.011 **	0.005			−0.022	0.013			0.005	0.00881
_cons	0.6753 ***	0.111	0.506 ***	0.052	0.9449 ***	0.34014	0.659 ***	0.138	−0.0025	0.15747	−0.117	0.08055
R2	0.2075		0.2026		0.1187		0.1161		0.166		0.1617	
N	2355		2355		2355		2355		2355		2355	
Rho	0.7162		0.6291		0.589		0.4962		0.7456		0.6948	

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

5. Discussion and Conclusions

This study was conducted as a mechanism to contribute to academic and research discussions regarding the relationship between carbon management and the financial performance of organizations. Although the research on this relationship is recent, studies are not conclusive in this regard. Our study's contribution is to show different measures for both dependent and independent variables to contribute to accounting, organizations, and research topics. A unique feature of this work is how carbon management systems can reduce gas emissions and increase profitability.

Companies that abide by the Kyoto protocol have made corporate efforts to comply with environmental agreements, some of which are focused on environmental and economic performance affairs and prefer to make short-term decisions to minimize CO₂ emissions [52]. Therefore, carbon emissions represent a critical factor for corporate performance. For this, the study outlines how European Union companies consider carbon management aspects within their environmental management schemes, which in turn impacts financial performance.

As Schaltegger and Csutora [19] put it, reducing emissions and carbon management are external measures that could provide an insight into the internal behavior of the change at hand. Therefore, this document used different measures to recognize the influence of carbon management on financial performance. The Score, Vemi, and Pcc measures make up carbon management in the primary model, while VAREM and VARPA do so in the robustness model. These measures, as a whole, have been incorporated in this study as novel variables, and clearly are a fundamental contribution from this work. In terms of financial performance, profitability measures such as ROA, ROE, and ROS were used.

At a general level, the Score measure, a variable introduced as a fundamental contribution in this study, impacts profitability, especially in non-polluting industries. Its positive and significant relationship with the ROA, ROE, and ROS clearly shows that this rating, which measures the company's commitment and effectiveness in reducing environmental emissions in its operational and production processes, has become the most highly valued of the beneficial spinoffs on profitability.

The Pcc variable, a ratio related to carbon performance, negatively affected the ROA and ROE estimated under random effects for companies belonging to sensitive and non-sensitive industries. Considerable efforts have been made to address greenhouse gas emissions in recent years due to the problems caused by global warming [44]. In this regard, we can say that if CO₂ emissions increase, it will negatively affect the firm's profitability. Therefore, it is a factor to take into account in terms of environmental performance and corporate management.

The Vemi variable shows us that it negatively impacts the ROA and ROE measures in non-sensitive companies. Therefore, annual emissions will have a more significant effect on profitability than on revenue from resources or investment. This is something that must be evaluated internally by the organization. Although different authors argue [10,53–55] that reducing emissions can bring about competitive advantages from the regulatory point of view, it can affect a company's cost-benefit ratio. Thus, adopting environmental regulations—in this case, the Kyoto protocol—will affect profitability, especially in those companies that belong to a non-polluting sector.

Let us return to the first research question: does carbon management impact profitability in connection with organizational performance? Our study shows that not only is there a relationship between carbon management and performance, but it also affects financial performance depending on the measure under analysis. Additionally, we cannot conclude the existence of a single impact since their impact on profitability depends on performance (external or internal), as explained above. Therefore, the results support a relationship between carbon management and performance, especially influencing the ROA, and the ROE and ROS to a lesser extent. This evidence implies that environmentally friendly behavior related to CO₂ reduction is worthwhile for companies that seek to improve their profitability, especially for those in a non-polluting sector.

When the presence of the variable related to the EMA was analyzed, the effect of the interaction is representative only in sensitive industries, impacting positively and significantly on the ROA. When involving the aspects of the management control system, the impact is more prominent in

polluting industries since the results of the study show a positive and significant relationship in this case. In this regard, the companies' internal performance in connection to the environment could provide a competitive advantage, as stated by Porter and Vanderlinde [55]. Furthermore, they argue that pollution is often a form of economic waste. The authors state that companies must learn to frame environmental improvement in terms of resource productivity; in this sense, environmental improvement and competitiveness come together.

The Certificate and Certvemi variables, when significantly and positively related to the ROA measure, show that environmental factors can affect profitability and financial status, and also bring about other incentives based on the regulation to implement these systems [25]. Likewise, companies that adopt an environmental management system do reduce negative environmental impacts [56]. Therefore, implementing this type of mechanism can bring on great benefits for companies, as the results have shown.

Next on, we will examine the second research question: do emission-controlling entities using EMA show higher profitability than non-controlling entities? The presence of EMA in organizations only impacts those companies that belong to polluting sectors, which occurs when related to the variation in emissions. The evidence at hand is only preliminary, wherefore future studies need to delve deeper into the impact of carbon management on the firm's stocks and also intensify the benefits of implementing carbon management and control systems.

The robustness analysis allows us to conclude that the effects on profitability depend on the measure used. Variation in emissions (VAREM) positively and significantly affects all financial performance measures, but when compared to the variation in carbon performance (VARPA), its effect is negative and significant. This shows, in a certain way, that internal and direct variation in emissions impact profitability better than the measure that assesses carbon performance. There is the perception that changes affect profitability; however, companies must review any environmental performance measures they put in action since they negatively affect performance in the different scenarios presented. Likewise, the most impacted measure is the ROA, which, in turn, is the most widely used in the literature. Furthermore, we have also examined the impact on measures such as ROE and ROS, thereby contributing to the research in this field, which should be broader in future studies.

The study has some limitations, which in turn are future research opportunities. One limitation of these findings is that the published and synthesized data came from a single database. Although we originally intended to have comparable data to make comparable measurements, it is clear that this may prompt some restrictions. Another limitation in the data itself is the loss of information when trying to obtain an economically clean database—i.e., with missing data or values whose measurements are not logical. Additionally, there are limitations in the CO₂ data, since we worked with the final number—that is, the data on carbon emissions recorded in the annual reports without knowing the internal investment processes, technological changes in production processes, or any other method to control and reduce the emissions. On the other hand, another limitation is not being able to observe internal practices and elaborate on the impact of environmental management systems and other emission-reducing mechanisms on companies' economic and environmental performance.

Furthermore, we highlight the need to analyze how profitable a company is in relation to its total assets to see what factors, including profitability, affect carbon management and returns. Another line of study is to compare the results obtained in other economies that are not as invested and lack control over aspects related to climate change, such as non-signatory countries of climate agreements or countries without a robust legal scheme in this regard. Indeed, further studies should explore the impact of environmental certifications as a measure of legitimacy or as an aspect that highlights a firm's real concern for the environment, especially in reducing greenhouse gases. Finally, it is necessary to highlight the contribution of this work concerning the participation of the variable related to the recognition of an EMA or the like in organizations. While this may be considered a minor aspect in the literature, in general terms, further research in this area could make significant contributions to the organizational and academic fields.

Author Contributions: Designed the research, collected the data, processed the data, developed the model for analysis, analyzed the simulated results, wrote the paper, and checked the results, Y.N.T.; provided comments and review suggestions, C.C.S. and V.R.F. All authors have read and agreed to the published version of the manuscript.

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Appendix A

Table A1. Definition of variables and measurement.

<u>DEPENDENT VARIABLE</u>			
Nomenclature	Variable	Definition	Measure Variable
ROA	Return on Asset	Profitable a company is relative to its total assets	EBIT/Total Asset
ROE	Return on Equity	Profitability on own resources	EBIT/Capital
ROS	Return on Sales	Profitability on sales - productivity	EBIT/Net Sales
<u>INDEPENDENT VARIABLE</u>			
Nomenclature	Variable	Definition	Measure Variable
SCORE	Score Emission	The Emission Reduction Score measures a company's commitment and effectiveness towards reducing environmental emission in the production and operational processes. 22 Indicators in Rating	Emission score Thompson
EMISSION	Emission	Report the company in tons the one-year emission	Emission ton (Em)
VEMI	Variation of emission	It is the variation of the one-year emission	$Em(t) - Em(t-1)/Em(t-1)$
PCC	Carbon performance	Measures the relationship of the emission level with sales or operational income	Emission/Sales
VAREM	Variation of emission	Consolidated variations of the emission per year	$Vemi2008 = ((emission-em_1)/em_1)$ if year==2007 $Vemi2009 = ((emission-em_1)/em_1)$ if year==2008 $Vemi2017 = ((emission-em_1)/em_1)$ if year==2016
VARPA	Variation of carbon performance	It is Consolidated variations of carbon performance per year	$Vpcc2008 = ((pcc-pcc_1)/pcc_1)$ if year==2007 $Vpcc2009 = ((pcc-pcc_1)/pcc_1)$ if year==2008 $Vpcc2017 = ((pcc-pcc_1)/pcc_1)$ if year==2016
<u>OTHER VARIABLES</u>			
Nomenclature	Variable	Definition	Measure Variable
GRI	Lineaments of GRI	If the company reports under the guidelines of the GRI (Global Report Initiative)	1 = Yes 0 = No
VPPE	Variation at PPE	The company has had the variation in ownership of plant and equipment. Change in fixed assets	$PPE1 - PPE(T-1)/PPE(T-1)$
SIZE	Size of the company	It establishes the size of the company in relation to the total of its assets	Ln asset
LEVERAGE	Total debt	It measures the level of leverage of the company.	T.Liabilities/T.Asset
COMMON	Legislation of the country	If the country has a Common or Civil Law system.	1 = Common 0 = Civil

Table A1. Cont.

OTHER VARIABLES			
Nomenclature	Variable	Definition	Measure Variable
CERTIFICATE	Certificate	If the company have an environment certification or ISO 14001	1 = Yes 0 = No
SENSITIVE	Sensitive of company	It establishes if the industry / sector is part of a sector sensitive to being polluting	1 = Yes 0 = No
OPEX	Operating expenses	Operating expenses reported by the company each year	Operating expenses
GROWTH	Growth of the company	Growth of the company with respect to sales	(sales-sales_1)/sales_1)
SHARE	Market share of the company	It's related to the market share of the company in relation to the industry to which it belongs.	(tinc_emp/tinc_sec)*100

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