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Greenhouse gas emission practices and financial performance

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Abstract

Purpose – The ambiguous effect of sustainable business practices on business financial performance is explained empirically as the result of the disparity of the practices analyzed, the inadequate relation proposed and the misspecification of the moderating variables. The purpose of the present study is to determine the effect that each of these factors can have as justification for the divergence of outcomes in previous studies.

Design/methodology/approach – Several dependence models have been estimated in order to observe the type of effect of greenhouse gas emissions (GHGE) practices on FP, attempting to establish whether this relationship is linear, positive or negative, or a curve. Additionally, the authors interacted these GHGE practices with the level of firms' innovation in relation to their competitors.

Findings – The results show that greenhouse gas emission controls have an inverse-linear effect on firm performance, independently of their level of innovation. This relationship is justified in that in contrast to previous articles, the authors have evidence of a null relationship between particular corporate social responsibility (CSR) practices and research and development expenses.

Originality/value – It is shown that it is the type of CSR practice observed and the business motives underlying it that is the determining factor of these divergences.

Keywords Greenhouse gas, Corporate performance, Financial performance, Environment, Corporate social responsibility, Social responsibility, Emission

Paper type Research paper

Introduction

The relationship between corporate social responsibility (CSR) and financial performance (FP) has been debated for decades without any unanimous conclusion having been reached, owing mainly to its complexity (Hull and Rothenberg, 2008, p. 781).

This complexity is basically a result of three factors:

(1) the lack of a definition of suitable measures of CSR, a term that has been formed by different elements that may have different effects on FP (Prado-Lorenzo *et al.*, 2008);

(2) the existence of an indeterminate linear (positive or negative) or non-linear relationship between them (Brammer and Millington, 2008); and

(3) the existence of a series of contingent variables that moderate the effect of CSR on FP (Fernández-Sánchez and Lun-Sotorrío, 2007; Hull and Rothenberg, 2008).

The objective of this study is to identify these factors and establish their behaviour. To do so, first the authors focus on one particular element of CSR which is becoming

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increasingly important: companies' efforts to reduce greenhouse gas emissions (GHGE). This particular element is considered because different aspects of CSR may be expected to be differently motivated and may accordingly have diverse implications for FP (Griffin and Mahon, 1997; Margolis and Walsh, 2003; Rowley and Berman, 2000; Brammer and Millington, 2008). This type of environmental behaviour was selected because of the importance of the effect of GHGE on the environment. Moreover, although governments and the public in general agree that climate change is happening and it is necessary for business to do something about it, the cost of reducing GHGE is quite significant and it could be higher than stakeholders' expectations. On the other hand, businesses have received enormous pressure from governments to comply with the 5 percent reduction in emissions to below the 1990 levels (as established in the Kyoto Protocol that expires in 2012) (Moomaw, 2007, p. 64).

Second, the authors considered the type of effect of GHGE practices on FP, attempting to establish whether this relationship is linear, positive or negative, or a curve. The latter possibility was observed in previous works such as those of Barnett and Salomon (2002) and Brammer and Millington (2008), among others.

Third, and in accordance with the results of Hull and Rothenberg (2008), innovation is a moderating factor of the CSR effect on FP. In this sense, the previous GHGE practices are interacted with the level of firms' innovation in relation to their competitors. Moreover, the authors analyze whether this effect is similar for the firms that developed environmental practices above the 80th percentile and below the 20th percentile of the industry's GHGE practices.

The study is structured in five additional sections. In Section 1, the authors briefly review the state of the art and the theoretical basis that enables us to establish hypotheses to be tested. In Section 2, the method is established. The results are shown and discussed in Sections 3 and 4, and the most important conclusions of the study are presented in Section 5.

1. The effect of CSR on FP

1.1 The shape of the relationship

A review of the different theoretical proposals on the relationship between CSR and FP offers arguments for a neutral, linear positive or negative and a curvilinear effect. Empirically, evidence has not clarified the effect of sustainable practices. While some researchers have found a negative relationship between CSR and FP (Wier, 1983; Bromiley and Marcus, 1989; Davidson *et al.*, 1987; Davidson and Worell, 1988), others have found an inconclusive relationship (Alexander and Buchholz, 1976; Abott and Monsen, 1979; Ingram and Frazier, 1980; Aupperle *et al.*, 1985). However, most research has found a positive relationship (Moskowitz, 1972, 1975; Sturdivant and Ginter, 1977; Bowman, 1978; Ingram, 1978; Fry *et al.*, 1982; Cowen *et al.*, 1987; Spencer and Taylor, 1987; Abratt and Sacks, 1988; Russo and Fouts, 1997; Griffin and Mahon, 1997; Waddock and Graves, 1997; Preston and O'Bannon, 1997; Simpson and Kohers, 2002; López *et al.*, 2007), but with presence of several diminishing returns that show a non-linear relationship (Barnett and Salomon, 2002; Brammer and Millington, 2008).

The neutral relationship is proposed by pure moral philosophy models that consider that the effect of CSR on FP could be positive or negative but that it is not the basis for action because companies bear a fiduciary responsibility to all stakeholders, not just shareholders (Freeman, 1984), and can make a substantial contribution toward

social betterment; however, their obligations are limited to areas of expertise and/or direct influence. Other proponents argue that corporations reap the benefits of serving as a community citizen and therefore owe a congruent contributory obligation to that community (Daly and Cobb, 1996; Korten, 1996); in other words, "it is the right thing to do" (Kang and Wood, 1995).

The negative linear relationship is defended from the point of view of the neoclassical economic model or shareholder capitalism (Prado-Lorenzo *et al.*, 2008). Under this paradigm, "the only responsibility of business towards society is the maximization of profits to the shareholders within the legal framework and the ethical custom of the country" (Friedman, 1970, p. 123). They expect a negative association between CSR and FP, since firms could face some competitive disadvantages (Aupperle *et al.*, 1985). They would be incurring costs that might otherwise be avoided or which should be borne by others (Waddock and Graves, 1997).

The positive linear effect is postulated by the hybrid models that consider that the incorporation of CSR can lead to differentiation and competitive market advantages for the firm, something that can form part of the brand for the present and future (Carroll, 1979, 1991). More specifically, business contributions can have a direct impact on both social welfare and a corporation's profits (Frank, 1996; Mohr *et al.*, 2001). Prado-Lorenzo *et al.* (2008) affirmed that, according to their arguments, the costs of CSR are minimal whereas the benefits may be potentially great. Within this perspective, firms design meaningful strategies that emphasize the importance of stakeholders' values.

The non-linear relationship between CSR and FP may be due to the fact that CSR practices are subject to diminishing returns (Brammer and Millington, 2008, p. 1327). Two alternative models are considered, the U-shaped and the inverted U-shaped effect ($\cap$).

The U-shaped relationship mean that:

> [...] improved sustainable practice that is associated with effective management of stakeholder relationships confers financial benefits, but if the scope and extent of corporate social responsiveness strays beyond stakeholder management to address social concerns that bear little or no relation to a firm's stakeholder relations, then improvements in social performance come to be associated with declining FP (Brammer and Millington, 2008, p. 1329).

The $\cap$-shaped effect is based on Porter's (1980) competitive advantage posture and indicates that firms that develop low or high (differentiation) corporate social practices outperform those firms that are stuck in the middle (Brammer and Millington, 2008, p. 1329).

1.2 The moderating effect of innovation

Previous studies, according to McWilliams and Siegel (2000, p. 603), suffer from several important theoretical and empirical limitations with the major concern being that they use models that are misspecified in the sense that they omit variables that have been shown to be important determinants of profitability, such as innovation.

Like CSR, innovation is a source of competitive advantage for a firm, a way to differentiate it from competitors. The interrelation between both differentiation practices, according to Hull and Rothenberg (2008, p. 783-4), could be synthesised in the following way:

- For high innovation companies, if innovation is essential to immediate survival, CSR may not have much effect on FP. On the contrary, if firms voluntarily innovate, then CSR, as a differentiation strategy, may have some impact on FP.
- For low innovation companies, CSR has an important effect on FP because it may still manage to differentiate the firm from its competitors in an industry.

1.3 The proposed analytical model for the impact of GHGE practices on FP

The adoption of the Kyoto Protocol by several important developing countries, and the pressure that several continents such as Europe are exerting over other countries such as the USA, have brought about an increase in the exigencies over business environment behaviour (Carbon Disclosure Project Report, 2007).

In general, the regulation of emission trading requires companies to develop organisational routines to deal with emission allowances and represent this new object in the firm's accounting system (MacKenzie, 2007). However, studies focusing on how companies learn about carbon markets, e.g. Engels (2009), have shown they have a low level of knowledge in relation to the costs of reducing CO_2 emissions, and in some cases, companies did not even assign explicit responsibility for emission trading and did not use internal or external sources of advice.

In this sense, it may be appropriate to think that companies have a limited interest in developing most GHGE friendly practices, especially considering that the costs of this reform are quite significant, with a potential negative or unclear effect on profit. Moreover, it could be logical to think that the efforts that companies have made in this sense are more in line with legal pressures than with voluntary action.

Thus, according to previous theoretical arguments, the relationship between GHGE practices and FP could be defined by a negative linear effect such us neoclassical authors have proposed. Therefore, the first hypothesis is proposed as follows:

H1. The significant short-term relationship between investment in GHGE control practices and firm performance has a linear effect.

Moreover, and it can be argued that, in general, the efforts are limited to legal requirements, the reforms of the process are not orientated to obtaining competitive advantages over competitors either by costs reduction or by differentiation.

Top innovation firms may develop GHGE control practices at some minimal level in order to prevent the negative consequences of inadequate behaviour (Miles *et al.*, 2002), so the effect of their GHGE behaviour has a null effect on performance. In contrast, top innovation firms that have not improved their emission controls could see a more negative impact on their profits.

On the other hand, it may be that several firms with low innovation levels try to differentiate themselves through environmentally friendly behaviour in order to boost their incomes. However, those low innovation firms that have not developed higher GHGE control practices may not see their performance penalized.

Thus, the following hypothesis is established:

H2. There is a short-term moderating effect of investment in innovation on the impact of GHGE control practices on FP.

H2.1. In those companies with higher innovation and GHGE control practices, the short-term moderating effect of innovation causes a non-significant relationship between GHGE control practices and FP.

H2.2. In those companies with higher innovation and lower GHGE control practices, the short-term moderating effect of innovation causes a more negative relationship between GHGE control practices and FP than the effect expected in *H1*.

H2.3. In those companies with lower innovation and higher GHGE control practices, the short-term moderating effect of innovation causes a non-significant or positive relationship between GHGE control practices and FP.

H2.4. In those companies with lower innovation and GHGE control practices, the short-term moderating effect of innovation does not cause a more negative relationship between GHGE control practices and FP than the effect expected in *H1*.

2. Method

2.1 Sample description

The population was comprised of the USA S&P 500 Index companies that received the Carbon Disclosure Project Questionnaire in 2007. These organizations have as their mission the creation of a rigorous database of corporate carbon emissions, seeking information on the business risks and opportunities presented by climate change and global GHGE.

The initial sample included 282 firms (56 percent) that answered the CDP5 survey. Owing to problems in defining the financial variables, the authors eliminated forms belonging to the financial industry and those whose financial statements were not available on the Forbes webpage.

The final sample consisted of 81 companies belong to different industries. In Table I, the frequencies for each of the industries are synthesised.

2.2 Variables

2.2.1 Dependent variable. According to previous studies analysing the determinants of FP, e.g. Fernández-Sánchez and Lun-Sotorrío (2007) and Andres *et al.* (2005), the authors use two alternative measures: an accounting ratio, return on assets (ROA), and a proxy of social performance, MtoB (market to book).

Sector	Frequency	
	Absolute	Relative (%)
Carbon intensive industry	45	55.55
Pharmaceutical	16	19.75
Hospital	7	8.64
Manufactures	8	9.88
Oil	10	12.35
Raw materials	2	2.47
Retail	14	17.28
Technological	15	18.52
Transport	1	1.23
Utilities	8	9.88

Table I.
Sample description

The former identifies the real economic and financial effects that GHGE control practices can lead to. The latter represents the stakeholders' valuation of the environmental sustainable practices developed by corporations.

These two variables are short-run calculated, concretely, for the last day of 2008 since environmentally sustainable practices are typically fixed cost investments (Hart, 1995), having physical asset properties that depreciate over several years (Russo and Fouts, 1997) and may bring financial benefits relatively quickly (Brammer and Millington, 2008).

2.2.2 Independent variables: GHGE practices and innovation. GHGE practices are measured by the Climate Governance Index, elaborated by the Carbon Disclosure Project for the year 2006, which evaluates corporate climate change activities in five main governance areas: board oversight, management execution, public disclosure, emissions accounting, and emissions reductions and strategic opportunities.

In order to observe a possible U-effect of GHGE control practices on FP (*H1* would be rejected), as several authors such as Brammer and Millington (2008) have defended, the quadratic form of these practices is considered.

The direct effect of innovation on FP is represented by R&D intensity (the three-year average R&D expenditures/sales), a variable traditionally used in previous articles, particularly since the work by McWilliams and Siegel (2000).

In order to analyze the moderating effect of innovation, the authors carried out the following steps to create four final dummy variables, considering the level of innovation and the percentiles used in previous works such us those by Fernández-Sánchez and Lun-Sotorrío (2007) and Brammer and Millington (2008):

(1) First, in order to identify high and low innovation companies, a dummy variable is created, HIGHINNO, which takes the value of 1 if the R&D intensity of each company is over the R&D-intensity-mean for each industry, and 0, otherwise.

(2) Second, the authors estimated the 20th and 80th percentiles of GHGE control practices for each industry. Then two dummies are defined as follows: HIGHGHGE which takes the value of one if the firm's GHGE control practices are above the 80th percentile and 0, otherwise; and LOWGHGE which takes the value of one if the firm's GHGE practices are below the 20th percentile and 0, otherwise.

(3) Third, the previous variables are interacted, which allowed us to devise four types of globally innovative firms, identified by four dummies:

- HIGHINNOHIGHGHGE which takes the value of 1 if companies are high innovators and implement GHGE control practices above the 80th percentile of the industry.
- HIGHINNOLOWGHGE which takes the value of 1 if companies are high innovators and implement GHGE control practices below the 20th percentile of the industry.
- LOWINNOHIGHGHGE which takes the value of 1 if companies are low innovators and implement GHGE control practices above the 80th percentile of the industry.

- LOWINNOLOWGHGE which takes the value of 1 if companies are low innovators and implement GHGE control practices below the 20th percentile of the industry.

(4) Finally, these last four dummies are interacted with the GHGE control practices in order to determine the moderating effect of innovation on the relationship between GHGE control practices and FP.

2.2.3 Control variables. The authors included as control variables a firm's size, risks and industry. Firm size is measured by its market capitalization, SIZE. Risks are identified by leverage (the ratio formed by short-term debt + long-term debt divided by total shareholders equity), LEVERAGE. The variable INDUSTRY is categorical and takes the values one to nine to identify the industrial classification according to Table I.

3. Results

3.1 Description of the statistics

Table II identifies the main statistics, mean and standard deviation, of the numerical variables proposed.

In Table III the authors show the bivariate correlations between the dependent, independent and control variables proposed for the empirical analysis. The variable GHGE control practices shows the highest correlations with the two dependent variables, ROA and MtoB, with a negative effect.

The correlations between independent and control variables are not significant indicating a lack of multicollinearity problems.

3.2 The shape of the relationship between GHGE practices and FP

In order to test the non-linear relationship between GHGE practices and FP, a U-shaped regression analysis (available in the statistical program SPSS) is estimated.

Table II.
Descriptive statistics

	Mean	SD
ROA	8.34	8.23
MtoB	2.54	2.12
LEVERAGE	2.76	1.26
SIZE	55.70	50.65
R&D intensity	1.67	1.22
GHGE control practices	41.36	17.62

Table III.
Bivariate correlations

	ROA	MtoB	LEVERAGE	SIZE	INDUSTRY	R&D intensity
LEVERAGE	− 0.15703176	0.15545466				
SIZE	0.20029217	0.0064197	− 0.11470297			
INDUSTRY	− 0.15483226	− 0.07006451	0.20462169	0.00948408		
R&D intensity	− 0.02948636	− 0.09828914	− 0.01822179	0.31147533	− 0.19214484	
GHGE practices	− 0.25196794	− 0.20134613	0.07775725	0.21289873	0.11693135	0.20852116

Table IV synthesizes the results obtained for GHGE practices for all firms, and GHGE practices for higher and lower innovation companies, respectively.

The only significant model, for a confidence level of 95 percent ($0.01 < p\text{-value} < 0.05$) is that which shows a negative linear relationship between GHGE control practices and ROA. The rest of the models proposed are statistically non-significant, so the potential U-shaped effect of this particular social practice on performance has been rejected. Moreover, the results may point to a null effect of GHGE practices on MtoB.

However, in order to test whether the previous results are biased by the misspecification of another set of variables that could be affecting the U-shaped relationship, two other models are estimated, including all the variables proposed for the analysis and the quadratic form of the GHGE practices variables.

The results obtained for the U-shaped models are shown in Table V. The authors have observed that the quadratic form of GHGE control practices has no effect on FP, so these results provide greater robustness to those obtained in the previous analysis.

In this sense, several linear regressions are estimated in order to solve the following models (1a) and (2a). The authors also proposed an alternative to them, models (1b) and (2b), in order to observe whether the GHGE control practices have a different effect in industries that are carbon intensive. On the other hand, the authors have indicated that in models (2a) and (2b) the variable ROA mean (mean of the ROA of the three previous years) is included because it is an important determinant of the companies' market value:

$$\mathrm{ROA} = \mathrm{B}_0 + \mathrm{B}_1\mathrm{size} + \mathrm{B}_2\mathrm{leverage} + \mathrm{B}_3\mathrm{industry} + \mathrm{B}_4\mathrm{R\&Dintensity} + \mathrm{B}_5\mathrm{GHGEpractices} + \varepsilon \quad (1a)$$

	Model summary		Estimation of the parameters		
	R^2	F	Constant	B_1	B_2
GHGE practices effect on ROA					
Linear	0.063	5.017**	12.709	−0.111	
Quadratic	0.063	2.474*	12.683	−0.110	-1.58×10^{-005}
GHGE practices effect on MtoB					
Linear	0.041	3.127*	3.622	−0.024	
Quadratic	0.041	1.543	3.669	−0.026	2.84×10^{-005}
GHGE practices effect on ROA in high innovation firms					
Linear	0.015	2.115	8.869	−0.038	
Quadratic	0.021	1.527	8.732	0.042	−0.001
GHGE practices effect on MtoB in high innovation firms					
Linear	0.015	2.169	2.760	−0.011	
Quadratic	0.016	1.126	2.748	−0.004	0.000
GHGE practices effect on ROA in low innovation firms					
Linear	0.002	0.348	8.363	0.000	
Quadratic	0.002	0.175	8.375	−0.001	2.61×10^{-010}
GHGE practices effect on MtoB in low innovation firms					
Linear	0.000	0.069	2.499	4.92×10^{-005}	
Quadratic	0.010	0.718	2.443	0.001	-1.30×10^{-007}

Note: Significance at: *p-value < 0.10 and **p-value < 0.05

Table IV.
Shape of the relationship between GHGE practices and FP

Variables	Dependent variable: ROA Model a B	*t*	Dependent variable: MtoB Model b B	*t*
Constant	–	*3.295* ***	–	1.360
SIZE	*0.472*	*2.851* ***	0.053	0.321
LEVERAGE	−0.021	−0.147	0.393	3.016***
INDUSTRY	−0.049	−0.356	−0.244	−1.862*
ROA mean	–	–	*0.510*	*3.523* ***
R&D intensity	−0.129	−0.782	−0.082	−0.534
GHGE control practices	*−1.085*	*−1.783* *	−0.832	−1.433
GHGE control practices × squared	0.713	1.190	0.555	0.966
	$R^2 = 0.272$		$R^2 = 0.400$	
	$F = 2.683$**		$F = 3.809$***	

Note: Significant at: *p-value < 0.10, **p-value < 0.05 and ***p-value < 0.01

Table V.
U-shaped models for effect of GHGE practices on FP

$$\begin{aligned}\text{ROA} =& B_0 + B_1\text{size} + B_2\text{leverage} + B_3\text{industry} + B_4\text{R\&Dintensity} \\ &+ B_5\text{GHGEpractices} + B_6\text{GHGEpractices*CarbonIntensityIndustry} + \varepsilon\end{aligned} \tag{1b}$$

$$\begin{aligned}\text{MtoB} =& B_0 + B_1\text{size} + B_2\text{leverage} + B_3\text{industry} + B_4\text{ROAmean} \\ &+ B_5\text{R\&Dintensity} + B_6\text{GHGEpractices} + \varepsilon\end{aligned} \tag{2a}$$

$$\begin{aligned}\text{MtoB} =& B_0 + B_1\text{size} + B_2\text{leverage} + B_3\text{industry} + B_4\text{ROAmean} \\ &+ B_5\text{R\&Dintensity} + B_6\text{GHGEpractices} \\ &+ B_7\text{GHGEpractices*} \quad \text{CarbonIntensityIndustry} + \varepsilon\end{aligned} \tag{2b}$$

The results obtained for the four linear models are shown in Table VI. They are quite similar to those obtained in previous estimations, suggesting a negative linear relationship between sustainable practices in GHGE and company performance as measured by the ROA. Again, these sustainability practices do not have a statistically significant effect on the market to book ratio variable.

Specifically, the model proposed to test the relationship between GHGE control practices and ROA (Equation (1a)) has an explanatory power of 24.80 percent for a confidence level of 95 percent ($0.01 < p$-value < 0.05). The variable GHGE control practices have a significant inverse effect on ROA for a confidence level of 99 percent (p-value < 0.01). The control variable SIZE has a significant direct effect for a confidence level of 95 percent. The rest of the proposed variables (LEVERAGE, INDUSTRY and R&D intensity) have a negative relationship with ROA although it is not statistically significant.

These results of the model in which the authors analyze whether the effect of GHGE control practices on ROA (Equation (1b)) is divergent for firms in carbon intensive industries in relation to the other companies, confirming that there are not any differences between them. The interactive variable between GHGE practices and carbon intensive industry has a positive effect but it is not statistically significant.

Model (2a), proposed to test the relationship between GHGE control practices and MtoB ratio has an explanatory power of 38.60 percent for a confidence level of 99 percent.

Table VI. Linear models for effect of GHGE control practices on FP

Variables	Dependent variable: ROA Model (1a) B	t	Model (1b) B	t	Dependent variable: MtoB Model (2a) B	t	Model (2b) B	t
Constant	–	*3.764******	–	*3.587******	–	0.959	–	*1.315*
SIZE	*0.433*	*2.656****	*0.432*	*2.599****	0.030	0.186	0.055	0.343
LEVERAGE	−0.051	−0.370	−0.052	−0.368	*0.377*	*2.918******	*0.366*	*2.876******
INDUSTRY	−0.035	−0.256	−0.031	−0.167	*−0.228*	*−1.753**	*−0.417*	*−2.336****
ROA mean	–	–	–	–	*0.494*	*3.436******	*0.518*	*3.640******
R&D intensity	−0.141	−0.858	−0.141	−0.835	−0.090	−0.589	−0.128	−0.841
GHGE practices	*−0.379*	*−2.796******	*−0.382*	*−2.337****	*−0.285*	*−2.233****	−0.144	−0.925
GHGE practices × carbon intensive industry	–	–	0.008	0.041	–	–	−0.296	−1.520
	$R^2 = 0.248$		$R^2 = 0.248$		$R^2 = 0.386$		$R^2 = 0.420$	
	$F = 2.909^{**}$		$F = 2.369^{**}$		$F = 4.296^{***}$		$F = 4.130^{***}$	

Note: Significant at: $^{*}p$-value < 0.10, $^{**}p$-value < 0.05 and $^{***}p$-value < 0.01

The variable GHGE control practices has a significant inverse effect on MtoB for a confidence level of 99 percent (p-value < 0.01). The control variables LEVERAGE and ROA mean have a significant direct effect for a confidence level of 99 percent, while the INDUSTRY categorical variable has a marginal negative effect for a confidence level of 90 percent ($0.05 < p$-value < 0.10). The variables SIZE and R&D intensity have, respectively, a positive and negative relationship with MtoB although they are not statistically significant.

These results of model (2b), in which the authors analyze whether the effect of GHGE practices on MtoB is divergent for firms in intensive carbon sector industries in relation to the other companies, showed similar results for control variables but the effect of GHGE control practices is not statistically significant. The interactive variable between GHGE control practices and carbon intensive industry also has a negative non-significant effect.

The results of the previous model allow us to reject *H1a* and to accept *H1b*, relating to the existence of a negative linear relationship between GHGE control practices and FP.

R&D intensity shows an insignificant negative short-term effect on FP. This null effect may be explained by the fact that these investments initially entail expenditures and have little effect on profits, but could have a positive effect on them in the long term.

3.3 The moderating effect of R&D on the relationship between GHGE control practices and FP

In order to analyse the moderate effect of innovation on the relationship between GHGE practices and FP, the following analytical models are proposed:

$$\begin{aligned} \text{ROA} = {} & \text{B}_0 + \text{B}_1\text{size} + \text{B}_2\text{leverage} + \text{B}_3\text{industry} + \text{B}_4\text{R\&Dintensity} \\ & + \text{B}_5\text{GHGEpractices} + \text{B}_6\text{GHGEpractices*HighInnoHighGHGE} \\ & + \text{B}_7\text{GHGEpractices*HighInnoLowGHGE} \\ & + \text{B}_8\text{GHGEpractices*LowInnoHighGHGE} \\ & + \text{B}_9\text{GHGEpractices*LowInnoLowGHGE} + \varepsilon \end{aligned} \tag{3}$$

$$\begin{aligned} \text{MtoB} = {} & \text{B}_0 + \text{B}_1\text{size} + \text{B}_2\text{leverage} + \text{B}_3\text{industry} + \text{B}_4\text{ROAmean} \\ & + \text{B}_5\text{R\&Dintensity} + \text{B}_6\text{GHGEpractices} \\ & + \text{B}_7\text{GHGEpractices*HighInnoHighGHGE} \\ & + \text{B}_8\text{GHGEpractices*HighInnoLowGHGE} \\ & + \text{B}_9\text{GHGEpractices*LowInnoHighGHGE} \\ & + \text{B}_{10}\text{GHGEpractices*LowInnoHighGHGE} + \varepsilon \end{aligned} \tag{4}$$

The results of the linear regression estimation for both models are synthesised in Table VII.

Model (3) has an explanatory power of 32.00 percent for a confidence level of 95 percent. The control variable SIZE has a significant positive effect for a confidence level of 99 percent. The variables LEVERAGE, INDUSTRY and R&D intensity have a negative relationship with ROA although it is not statistically significant.

The variable GHGE control practices has a significant negative effect on ROA for a confidence level of 95 percent. This negative effect is common among all types of companies independently of their level of innovation, except for those that are characterized by low levels of innovation and GHGE practices. These last firms undergo

Variables	Dependent variable: ROA Model (3) B	*t*	Dependent variable: MtoB Model (4) B	*t*
Constant	–	*3.887* ***	–	1.118
SIZE	*0.444*	*2.695* ***	0.032	0.184
LEVERAGE	−0.035	−0.247	*0.380*	*2.848* ***
INDUSTRY	−0.116	−0.809	*−0.270*	*−1.900* *
ROA mean	–	–	*0.521*	*3.385* ***
R&D intensity	−0.121	−0.682	−0.166	−0.974
GHGE practices	*−0.370*	*−2.376* **	*−0.310*	*−2.047* **
GHGEpractices × HighInnoHighGHGE	−0.084	−0.549	0.128	0.833
GHGEpractices × HighInnoLowGHGE	*−0.264*	*−1.900* **	−0.027	−0.203
GHGEpractices × LowInnoHighGHGE	−0.057	−0.413	−0.113	−0.820
GHGEpractices × LowInnoLowGHGE	−0.098	−0.693	−0.030	−0.224
	$R^2 = 0.320$ $F = 2.090$**		$R^2 = 0.413$ $F = 2.601$**	

Note: Significant at: *p-value < 0.10, **p-value < 0.05 and ***p-value < 0.01

Table VII.
Linear models for the moderating effect of innovation on the relationship between GHGE control practices and FP

a higher negative effect on their performance than the rest. These results led us to reject all of the sub-hypotheses of *H2*.

These previous affirmations are a consequence of the negative significant effect of the interaction between GHGE control practices and low innovation and GHGE control practices. This statistical significance means that the effect of GHGE control practices in this type of company is defined by the addition of coefficients B_5 and B_9 for ROA and B_6 and B_{10} for MtoB.

The other three interactions also have this negative effect but it is not statistically significant, which means that the effect of GHGE control practices on FP for these types of firms is identical to that shown by the rest of the firms in the study.

Model (4) has an explanatory power of 41.30 percent for a confidence level of 95 percent. The control variables LEVERAGE and ROA mean have a significant direct effect for a confidence level of 99 percent, while the INDUSTRY categorical variable has a marginal negative effect for a confidence level of 90 percent. The variables SIZE and R&D intensity have, respectively, a positive and negative relationship with MtoB although they are not statistically significant.

The variable GHGE control practices has a significant negative effect on MtoB for a confidence level of 95 percent. The interaction between GHGE control practices and high innovation and GHGE control practices has a positive effect, while the other three interactions show an inverse relationship with MtoB. None of these are statistically significant, so the negative effect of sustainable GHGE on MtoB is common to all of the firms analyzed.

4. Discussion of the results

Previous authors have affirmed that the lack of a clear pattern in the relationship between CSR and FP is due to the misspecification of moderating factors such as innovation (McWilliams and Siegel, 2000) or/and the potential nonlinearity of the CSR-FP relationship (Brammer and Millington, 2008).

The main evidence of our study indicates that the ambiguity of previous results is not only a consequence of these factors, but is caused by the joint consideration of different social and environmental practices that have diverse implications for firm performance.

As regards the possible existence of a non-linear relation between CSR and FP, Barnett and Salomon (2000) and Brammer and Millington (2008) evidenced a U-shaped relationship between two types of social practices and performance: the strength of screen and charitable donations.

Our results have confirmed a negative linear effect of sustainable GHGE practices on accounting and market performance measures. This evidence confirms the assumption that there are no financial profits to be made with this particular environmental behaviour. According to pro-neoclassical authors, environmentally responsive firms are at a competitive disadvantage compared with their competitors because, *ceteris paribus*, they incur higher costs (Aupperle *et al.*, 1985).

This negative effect is quite important in ROA as a consequence of the increment in the volume of investment in assets as well as the reduction in income owing to their annual depreciation. Moreover, investment in assets gives rise to additional maintenance costs and so forth, and, like all investments, it can only be recovered in the long term.

Likewise, the stock market negatively values the environmental effort of companies, and therefore it is suggested that these improvements are concerns that are not related to several stakeholders' demands.

In this sense, Hoffman (2005) observed that corporations are implementing GHGE reduction programs although many of these companies are agnostic about the science of climate change or the social responsibility of protecting the global climate. Their reasons for making these emission reductions are decidedly strategic: firms must be aware of developments in policy standards at the international, national and regional levels, and in this sense, they must be prepared to respond if and when standards emerge and assess whether they can have an influence on the form those standards might take.

Furthermore, it is necessary to point out that aside from financial issues, companies have obtained strategic benefits from voluntary GHGE reductions, such as: operational improvement, anticipating and influencing climate change regulations, accessing new sources of capital, improving risk management, elevating corporate reputation, identifying new market opportunities, and enhancing human resource management (Howard-Grenville and Hoffman, 2003).

In relation to the moderate effect of innovation, our results differ from those obtained by Hull and Rothenberg (2008), also perhaps because of the type of CSR practices considered. These authors observed that global CSR components most strongly affect performance in low innovation firms and in industries with little differentiation.

In contrast, our results show that innovation is not a moderating factor in the relationship between GHGE control practices and performance. Concretely, the effect of this environmentally responsible behaviour is common for high and low company innovation, and, moreover, independent of the best or worst sustainable behaviour. However, the firms that have lower levels of innovation and environmental practices perform more poorly than the others.

Nonetheless, the results of this work could be justified by the fact that industries are more orientated to greenhouse gas emission controls in order to improve their

environmental behaviour owing to the pressures exerted by governments that have adopted the Kyoto Protocol (e.g. Europe, Canada, etc.) or have recently changed their legislation, as in the USA.

Thus, the imperative motivation of these practices only has a negative effect on company performance because companies do not use these new environmental friendly practices to reduce costs or to differentiate themselves from their competitors.

In this sense, the authors considered it of interest to analyse the relationship between innovation and GHGE control practices in order to observe whether it is more direct than the previous studies have affirmed. To do so, the authors observed the relationship between R&D expenses and GHGE practices by means of Pearson's correlation coefficient. The results show a non-significant correlation of 0.209 between the two variables, reinforcing our affirmations relating to the development of innovative GHGE control practices independent of the innovation strategies of companies orientated towards differentiating themselves from their competitors.

5. Conclusions

This study was aimed at shedding some light on the ambiguity of the CSR-FP relationship. To do so, the authors considered the three main factors that could bias this relationship: the diversity effect of the different CSR components on performance, the potential existence of a non-linear effect, and the moderating effect of innovation.

Our evidence shows that the conflicts among previous results have more to do with the overall analysis of different components of CSR than with the other two factors. In this sense, the deployment of GHGE control practices has a negative effect on FP, reflected in accounting and market performance because these improvements are motivated by legal pressures and are not a business mechanism for obtaining a competitive advantage.

On the other hand, this work suffers from several limitations that could be defined as future research directions. Sustainability practices may be an opportunity to enhance a corporation's reputation, thus affecting FP (Porter, 1985; Rindova and Fombrun, 1995) but gaining this intangible advantage from climate change is difficult given the public's uncertain thinking on the issue (Hoffman, 2005). In this sense, the economic impact of GHGE practices could be observed, initially, through other corporate indicators such us positive reports about companies' environmental practices and products, prizes awarded for sustainable activity in the face of activists' protests, etc. that have a positive impact on shareholder value. Moreover, it is necessary to consider that GHGE control practices could be strategically defined in order to influence future international standards regarding emission reductions.

Thus, it could be of interest to apply the present analysis to long-run performance measures in order to observe whether this effect is time-invariant or not. Another future direction could be the analysis of the effect of other CSR components, individually and overall, on performance with the objective of obtaining more robust evidence. Finally, in future studies it will be necessary to consider other indicators of corporate performance different to the financial perspective and the impact that these factors have on value creation.

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