Does reducing carbon emissions affect business profitability? An analysis of family and non-family businesses

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Abstract

With regard to greenhouse gas (GHG) emissions, this article addresses the question of whether it is more profitable to be an environmentally friendly company or one that ignores recommendations to limit GHG emissions. The academic discussion has an additional interest when applied to the field of family businesses, integrating the Sociemotional Wealth (SEW) perspective, through which family businesses have been shown to have better environmental performance than their non-family counterparts. The data used in this paper were obtained from the Carbon Footprint Register created by the Spanish Ministry for Ecological Transition. This information was complemented with financial data of manufacturing companies from the Iberian Balance Sheet Analysis System (SABI) database. The methodology consisted of developing a regression model in which the GHG emissions released into the atmosphere are related to the type of ownership of the company and to other variables that characterise each company in the sample. In the end, the results show that GHG emissions are negatively associated with the level of ROA, which means that reducing a company's emissions contributes to improving its economic performance. The results also show that family ownership of the organisation has a significant negative influence on total emissions, from which we conclude that there are economic benefits to be gained from environmental investment by family businesses. The recommendation for policy makers is that regulation can push companies towards an effective carbon reduction strategy and encourage financial market recognition of low carbon companies.

Keywords: greenhouse gas emissions, manufacturing companies, family businesses, environmental performance, economic performance.

1. Introduction

The main driver of climate change is the greenhouse effect, whereby some gases in the Earth's atmosphere act like a greenhouse, trapping heat from the sun and preventing it from escaping into space, causing global warming. The CO2 produced by companies is the main factor responsible for global warming. By 2020, the concentration of CO2 in the atmosphere had risen to 48% above pre-industrial levels. Around the world, countries such as the European Union and organisations such as the United Nations are aiming to

reduce overall carbon emissions (Van Emous et al., 2021). The EU aims to reduce carbon emissions by at least 40% by 2030 (European Commission, 2022).

Companies have a leading role to play in achieving this goal of reducing emissions. According to the latest report of the United Nations Global Compact (UNGC), Spain has a growing number of companies committed to the fight against climate change Compromiso RSE (2022). The UNGC report analyses the sustainability progress reported by companies that have signed up to the initiative. According to the report, almost 87% of the companies surveyed include actions related to climate change in their strategy (CSR Commitment, 2023). In general, investment in emission efficiency is one of the solutions to the problem of GHG pollution adopted by companies, observing the existence of a relationship between the investments associated with eco-efficient commitments and the financial economic profitability of companies (Pérez-Calderón et al., 2021).

In particular, family businesses (FBs) pay great attention to the environment and demonstrate that they care about the situation, and FBs have unique characteristics that differentiate their governance, structures and behaviour from non-family businesses (Claub et al., 2022). FBs tend to be more principled and have long-term investment objectives because they are less constrained by shareholder accountability pressures than non-family businesses (Miller et al., 2006). In addition, FBs have the potential, resources and market position to lead sustainable change in the key global sectors they dominate. Indeed, it is noteworthy that more than a fifth of the global shipping industry is run by a handful of family businesses. In the automotive industry, just 36 families control companies that account for 55% of the total global market. Large FBs also dominate many other sectors such as clothing retailing, engineering and construction (Englisch, 2021). The widespread presence of FBs in a variety of activities represents a major opportunity for positive change in limiting GHG emissions.

This research is focused on the carbon emissions of firms and the influence on their economic profitability, for which it establishes a relationship between GHG emissions and the type of ownership of the firm. FBs aim to protect a legacy for future generations, coupled with the belief that the family's reputation is closely and inextricably linked to the success and reputation of the company (Chrisman et al., 2012; Naldi et al., 2013). Upholding a good name and reputation encourages many family firms to protect environmental, social and governance (ESG) elements across industries and geographies (Sun et al., 2023).

The data used were obtained from the Carbon Footprint Register (Spanish Ministry for Ecological Transition, MITECO), according to the Carbon Footprint (a measure of the number of tonnes of CO2 emitted per year), a concept adopted and certified by the Carbon Trust (2008), based in the UK. This measure calculates all the GHGs emitted by an organisation or company. In our research, these data are supplemented with financial data obtained from the balance sheets and profit and loss accounts of the manufacturing companies from the SABI database.

The question is whether it pays to be an environmentally friendly company or whether it is more advantageous to ignore the recommendations and not become a green company (i.e. one with a green business model and a commitment to environmental responsibility). The literature is mixed. For example, there are authors who find that the most polluting companies are in a better financial position; the reason being that being green requires investments that are not certain to be recouped through a company's productive activity (Busch et al., 2022). Other authors have found evidence that companies with lower

emissions have better financial performance (Gallego-Álvarez, 2015), Likewise, other authors find that corporate carbon emissions have a negative relation with the market value of equity (Saka and Oshika, 2014; Desai and Raval, 2022). Certainly, compliance costs and reputational risks increase the credit risk of carbon-intensive companies by creating contingent liabilities. In this respect, FBs show a commitment to continuity with subsequent generations, which forces them to avoid such risks (Sun et al., 2023). In our study, we introduce the moderating effect that operates in FBs compared to non-family businesses from the perspective of Socio-Emotional Wealth (SEW). Some authors argue that the protection of this SEW leads FBs to have better environmental performance than their non-family counterparts (Berrone et al., 2010). For this reason, we have adopted an approach that aims to deliver results for FBs compared to other businesses.

Our study contributes to the progress made on the influence of carbon emissions on return on assets (ROA). The distinguishing characteristic of this study is that it approaches the problem from an accounting perspective, distinguishing between the family and non-family nature of the companies. This means that from the accounting data of SABI base, the influence of CO2 emissions on profitability ratios is observed together with financial characteristics that are introduced into the model as control variables, such as: sales figure, financial leverage, total assets and others. This approximation provides a more realistic picture of the real impact of carbon emission reductions on profitability and consequently on business continuity.

To this end, we developed a regression model that relates the GHG emissions released into the atmosphere to the type of ownership of the company and other variables that characterise the companies in the sample. Our results show that GHG emissions are negatively associated with the level of ROA, which means that reducing a company's emissions helps to improve its ROA. The results also show that family ownership of the company has a significant negative impact on total emissions. These results confirm the more environmentally responsible behaviour of FBs compared to non-family businesses, and a positive relationship between this behaviour and economic profitability, from which we conclude that there are economic benefits to be gained from environmental investment by FBs.

The rest of this paper is structured as follows: Section 2 discusses the relevant literature that allowed us to formulate the working hypotheses. Section 3 explains the data and methodology, while section 4 interprets the results. Finally, section 5 draws conclusions and offers recommendations to those who have to take decisions in the field of carbon emissions, such as policy makers.

2. Literature review and hypotheses development

Little is known about the influence of family ownership and management on the social and environmental performance of businesses. Improving sustainability through the simultaneous pursuit of economic, environmental and social goals has become a key requirement for FBs across industries and countries (Claub et al., 2022). Research shows that FBs are more socially responsible than non-family businesses on several dimensions. This is likely due to family concerns about image and reputation and the desire to protect family wealth (Dyer and Whetten, 2006).

Some scholars have suggested that FBs are unlikely to act in a socially responsible manner (Craig and Dibrell, 2006), while others have pointed out that socially responsible behaviour by the FBs protects the family's wealth and their reputation (Berrone et al.

2010). This negative effect is more pronounced in primary studies that measure environmental performance in terms of the environmental operational practices adopted and in those that define the FBs in terms of family ownership and management (Miroshnychenko et al., 2022).

The mixed empirical evidence as to whether the effect of corporate environmental investment on financial performance is positive, negative or insignificant has been explained in terms of the different conditions and contexts that facilitate or hinder the ability to generate a profit situation. This explanation has gradually led the academic debate to consider the factors and conditions that moderate such a relationship (Gárces-Ayerbe et al., 2021).

Previous research has found that the positive effect of family ownership on environmental performance persists regardless of whether the CEO is a family member or serves as both CEO and chairman of the Board (Berrone et al., 2010). Sun et al. (2023) used stock market data to test shareholder reaction to the adoption of social, environmental and governance (ESG) criteria and found that both family ownership and control are positively related to ESG fundamentals, but that market competition negatively moderates family influence on the adoption of ESG criteria. From the previous studies, the relationship between the ownership of the company and its environmental behaviour is intuitive, so we introduce the component of the company being family or non-family in the belief that the characteristics of the family business moderate the value placed on the environment, and we establish the second hypothesis of this study, which takes into account the family ownership of the company.

H1. Family businesses are more environmentally friendly, which results in lower GHG emissions.

Meeting the expectations of society and the other stakeholders of organisations regarding the impact of business activities on climate change must go hand in hand with the necessary economic and financial viability (Pérez-Calderón et al. 2021). Given the importance of this issue to society, the relationship between carbon emissions and financial performance has been studied before, with mixed results. Some papers found that companies that are unconcerned about carbon emissions outperform companies with lower emissions (Busch et al., 2022; García-Sánchez et al., 2020, Thomas 2001). The environmental impact of business activities is strongly related to the technology that companies use in their production processes (Teece, 2010; Kneller and Manderson, 2012; Przychodzen and Przychodzen, 2015), and it is unclear to what extent it is economically beneficial for companies to invest in new technologies that lead to lower GHG emissions. Delmas et al. (2015) showed that going green reduces a company's profitability in the short-term, but compensates for this in the long term. This reduction in short-term profitability may affect managers' decision making due to short-term performance goals. However, Lewandowski (2017) found evidence that companies with lower emissions have better financial performance in the long run. In a similar way, other papers found a positive relation between reduction of GHF and financial performance (Gallego-Alvarez et al., 2015; Misani and Pogutz, 2015; Iwata and Okada, 2011; Wagner, 2015). This positive relation suggests that a prevention approach entails competitive advantages that increase demand and improvements in productivity (Nishitani et al. 2011). This is in line with the Porter hypothesis (Porter, 1991) according to which companies must be able to generate capacities and abilities to reduce GHG emissions and at the same time maintain both economic and financial benefits. Environmental performance is an opportunity for

firms because if they are able to adapt their operations to the requirements of reducing their environmental impact, they will become more competitive and improve their economic and financial performance (Porter and Van der Linde, 1995a, 1995b). Based on the above, we propose the following hypothesis:

H2. The reduction of GHG emissions has a positive effect on corporate performance as measured by return on assets (ROA).

3. Data and methodology

The data corresponding to the CO2 emissions of the companies were obtained from the Carbon Footprint Register. This register, which is voluntary, depends on the Ministry for Ecological Transition and Demographic Challenge (MITECO) of the Spanish government and is regulated by Royal Decree 163/2014. It is a tool that aims to promote the fight against climate change, thus contributing to the reduction of GHG emissions. The carbon footprint identifies the amount of GHG emissions released into the atmosphere as a result of the development of an activity. It makes it possible to identify all the sources of GHG emissions and, on the basis of this knowledge, to define effective reduction measures (Spanish Ministry for Ecological Transition and Demographic Challenge, 2020).

The companies included in the register have received a certificate of registration and the right to use a seal, which makes it possible to distinguish the level of participation of the company in the register and the achievements made in the attempt to reduce the carbon footprint. It is therefore assumed that the companies in the sample already have a certain level of environmental awareness, as demonstrated by their voluntary registration in the register.

The economic and financial data of the companies, as well as the information related to the type of ownership, were obtained from the Iberian Balance Analysis System (SABI) database, prepared by Bureau Van Dijk, which contains information on more than 2,600,000 Spanish and 800,000 Portuguese companies, including financial profiles of the companies, information on their activities, annual accounts and financial ratios.

The final sample is made up of all Spanish manufacturing companies that have voluntarily registered in the Carbon Footprint Register and provided information on their emissions for at least one year during the period 2014-2019. In total, the sample consists of 222 companies providing a total of 562 observations.

To explore the differences in carbon emissions between family and non-family businesses, the following regression model was estimated:

$$GHG\ emissions_{it} = \alpha + \beta_1 Family_{it} + \beta_{2-6} Control\ Variables_{it} + \varepsilon_{it} \quad \text{(Eq 1.)}$$

In equation 1, the following variables were taken as the dependent variable:

- Total GHG emissions (measured in tonnes of CO2): Total GHG emissions released into the atmosphere by an organisation as a result of its activities, both directly and indirectly. Due to its high variability, this variable has been taken in form of logarithm to minimise asymmetry.

Next, in order to check the robustness of the results, we also used as dependent variable two other proxies related to GHG emissions, taking into account whether they are directly

or indirectly generated as a result of the activity of the companies in the sample. These proxies are the following:

- Scope 1 + Scope 2 carbon footprint (in tonnes of CO2): GHG emissions from sources owned or controlled by the organisation, and indirect GHG emissions associated with the generation of electricity purchased and consumed by the organisation.
- Scope 3 carbon footprint (in tonnes of CO2): Emissions resulting from the organisation's activities but caused by sources owned or controlled by another company, and indirect GHG emissions associated with the generation of electricity purchased and consumed by the first organisation.

To distinguish between family and non-family businesses we focus on the control and management of the company, which has already been used in the literature on the decision to adopt ESG criteria or on carbon emissions by authors such as Sun et al. (2023) and Garcés-Ayerbe (2021). It is the family dummy, a dichotomous variable that takes the value 1 if the company is family owned and 0 if it is non-family owned. In classifying businesses as family-owned or non-family-owned, the definition proposed by the Family Business Institute (2015) was used. This definition is based on the percentage of capital controlled by the owner family, taking into account that it is inappropriate to apply the same percentage to all companies, since in companies with more dispersed ownership, it is not necessary to have such a high percentage of ownership to exercise control over the company (Sánchez-Pulido et al., 2022). Based on this consideration, the definition proposed by the Family Business Institute (2015) establishes that a company is considered a FB in the following cases:

- Dispersed ownership (no shareholder owns more than 50% of the capital). The company is classified as family-owned if any one person or family owns more than 5% individually or 20% collectively, and in addition the individual shareholder is a member of the board of directors, or there are shareholders with more than 20% of the capital who hold a directorship. Otherwise, the company is classified as non-family.
- Concentrated ownership structure (one shareholder owns more than 50% of the capital). The company is classified as family-owned if the family shareholder controls the ownership with a high percentage (50.01%) or if there are shareholders-directors with a shareholding of more than 50.01%. Otherwise, the company is classified as non-family.

We used the following control variables that are specific to the company:

Size (Ln Sales)

We define company size on the basis of turnover and assume that size influences the relationship between GHG emissions and profitability. In fact, large companies face higher pressures or social and political demands, as well as the monitoring and application of strict regulations; therefore, the larger companies are forced to take environmental responsibility, including the implementation of measures to limit carbon emissions (Deantari et al., 2019). Large companies face higher requirements or pressures to disclose carbon emissions because their operational activities generate large emissions, which makes large companies subject to public supervision (Deantari et al., 2019) and more likely to implement ESG practices (Sun et al., 2023). These observations led us to investigate the effect of firm size, and whether the benefits of environmental performance differ between large and small companies.

Variation in fixed assets

The change in fixed assets of the companies in the sample expresses the increase in investment in fixed assets and can lead to the reduction of GHG (Debbarma, 2022). This variable is related to the internal generation of resources and the existence of financial constraints at the time of obtaining these resources. Small companies and FBs resort to self-financing to a greater extent, probably because they have difficulties in carrying out capital increases and also because they are close to their credit limits; therefore, the execution of their investment projects depends to a greater extent on the generation of their own resources (Hernando et al., 2014). In terms of new investment projects, we expect the change in fixed assets to be significant. There are prospective studies where investments in climate action mean an increase in infrastructure that can open up economic and employment opportunities in the coming years (World Resources Institute, 2018). Therefore, we assume that the companies in our sample characterised by a high level of environmental concern will implement new eco-efficient investment projects.

Growth (Variation in Sales)

Sales growth can be influenced by actions taken by companies to reduce their carbon footprint. Integrating circular economy principles into the design of products and services, and engaging customers through marketing, are actions that convey an image of reputation and business innovation to the market, which can have a positive effect on sales (SBT, 2018).

Age (years since founding)

The age of the company has been shown to have a positive effect on carbon disclosure. That is, companies with more experience are more used to disclosing carbon emissions and participating in environmental protection is a way for the company to gain legitimacy (Solikhah et al., 2021). This greater knowledge of the company's reputation within the financial community leads the longest-standing companies to adopt policies that limit GHG emissions.

Leverage (calculated as Debt/Equity Ratio)

Companies with high levels of leverage have higher financial obligations to pay debt and interest. A high level of leverage can lead to a higher risk of default, threatening the continuity of the firm. The risk arises because the company with high leverage has a capital structure with higher debt and a high dependence on that debt (Hernando et al., 2014). A firm's default risk could be negatively affected by a lack of environmental sustainability (Eichholtz et al., 2019). Firms with higher environmental sustainability have lower regulatory risks, as they are less likely to be fined for environmental misconduct and are better prepared to adopt any regulatory changes in environmental matters (Höck et al., 2020).

Indeed, research has been conducted to determine whether the leverage of a company has a moderating effect on the relationship between environmental sustainability and credit risk premium. The results show that companies that are more sustainable have lower credit risk premiums along with higher creditworthiness (Dorfeitner et al., 2015). Investments to limit carbon emissions are likely to increase a company's leverage. However, these efforts do not prevent or control the risk of non-compliance with the company's obligations related to environmental protection regulations (Lewandowski,

2017). In a situation of capital scarcity, a company that decides to limit its carbon emissions will require a high level of debt to be able to make the necessary investments (Wang et al., 2022).

The relationship between profitability, GHG emissions, the type of ownership and the control variables was analysed using a panel data methodology. The Breusch-Pagan test was used to select the most appropriate regression technique. This has led us to reject the null hypothesis (X=27.19 p-value 0.0001), indicating that in this case that the Random Effects model is more appropriate for estimation than Ordinary Least Squares for estimation. Then we run a Hausman test to compare Random Effects Model and the Fixed Effects Model. According to this latter test, the model had some significant exogeneity issue with the unobserved error. Thus, the random-effects model is preferred in this case. Therefore, the results presented in this study correspond to this best-fit model. The estimation of these models was carried out using the statistical software package Stata.

To analyse the influence that GHG emissions exert on the performance of these companies, the following model was estimated:

$$Economic\ performance_{it} = \alpha + \beta_1 Total\ GHG\ Emissions_{it} + \beta_{2-6} Control\ Variables_{it} + \varepsilon_{it} \quad \text{(Eq. 2)}$$

Return on assets (ROA) was used in this equation 2 as a measure of business performance; it shows the return on the capital invested in the asset. ROA is calculated as earnings before interest and tax (EBIT) divided by total assets (Stickney et al., 2004). We use this variable as an approximation of the financial performance of the company, in line with other works in the field of environmental action research (Álvarez, 2012; Dixon-Fowler et al., 2013; Angelia et al., 2015; Garcés-Ayerbe et al., 2021).

4. Results

Descriptive statistics

Table 1 summarises the descriptive statistics corresponding to the variables used in the model.

In terms of total GHG emissions, the results show that the manufacturing companies registered in the Carbon Footprint Register were responsible, directly or indirectly, for the annual emission of an average of 493,714 tonnes of CO2 per company over the period 2014-2019. It can be seen that around 80% of the total GHG emissions generated are Scope 3 emissions, i.e., emissions resulting from the organisation's activities but occurring in sources owned or controlled by another organisation, with the exception of emissions associated with the generation of electricity purchased and consumed by the first organisation. It should be noted, however, that there are significant differences between the organisations included in the register, as evidenced by the high dispersion. This indicates that there are large differences between the amounts of GHG emitted by these companies.

Table 1. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
Total GHG emissions (in tonnes of CO_2)	493,714	5,742,868	0	86,158,033
Scope 1 + Scope 2 carbon footprint (in tonnes of CO_2)	96,842	744,710	0	11,005,389

Scope 3 carbon footprint (in tonnes of CO_2)	396,873	5,297,229	0	80,516,949
Return on assets (ROA)	0.0794	0.0967	-0.3820	0.9423
Family businesses	0.7064	0.4554	0	1
Size (Assets in thousands of euros)	165,088	986,137	44	12,673,609
Variation in fixed assets	0.23	1.97	-0.87	37.89
Growth (variation in sales)	0.11	0.41	-0.81	5.66
Age (years since its constitution)	30.61	17.91	1	118
Leverage	1.77	2.55	0.05	26.71

Regarding the characteristics of the companies included in the register, we observe that, on average, they were quite profitable throughout the period (7.94%). This is an idea echoed in previous research, which suggests that corporate virtue in the form of social responsibility and, to a lesser extent, environmental responsibility, is likely to pay off. (Orlitzky et al., (2003); Dixon-Fowler et al., 2013). However, the coexistence of companies with high economic returns and companies with negative returns is again observed. In terms of ownership, about 70% of these companies meet the criteria to be classified as FB, while the remaining 30% are classified as non-family businesses.

There are also significant differences in the size of the businesses, with both large manufacturing businesses and micro-enterprises included in the register. Nevertheless, the results show that, on average, the enterprises in the sample experienced significant annual growth throughout the period, both in terms of fixed assets (23% per year) and turnover (11% per year). The average age of the companies analysed throughout the study was around 30 years. As for the level of debt, it exceeds equity by about 77%.

A correlation matrix was used to test for multicollinearity of the model variables (see Table 2). As expected, there is a high correlation between the different Footprints, but this is not a problem as these variables do not coincide in any model. In general, the correlation between most variables is low and would not be significant as it does not exceed 0.4. At the same time, a higher correlation (0.72) is observed between sales and Scope 1+2 footprint. To complement the analysis of multicollinearity, the variance inflation factor (VIF) is also shown in Table 2. We can see that the VIF is below 2.5 in all cases, meaning the results are not biased due to mulicollinearity (Sheather, 2009).

Table 2. Pairwise correlation matrix and Variation Inflation Factor (VIF)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	VIF
(1) ROA	1										
(2) LnTotal GHG	-0.0079	1									2.30
(3) LnScope1+2	-0.0094	0.9839*	1								
(4) LnScope 3	0.0201	0.5473*	0.4302*	1							
(5) Family business	0.0351	-0.2420*	-0.2213*	-0.1925*	1						1.10
(6) LnSales	0.1387*	0.7255*	0.7215*	0.3542*	-0.1979*	1					2.24
(7) Var. Fixed assets	0.0650	-0.0850	-0.0847	-0.0345	0.0125	0.0404	1				1.05
(8) Growth	0.1316*	-0.0979	-0.1211*	0.0763	-0.0005	-0.0996*	0.0716*	1			1.07
(9) LnAge	0.0224	0.3526*	0.3501*	0.0986	0.0066	0.4339*	-0.1790*	-0.2194*	1		1.54
(10) Indebtedness	-0.1536*	-0.0032	0.0006	0.0226	-0.0736*	-0.0822*	0.0531	0.0786	-0.2261*	1	1.20

*Significance at 1%

Regression results

Table 3 shows the influence of ownership type and other control variables on GHG emissions for total GHG emissions, those included in the Scope 1+2 footprint and those included in the Scope 3 footprint.

Table 3. Impact of family ownership on CO2 emissions

	Total GHG emissions		Scope 1+2 Footprint		Scope 3 Footprint	
	Coef.	z	Coef.	Z	Coef.	z
Independent variable						
Family business	-0.6798	-2.45**	-0.5204	-1.99**	-0.6737	-1.86*
Control variables						
Size	0.8808	11.95***	0.8633	12.34***	0.3846	3.86***
Var. Fixed Assets	-0.0129	-0.75	-0.0139	-0.82	-0.0053	-0.17
Growth	-0.2088	-2.25**	-0.2435	-2.65***	-0.0267	-0.16
Age	0.1906	1.15	0.1748	1.11	0.0115	0.05
Indebtedness	0.0530	2.10**	0.0535	2.16**	0.0348	0.83
Constant	-2.3886	-3.23***	-2.3752	-3.38***	-2.5490	-2.52**
Observations	562		562		562	
Wald Chi^2	221,27***		230.38***		26.49***	
R^2	0.551		0.5439		0.1448	

***, ** and * indicate significance at the 1 %, 5 % and 10 % levels, respectively.

For the general model, the results show that family ownership has a significant negative influence (at the 5% significance level) on the total GHG emissions released into the atmosphere by an organisation. These results are also confirmed in the subsequent models, when analysing its influence on the Scope 1 + Scope 2 footprint, which includes the company's most direct emissions, and also its influence on the Scope 3 footprint, which takes into account the emissions that are indirectly caused by the organisation's activities. The results therefore confirm that FBs are more environmentally responsible than non-family businesses.

Regarding the control variables, as expected, a direct and significant relationship was observed between GHG emissions and company size (at the 1% significance level), confirming that it is the larger companies that emit more GHGs into the atmosphere as a result of their activities. A significant relationship (at the 5% significance level) was also observed, but in the opposite direction, between sales growth and total GHG emissions. This relationship is also observed for the Scope 1 + Scope 2 footprint, but not for the more indirectly generated emissions (Scope 3). A significant positive relationship is also observed between a company's level of debt and its total GHG emissions (at the 5% significance level). On the other hand, no significant relationship is observed between the change in fixed assets and GHG emissions in any of its classifications.

Table 4 shows the relationship between GHG emissions and economic profitability for manufacturing companies registered in the Carbon Footprint Register.

Table 4. Influence of GHG emissions on economic profitability

	ROA

	Coef.	z
Independent variable		
Ln Total GHG emissions	-0.0043	-1.74*
Control variables		
Ln Sales	0.1597	4.06***
Var. in fixed assets	0.0028	1.72*
Growth	0.02563	3.09***
Ln Age	-0.0210	-2.76***
Indebtedness	-0.0084	-4.79***
Constant	0.0312	0.95
Observations	562	
Wald Chi^2	67.16***	
R^2	0.1390	

*** and * indicate significance at 1% and 10% level respectively.

Table 4 shows that GHG emissions have a weak and negative relationship (10%) with the level of economic profitability of companies. This suggests that reducing GHG emissions contributes to improving the profitability of companies.

Regarding the control variables, all of them show a statistically significant influence and with the expected signs. A positive influence on ROA is observed (at the 1% level of significance) from both the volume and the growth of sales, and a positive influence (at the 10% level of significance) from the growth of fixed assets.

On the contrary, a significant negative effect (at the 1% level of significance) on ROA is observed for both age and debt. It can be seen that the higher the level of debt, the lower the profitability giving the appearance of negative leverage. Reducing emissions requires an increase in debt, which is used to finance investments that limit carbon emissions. Therefore, a higher level of debt implies a limitation of carbon emissions. The companies in the sample, being environmentally aware, make the decision to invest with a long-term return, with the strategic priority of reducing GHG emissions. At the same time, older companies are found to be less profitable due to higher energy consumption as a result of being less active in energy efficiency measures.

5. Discussion and conclusions

This paper develops information on the relationship between carbon emissions and firm performance. In a review of previous studies in the literature on the same topic, we observe a trend change in the profitability of environmentally committed companies. For example, in a sample of US companies, Delmas et al. (2015) suggest that higher carbon emissions are associated with higher ROA. More recently, Busch et al. (2022) revisited this particular study and found inverse results for EU companies. It is not surprising that European firms' practices have evolved towards greater respect for the environment in the face of stricter regulation and greater influence on corporate reputation, and that this has led to an improvement in profitability measures. In this article, our results are also in the same direction, where GHG emissions are negatively associated with the level of profitability, but we also find that for the companies included in our study, GHG

emissions have an inverse relationship with family ownership. Keeping ownership and decision-making in the hands of the family reduces GHG emissions.

Investor behaviour appears to anticipate the potential long-term risks of high carbon emissions, with Busch et al., (2022) showing that the most polluting companies have lower Tobin's Q. These authors suggest that while reducing carbon emissions may initially hurt financial performance in the short run, it would pay off in the long run. More recent contributions to the literature claim that competitive advantages derived from environmental investments, corporate image, stakeholder relations, product quality or market share lead to better financial performance of companies (Garcés-Ayerbe, 2021). In the same vein, the results of our study show a negative relationship between GHG emissions and the level of ROA, which means that the reduction of these emissions in a company contributes to the improvement of its ROA. Within the sample, we have distinguished the family nature of the companies according to the differences arising from their own nature, grouped in their Socioemotional Wealth (SEW). Craig and Dibrell (2006) have shown that FBs are better able than their non-family counterparts to facilitate environmentally friendly business policies, which are associated with better business innovation and financial performance. These results refer to a general concept of environmental protection and financial performance, which is confirmed in our results when we circumscribe it to the phenomenon of GHG emissions. Indeed, our results also show that family ownership of the organisation has a significant negative effect on total emissions.

Thus, we have found empirical evidence confirming the more environmentally responsible behaviour of FBs compared to non-family businesses, and a positive relationship between this behaviour and economic profitability, from which we conclude that there are economic benefits to be gained from business family members investing in the environment. The policy implication of these findings is that there is a clear need for stricter climate regulations to achieve the goals of the Paris Agreement at the United Nations Climate Change Conference (COP21). Such regulations can encourage companies to develop and implement an effective carbon reduction strategy and promote the leverage effect of financial markets for a low-carbon economy.

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