Unraveling the effects of environmental outcomes and processes on financial performance: A non-linear approach

Misani, Nicola and Pogutz, Stefano

Bocconi University, Bocconi University

21 November 2014

Unraveling the effects of environmental outcomes and processes on financial performance: A non-linear approach

Nicola Misani
Università Bocconi—Department of Management and Technology
Via Roentgen 1, 20136, Milan, Italy
Email: nicola.misani@unibocconi.it
Tel: +39.02.5836.3632; Fax: +39.02.5836.2530

Stefano Pogutz
Università Bocconi—Department of Management and Technology
Via Roentgen 1, 20136, Milan, Italy
Email: stefano.pogutz@unibocconi.it
Tel: +39.02.5836.5412; Fax: +39.02.5836.2530

November 21, 2014.

This is the pre-print version of the article, which has been published in final form by *Ecological Economics*, available at: http://www.sciencedirect.com/science/article/pii/S0921800914003449

Suggested citation: N. Misani and S. Pogutz (2015), "Unraveling the effects of environmental outcomes and processes on financial performance: A non-linear approach", *Ecological Economics*, 109(1): 150-160.

Unraveling the effects of environmental outcomes and processes on financial performance: A non-linear approach

ABSTRACT

We examine the roles of the outcome and process dimensions of environmental performance in determining financial performance as measured by Tobin's *q*. Outcomes refer to the impacts of the firm on the natural environment, while processes are the firm's actions to reduce these outcomes. We focus on a specific outcome—carbon emissions—and suggest that it affects Tobin's *q* non-linearly. We find that firms achieve the highest financial performance when their carbon performance is neither low nor high, but intermediate. We also find that environmental processes moderate this relationship as they reinforce firms' financial performance through improved stakeholder management. This mixed picture suggests that firms do not generally internalize the costs of poor carbon performance, but those that stand out in both environmental outcomes and processes achieve net financial benefits. These findings are based on a sample of carbon-intensive firms that disclosed their greenhouse gas (GHG) emissions through the Carbon Disclosure Project from 2007 through 2013.

Keywords: GHG emissions; climate change; environmental management; financial performance; Tobin's *q*

1. Introduction

Despite 25 years of intense research, the link between the firm's environmental and financial performance remains a subject of intense interest and debate both in economics and management. From the early works of Porter (1991), Jaggi and Freedman (1992), and Blacconiere and Patten (1994) to the meta-analyses studies conducted by Margolis and Walsh (2003), Orlitzsky et al. (2003), and more recently Horváthová (2010) and Albertini (2013), scholars have advanced theoretical arguments to support or reject the hypothesis that "it pays to be green."

The extant research yields contradictory results, suggesting that corporate actions to offset environmental pollution are likely to pay off (e.g., Christmann, 2004; Hart and Ahuja, 1996; Konar and Cohen, 2001; Russo and Fouts, 1997; Wagner 2010), that environmental and financial performance are negatively associated (Blacconiere and Patten, 1994; Cordeiro and Sarkis, 1997; Walley and Whitehead, 1994), that there is no significant relationship between the variables (King and Lenox, 2002), and that the causality is unclear (Margolis and Walsh, 2003). Similarly, most meta-analyses find that environmental performance is positively, but weakly, correlated with financial performance, although the variation in results across studies is significant.

The lack of conclusive results has led many scholars to reformulate the research question into *when* and *how* it "pays to be green," and to focus on the conditions that drive this relation and allow firms to capitalize on sustainability-oriented efforts (Ambec and Lanoie, 2008; Orsato, 2006). Moreover, some scholars highlight the necessity of clarifying the reliability and validity of the focal constructs analyzed (Walls et al., 2011).

In this paper, we build on the literature that distinguishes between the *process* and *outcome* dimensions of environmental performance (Busch and Hoffmann, 2011; Delmas et al., 2013) to study its relationship to financial performance. Environmental processes include firms' initiatives to address environmental problems (e.g., environmental management systems or cleaner technologies). Environmental outcomes capture the firm's impact on the natural environment (e.g., carbon emissions, pollution, and waste). Delmas et al. argued that "companies may excel at reporting, governance, and the utilization of environmental performance systems but still emit substantial amounts of pollution." (2013: 263). The reasons are that firms may be ineffective in their efforts, that it may take time for investments in environmental practices to produce benefits, or even that firms act for merely symbolic purposes to influence markets without achieving substantial improvements in environmental outcomes (Bansal and Clelland, 2004).

We focus on a specific outcome, *carbon emissions*, since climate change and carbon management have become important determinants of corporate strategy and acquired the potential to impact the bottom line through regulatory and stakeholders' pressures (Howard-Grenville et al., 2014; Reid and Toffel, 2009). Compared to other outcomes or environmental performance in general, research on the impact of carbon emissions on financial performance is relatively underdeveloped, even though recent contributions have begun clarifying it (e.g., Busch and Hoffman, 2011; Hatakeda et al., 2012; Iwata and Okada, 2011). Using a non-linear approach, we contribute to this nascent literature by hypothesizing and testing an interaction between carbon emissions and environmental processes in determining firm financial performance.

Many scholars have countered the dominant assumption of linearity in studies on the relationship between environmental and financial performance (Brammer and Millington, 2008; Marcus and Fremeth, 2009; Wagner et al., 2002). Barnett and Salomon (2012) provided evidence of a U-shaped relationship between corporate social performance and financial performance, showing that while engaging with socially and environmentally responsible practices is initially costly for firms, after a certain point, these costs are paid off and offset by the benefits from improved relations with stakeholders.

Regarding carbon emissions, Tatsuo (2010), Hatakeda et al. (2012), and Fujii et al. (2013) tested a U-shaped relationship in the context of Japanese manufacturing firms. However, these studies did not consider the interaction between outcome and process dimensions and used accounting measures of the dependent variable (such as ROA or ROS). In this paper, we measure financial performance through Tobin's *q*, which captures a firm's future stream of earnings, incorporating the expected long-term benefits of improved environmental outcomes and processes. Busch and Hoffmann (2011) studied the interaction between carbon emissions and environmental processes, but did not include non-linear effects. To our knowledge, Tobin's *q* has not yet been used to estimate a non-linear relationship between carbon emissions and financial performance.

To test our hypotheses, we studied a sample of 127 global firms that operate in carbon intensive industries (energy, materials, industrial, and utilities) and reported their greenhouse gas (GHG) emissions through the Carbon Disclosure Project (CDP) between 2007 and 2013. The paper is organized as follows. In Section 2, we review the extant literature and develop our hypotheses. In Section 3, we present our data, describe our methodology, and discuss the results. We provide our conclusions in Section 4.

2. Hypotheses development

2.1. Environmental performance: process versus outcome

Stakeholder theory (Donaldson and Preston, 1995; Freeman, 1984) is often employed to explain differences in firm's financial performance with regard to environmental issues (e.g., Delmas and Toffel, 2008; Wagner, 2011). Several scholars observed that stakeholders tend to favor relationships with companies that are more aligned to their expectations. For example, CSR practices tend to increase customers' trust (Castaldo et al., 2009); responsible consumers are willing to pay a premium price for more sustainable products (Brown and Dacin, 1997); employees are attracted and motivated by companies that are environmentally and socially conscious (Brammer et al., 2007); policy makers may reduce their regulatory, legislative, or fiscal pressures for responsible companies (Hillman and Keim, 2001); and sustainable firms can attract financial investors (Doh et al., 2010). The benefits for firms are expected to depend on the capacity to respond to and influence stakeholders (Barnett, 2007). On one hand, attention to environmental and social issues can provide important resources, offsetting the costs of initiatives (Brammer and Millington, 2008). On the other hand, for firms that lack the ability to build valuable ties with stakeholders, the costs of initiatives can be superior to the benefits, decreasing financial performance.

A further complexity is that stakeholders can react differently to different dimensions of a firm's environmental performance. Recent contributions highlighted the difference between process and outcome measures (Busch and Hoffmann, 2011; Delmas et al., 2013). These are a reaction to empirical studies that "have often blurred the lines between environmental management and environmental performance" (Walls et al., 2011: 74), for example, using pollution as a proxy for a firm's environmental management strategy, or adopting environmental management systems as proxies of emissions. Similar studies are methodologically suspicious because, as Delmas et al. (2013) remark, "Process measures indicate the efforts a company invests in attempting to mitigate its environmental impacts. Although process measures represent a potential for improvement in outcome performance, there is no guarantee that such improvements will indeed materialize" (258).

While the theoretical distinction between process and outcome measures is well established, there is no consensus on the impacts of these dimensions on a firm's financial performance. Delmas et al. (2013) determined that corporate financial performance is positively and linearly associated with process measures but not with outcome measures.

Busch and Hoffmann (2011) theorized that better environmental outcomes linearly and positively translate into superior financial performance while environmental processes moderate the relationship, such that these processes increase financial performance when outcomes are low but decrease financial performance when outcomes are high. However, their data did not support the expected moderation.

When examining environmental outcomes, it is important to consider that there may be many types such as air emissions, water emissions, waste, resource consumption, and effects on ecosystems. Each type can affect financial performance with a different sign or strength. Iwata and Okada argue, "each environmental issue has different characteristics such as the scope of pollution (e.g., local or global), length of time until damages emerge, severity of the damages, facilities for specifying the polluters, and existence of regulations and international treaties. These various characteristics suggest that different stakeholders may place emphasis on different environmental issues" (2011: 1692).

Building on stakeholder theory, stakeholder interest in different environmental problems and the firm's ability to provide responses may affect financial performance in different ways, thus leading to mixed results. Accordingly, we isolate a single environmental outcome. Following Busch and Hoffmann (2011), we focus on a measure—carbon emissions—that reflects a firms' contribution to climate change, a broadly relevant issue for business, policy makers, and stakeholders. Climate change has become a strategic issue for companies, and carbon performance is one of the most relevant, non-financial piece of information collected by stakeholders (Eccles et al., 2011).

2.2. Environmental performance: non-linear effects on financial performance

The view of a non-linear relationship between environmental and financial performance emerged with Wagner et al. (2001 and 2002), who argued that the "environmental and economic performance of firms does not have to be unidirectional but can change from positive to negative, or vice versa" (2001: 99). They continued that "the relationship between environmental and economic performance can be represented through a bell-shaped (i.e., inverse U-shaped) curve" (2001: 99). Brammer and Millington (2008) proposed a more articulated framework of these linkages, and introduced two descriptive models based on non-linear relationships. In one, the positive financial payoffs to good social performance are subject to diminishing and eventually decreasing returns. This suggests an inverse U-shaped relationship between social and economic performance. In the other model, they associated high financial performance with either very high or very low levels of social performance, implying a U-shaped curve. Subsequently, Barnett and Salomon (2012) found evidence of a U-shaped relationship between social and financial performance. In particular, they observed that benefits vary across the range of corporate social performance, such that when the capacity to influence stakeholders accumulates, benefits are generated that balance and then exceed the costs of socially responsible initiatives.

Focusing on Japanese companies or those listed on the Tokyo Stock Exchange, recent studies on environmental and financial performance also tested a curvilinear relationship, using carbon emissions as a measure of environmental outcomes. Tatsuo (2010), investigating a sample of manufacturing firms in three industries (chemical, food, and electrical equipment), identified an inverse U-shape relationship between CO2 emissions and ROA. In other words, "efforts to increase environmental performance will bring economic benefit, but eventually improvement of environmental performance will push up economic costs, implying the two performances will no longer coexist" (219). Hatakeda et al. (2012) investigated the relationship between GHG and profitability, considering various factors that can affect the benefit of reducing carbon emissions, such as market competition or uncertainty. They found a non-linear relationship between environmental and financial performance, and argued that the difference between marginal revenue and cost of reducing emissions is heterogeneous across individual firms. Finally, Fujii et al. (2013) addressed the question of economic performance versus environmental performance as measured by CO2. They identified both a positive linear effect of environmental performance on ROA and a positive quadratic relationship with ROS, concluding that environmental performance affects ROA by means of ROS. Explaining this relationship, they suggested that firms improve their overall economic performance through increased energy efficiency.

To summarize, a growing interest in the non-linear relationship between financial performance and carbon emissions has emerged. Scholars tested both positive and negative quadratic functions. However, none used Tobin's *q* as a dependent variable, even though it is widely used in studies on the impact of environmental performance on firm's economic results (King and Lenox, 2002; Konar and Cohen, 2001; Wagner, 2011). Tobin's *q* anticipates the future streams of firm cash flows expected by the stock market over and above the value that is already in the book value of firm assets (Kor and Mahoney, 2005). As such, it captures expected long-term benefits of emission-reducing firm investments (e.g., improved reputation or lower regulatory risk). Therefore, using Tobin's *q* to study the non-linear relationship between carbon emissions and financial performance allows covering the costs and benefits not immediately reflected in such short-term accounting measures as ROA or ROE.

2.3. Effects of carbon performance on Tobin's q

Addressing climate change requires actions like introducing innovations to increase the energy efficiency of production processes, the shift towards low-carbon energy technologies, or implementing compensation measures like emission credits (Busch and Hoffmann, 2007; Kolk and Pinkse, 2005). These actions use resources and entail investments that negatively impact the firm's financial performance, unless economic benefits materialize. In this regard, it is important to notice that carbon emissions do not directly generate costs for firms operating in regulatory regimes that do not internalize these emissions. Although various carbon-trading schemes and carbon taxes were implemented in some states and regions, the internalized costs of carbon emission appear to be very low when measured, for example, in terms of the market price of carbon (The Economist, 2013).

Therefore, firms with poor carbon performance (high emissions) are in a position to outperform rivals that make costly investments and engage in innovation to reduce their carbon footprints. Apart from regulatory interventions, the only sources of higher costs for firms with poor performance are reputation or legitimacy losses, which may lead to higher costs or lower revenues. Although such losses can be large, especially for highly visible firms under public scrutiny, they will mostly be lower than the savings associated with a lack of action against climate change. Therefore, we predict that low carbon performance will be associated with a higher Tobin's q, or generally with better financial performance.

When a firm improves its carbon performance through carbon-efficient investments and interventions, its costs increase, while rivals still benefit from avoiding expenditures. The initial costs can be substantial, because firms must acquire new competencies and technologies (Marcus and Fremeth, 2009). At the same time, carbon performance is still too low for relevant stakeholders to notice. Brammer and Millington observed that firms "that make moderate levels of investment in social performance neither save the resources for alternative investments nor achieve differentiation in the eyes of stakeholders" (2008: 1329). Therefore, we argue that intermediate carbon performance will be associated with lower financial performance.

Finally, building on Barnett and Salomon (2012), when firms accumulate a certain level of investment in low carbon initiatives, the accrued capacity to respond to stakeholders starts to generate positive net returns. Reinhardt (1998) and Orsato (2006) suggested that high environmental performance might enhance product differentiation, allowing the firm to apply premium prices or win new customers. Similarly, investors can see "superior corporate carbon performance (outcome based) as a virtue: firms with lower carbon intensity can generate a "carbon premium" (Busch and Hoffmann, 2011: 253). These benefits add to the savings resulting from learning effects and new capabilities that allow the firm to introduce valuable innovations (Fujii et al., 2013). Thus, costs related to carbon reduction initiatives are progressively offset. We hypothesize that the relationship between carbon performance and Tobin's *q* is U-shaped, with the highest values for financial performance reached at the lowest and highest levels of carbon performance:

> *Hypothesis 1: The relationship between a firm's carbon performance and financial performance is curvilinear (U-shaped), such that higher financial performance occurs at the two extremes of carbon performance.*

2.4. The moderation effect of environmental process

Environmental processes signal to observers that a firm wishes to mitigate its external impacts. These are usually more difficult to measure than outcomes (Delmas et al., 2013), and only represent the potential for improvement—there is no guarantee that an improvement will actually materialize. In addition, environmental processes do not always indicate a true strategic commitment, because institutional pressures may lead firms to adopt practices for the primary purpose of achieving legitimacy, rather than reducing impacts *per se* (Bansal and Clelland, 2004).

However, environmental processes may be important ways to improve relationships with stakeholders and to influence them. They cover a broad range of activities including the development of ecofriendly innovations, modification of manufacturing processes, or introduction of environmental management systems. These figure prominently in sustainability reports, avoid or reduce grievances by aggressive stakeholders, alleviate regulatory risks, and contribute to the firm's Environmental, Social, and Governance (ESG) rating, which improves the amount and stability of demand for its shares in the stock market.

This leads us to suggest that environmental processes moderate the relationship between the firm's carbon emissions and its Tobin's *q*. When carbon performance is low and the reputation and legitimacy of a firm are at risk, environmental processes can be used symbolically to modify stakeholder perceptions and influence financial markets. The fact that these processes are not accompanied by corresponding carbon performance does not weaken their effects, as stakeholders expect improvements to take time. Therefore, at low levels of carbon performance, environmental processes improve Tobin's *q* because of investors' positive evaluation of the actions taken.

In contrast, the benefits of environmental processes at moderate levels of carbon performance are negligible, because there is little need for a firm to sustain its reputation or legitimacy. Therefore, the costs of the actions taken are not recouped, and the net effect on Tobin's *q* is negative.

When the firm's carbon performance is high, environmental processes demonstrate to observers that the firm is highly committed to environmental issues and that its approach covers both the outcome and process dimensions. Such a "best-in-class" approach allows the firm to attain full support by stakeholders in all business activities, enjoy the reputation and legitimacy benefits derived from excellence in overall environmental performance, and even achieve internal efficiencies or resource-saving innovations.

In summary, at low and high levels of carbon performance, the level of adoption of environmental processes reinforces the impact of carbon performance on Tobin's *q*. At intermediate levels of carbon performance, a high level of adoption will be associated with a lower Tobin's *q*:

> *Hypothesis 2: Environmental processes moderate the curvilinear (U-shaped) relationship between carbon performance and financial performance, such that at low and high levels of carbon performance, high levels of environmental management enhance financial performance, while at intermediate levels of carbon performance, high levels of environmental management reduce financial performance.*

3. Data and methodology

3.1. Data

Our sample was created from the list of organizations that disclosed their GHG emissions through the Carbon Disclosure Project (CDP) from 2007 through 2013. CDP is an independent not-for-profit organization that collects and discloses information on organizations' GHG emissions and how they address climate change in their strategies and operations (CDP, 2013). Previous research has already drawn on CDP information (Kolk and Pinske, 2007; Reid and Toffel, 2009; Lewis et al., 2013; Ionnaou et al., 2014).

The initial list included 998 organizations that reported GHG emissions between 2007 and 2013. We then removed non-profit organizations and companies not listed on stock exchanges, as our main dependent variable was Tobin's *q*. Companies that radically changed scope of operations in the focal period through M&A transactions or spin-offs were also excluded. Finally, we focused on those industries responsible for significant amounts of GHG emissions, namely the energy, materials, industrials, and utilities industries. The absence of data for GHG emissions and other variables reduced the number of usable firm-year observations to 766 over the 2007 to 2013 period, including 127 companies. The panel is unbalanced. Financial data and other firm information were obtained from Thomson

Datastream. Table 1 reports the industry and country composition of the sample.

Insert Table 1 about here

Firms participating in CDP disclose their emissions according to the GHG Protocol, which was developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). This protocol defines three scopes for accounting and reporting purposes: Scope 1 includes GHG emissions from sources that the firm owns or operationally controls. These are direct emissions from activities such as electricity generation, physical or chemical processing, and fuel combustion. Scope 2 includes indirect GHG emissions whose source is the electricity that a firm purchases to conduct its own operations. Scope 3 includes all other indirect GHG emissions from sources that the firm does not own or operationally control, such as the transportation of materials bought by the firm or emissions related to the products and services it sells.

We focused on Scope 1 and Scope 2 GHG emissions. Including both scopes allows to consider all of the most important operational changes by the firm, investments, and innovations that impact GHG emissions, including switching to electricity suppliers that use renewable sources. Previous studies also covered both scopes (e.g., Busch and Hoffmann, 2011). In some industries, Scope 3 emissions are also representative of firm efforts to reduce carbon impacts (e.g., car emissions in the automobile industry). However, we excluded this category because few firms reported relevant data to the CDP.

Aligned to previous literature (Hoffmann and Busch, 2008), we defined our measure of *Carbon performance* as the ratio of the firm's Scope 1 and Scope 2 emissions to sales. Then, we divided this value by the industry average (defined at the sub-industry level) of the firm, since carbon performance is highly industry-dependent. A logarithmic transformation was applied to avoid skewness. Finally, we multiplied the results by (-1) and rescaled them on a positive range of values, so that larger values of this measure express better performance (i.e., lower carbon emissions).

Our *Environmental management* variable reflects the environmental processes firms adopted to reduce environmental impacts through their operations (e.g., cleaner technologies) and organizational policies (e.g., creating committees or incentives). Previous literature tried to quantify these efforts using count variables that mainly cover organizational policies (e.g., Busch and Hoffmann, 2011). We adopted the alternative approach of employing externally validated measures. The measure we used is the Environmental Performance Score calculated by Thomson-Reuters in its Asset4 database, which includes a large number of ESG indicators (Thomson-Reuters, 2014). Analysts use stock-exchange filings, news sources, financial statements, and other sources (including CDP data) to collect information on 900 data points of more than 3,500 firms. The data is converted into units that enable the calculation of scores ranging from 0 to 100, which represent a firm's performance in a given dimension relative to the entire Asset4 universe in a year. The Asset4 scores have been used in other studies (Cheng et al., 2014; Ioannou and Serafeim, 2012; Luo et al., 2014).

The Environmental Performance Score reflects "how well a company uses best management practices to avoid environmental risks and capitalize on environmental opportunities in order to generate long term shareholder value" (Thomson-Reuters, 2014). The items used to calculate the score cover interventions (such as emission-reduction policies or the percentage of firm sites that are certified as complying with an environmental management system) and outcomes (such as the volume of hazardous waste or CO2 and CO2-equivalent emissions). Therefore, the Environmental Performance Score overlaps with our carbon-performance measure, which is based on CO2 emissions. The overlap is small, as shown by the pairwise correlation between the two measures in our sample (.17, $p < .001$).

However, we eliminated the overlap by regressing the Environmental Performance Score on our measure of carbon performance and saving the residuals. These residuals represent the variance in the Score that is not explained by the firm's carbon performance. To ease interpretation, we rescaled the residuals on a positive range of values, thereby obtaining our *Environmental management* measure, which we use as a proxy of the firm's environmental processes.

Our main measure of financial performance is Tobin's *q*, which we calculated by dividing the sum of the firm's market capitalization, the book value of its long-term debt, and its net current liabilities by the book value of its total assets (King and Lenox, 2002). To make our results comparable to previous literature, we analyzed other dependent variables: return on equity (ROE), return on sales (ROS), and return on assets (ROA). Following mainstream definitions, ROE was calculated as the net income divided the shareholder's equity; ROS as the operating income divided by total sales; and ROA as the net income divided by total assets.

In addition to *Carbon performance* and *Environmental management*, we used several controls to predict financial performance. To control for *country* effects, we included a full set of dummies (one for each country). With regard to *year* effects, we included six dummy variables (from 2007 to 2012). *Industry* effects were controlled by three sector-level dummies (materials, industry, utilities), leaving the energy industry as the baseline case. The natural logarithm of the firm's total assets was included to control for firm *Size*, as research has shown that firm size is an antecedent of firm responses to environmental issues (Darnall et al., 2010; King and Lenox, 2002; Sarkis and Cordeiro, 2001).

As our Environmental Management measure is based on Asset4's Environmental Performance Score, it could vary with other ESG indicators that may independently affect the firm's Tobin's *q*, thereby producing spurious correlations. Thus, we added Asset4's

Corporate Governance Score as a control. This measures “a company’s systems and processes, which ensure that its board members and executives act in the best interests of its long term shareholders” (Thomson-Reuters, 2014). Therefore, it potentially impacts investors’ views of the firm, which in turn influence our main dependent variable (Tobin’s *q*).

Based on the same logic, we added a dummy variable that took the value 1 if a firm adhered to the United Nations’ Global Compact within a year, and 0 otherwise. This program, which encourages firms to embrace 10 principles in the areas of human rights, labor, environmental protection, and anti-corruption, is the largest voluntary corporate responsibility initiative in the world (Rasche et al., 2013). Participation in this program is frequently used as a proxy for social performance (e.g., Soleimani et al., 2014).

Firms can use technological innovation to address environmental issues (Berrone et al. 2013). The development of new products, processes, or services is crucial for reducing GHG emissions. Moreover, long-standing research—starting with Griliches (1981)—shows that Tobin’s *q* is sensitive to R&D and patents. We therefore included a variable that measures patents connected to climate change. Data were taken from the European Patent Office’s (EPO) Espacenet database, which contains 70 million patent documents issued worldwide (EPO, 2014). We examined documents tagged with the Y02 codes (Veefkind et al., 2012), which cover documents dealing with the capture, storage, sequestration, or disposal of GHGs (Y02C) and the reduction of GHGs emitted through energy generation, transmission, or distribution (Y02E). Our indicator, *Climate change innovation*, was obtained by calculating the ratio of “climate change patents” (Y02 codes) to the total number of patents granted to a firm in a year, and standardized relative to the average of the same ratio for the firms in the same sub-industry. Values larger than 1 mean that the firm outperforms its industry peers, while values below 1 indicate the opposite. This variable controls for technological innovation in climate change mitigation not directly recognized in the *Environmental management* measure.

We included *R&D intensity* following McWilliams and Siegel (2000), who emphasized this as a potentially confounding variable when exploring the relationship between social or environmental performance and financial performance. We calculated *R&D intensity* by dividing R&D expenses by total sales (Hart and Ahuja, 1996).

Debt/equity ratio was included as a proxy of the firm's riskiness, which could influence its market value (Choi and Wang, 2009). Riskiness is commonly used as a control in research on Tobin's *q* (Lu and Beamish, 2004). The value of this variable is the ratio of the firm's debt to shareholders' equity.

Table 2 displays the descriptions of the variables. ROE, ROS, and ROA were winsorized at the 5% level to mitigate the impact of extreme values (see Roberts and Sufi, 2009, for a similar procedure).

Insert Table 2 about here

Table 3 shows the correlation matrix as well as the means and standard deviations of the variables. The highest correlations are between the dependent variables (Tobin's *q*, ROE, ROS, and ROA). All correlations between predictor variables are comfortably between −.70 and .70, an interval within which collinearity is unlikely to be a problem (Bedeian, 2014). We also examined variance inflation factors (not reported) to test for multi-collinearity. As none approached the usually accepted threshold of 10 (Neter et al., 1990), we concluded that multi-collinearity is not an issue in our data.

Insert Table 3 about here

3.2. Methodology

We used hierarchical ordinary least square (OLS) regression to test both hypotheses. Our basic specification, expressed in reduced form, is as follows:

$$FP_{it} = \alpha + \beta_1 CP_{it} + \beta_2 CP_{it}^2 + \beta_3 EM_{it} + \beta_4 CP_{it} EM_{it} + \beta_5 CP_{it}^2 EM_{it} + \delta Z_{it} + \varepsilon_{it}$$

where i denotes firms and t periods. FP is financial performance, CP is *Carbon performance*, EM is *Environmental management*, δ is a vector of parameters, and Z is a vector of control variables including industry, year, and country dummies, *Size*, *R&D intensity*, *Debt/equity*, *Corporate Governance Score*, *UN Global Compact*, and *Climate change innovation*. Finally, ε is the error term.

Furthermore, we tested an alternative specification in which financial performance is lagged to $t + 1$. Slack resource theory (Waddock and Graves, 1997) implies that Tobin's q can be a cause and not only a consequence of firm actions that address climate change. As such, it may give rise to simultaneity or endogeneity issues. Lagging the dependent variable with respect to explanatory variables allows alleviating these issues.

4. Results

Table 4 reports the estimation results of our specification, using Tobin's q as the dependent variable. Model 1 includes all the control variables, showing that the industrials and utilities industries have significantly lower Tobin's q than the baseline case (energy). As expected, *R&D intensity* correlates positively with Tobin's q, while *Climate change innovation* has no statistically significant effect. Somewhat surprisingly, participation in the *UN Global*

Compact is significantly and negatively correlated with Tobin's *q*. The coefficients of other controls are not statistically significant. All these results are confirmed in the subsequent models.

Model 2 adds our variables of interest: *Carbon performance*, its quadratic term (to test for a curvilinear relationship with Tobin's *q*), and *Environmental management*. The increase in model fit is statistically significant (.0053, $p < .001$). The coefficients of both the linear and the quadratic term of *Carbon performance* are statistically significant; however, the coefficients are respectively positive and negative, indicating an inverse U-shape. This provides evidence against Hypothesis 1, in which we argued a U-shape.

In Model 3, to test Hypothesis 2, we added the interactions between *Environmental management* and the carbon-performance terms. Both interactions are statistically significant ($p < .001$). Their signs suggest an inversion of the U-shape (that is, a positive U-shape) for firms with the highest levels of *Environmental management*. Generally, interaction effects are only deemed significant if they explain a greater portion of the variance in the dependent variable than a model that includes only the main effects (Aguinis and Gottfredson, 2010). The size of the R^2 increase in Model 4 (.0082) and the F-test ($p < .001$) indicate that this is the case in our data. Models 4, 5, and 6 are similar to Models 1, 2, and 3 respectively, but Tobin's *q* is lagged forward by 1 year. The results are qualitatively the same as in the non-lagged models.

Insert Table 4 about here

To facilitate interpretation of the main and moderation effects, we plotted the relationship between *Carbon performance* and Tobin's *q* (Figure 1). The standard deviations on the horizontal axis cover the range of actual carbon-performance values in our sample. The graph indicates an inverse U-shape for average values of *Environmental management*. For firms with *Environmental management* values that are one standard deviation above the mean, the U-shape is positive, meaning that low and high levels of *Carbon performance* lead to a higher Tobin's *q*, while moderate levels of *Carbon performance* are associated with a low Tobin's *q*. For firms with *Environmental management* values that are one standard deviation below the mean, the opposite effect is seen: the U-shape is inverted and the slope is more negative than for firms with average levels of *Environmental management*. These effects amount to the moderation effect we predicted in Hypothesis 2. Hypothesis 1 is disconfirmed as a whole, even though it holds limitedly for firms with high levels of *Environmental management*.

Insert Figure 1 about here

The inverse U-shape we found also opposes findings of a positive U-shape in previous research, most notably in Barnett and Salomon (2012). However, this study used a comprehensive measure of social performance (based on KLD data) that conflates outcome and process dimensions. An inverse U-shape previously emerged in the study on carbon emissions by Japanese firms in Tatsuo (2010). Importantly, the main effect of *Environmental management* on Tobin's *q* is positive and statistically significant. While this is in line with Delmas et al. (2013), it disconfirms Busch and Hoffmann (2011), who found that environmental processes were negatively associated to financial performance.

To further investigate the moderating role of *Environmental management*, we divided the sample into two groups based on a median split for this variable. Firms above or equal to the median score were coded 1, while those below were coded 0. We ran a reduced version of the full specification without *Environmental management* and the interaction terms on the two sub-samples (Table 5). Models 1 and 3 have the non-lagged dependent variable; Models 2 and 4 have the lagged one. A Chow test (DeMaris, 2004) shows that the difference between the coefficients of the two sets of regressions is statistically significant: F(36, 766) = 3.570, p < .001, for Model 1 vs. Model 3 and F(35, 690) = 3.459, p < .001 for Model 2 vs. Model 4. In Model 1 (scores below the median), the coefficients of the *Carbon performance* terms are statistically significant and indicate an inverse U-shape, while the coefficients become much more smaller and lose their statistical significance in Model 3. This confirms that higher levels of *Environmental management* tend to filter the negative impact of carbon performance on Tobin's *q*. Results for the models with the lagged Tobin's *q* are considerably weaker: only the quadratic term is statistically significant for the below-median group; however, significance disappears again in the above-median group.

Insert Table 5 about here

We studied whether the relationship between carbon emissions, environmental processes, and financial performance is sensitive to the geographical regions in which firms are based. Social and environmental performance in general is related to national institutions (Ioannou and Serafeim, 2012), and the private costs of carbon emissions in particular depend on local regulations that vary across countries. Table 6 shows the findings. We found a sharp contrast between firms from the US and UK, and firms from the other countries (Models 1a and 1b). The first group exhibits the inverse U-shaped relationship between *Carbon performance* and Tobin's *q* (measured at *t*) that emerged in the whole sample, but *Environmental management* and the interactions are not statistically significant. The opposite is true for the other countries, where the terms of *Carbon performance* are not statistically significant, but *Environmental management* is positively and significantly related to Tobin's *q* and the interaction terms are aligned to Hypothesis 2. Therefore, it seems that Tobin's *q* is sensitive to *Carbon performance* in the US and UK and to *Environmental management* in other countries.

We investigated whether this result extends to further countries with an English legal origin (La Porta et al., 2006). However, we found that the magnitude of the coefficients decreases and that the statistical significance of *Environmental management* almost disappears (Models 2a and 2b). We also contrasted Annex B countries (signatories of the Tokyo Protocol that ratified it) and the other countries, assuming that in the former the internalized costs of carbon emissions for firms could be higher than in the latter. Models 3a and 3b show that this is not the case, since in the Annex B group no coefficients of our variables of interests were statistically significant. The same holds for Europe (including UK) versus other countries (Models 4a and 4b).

Insert Table 6 about here

Considering financial performance measures other than Tobin's *q* is useful because different measures may be affected by different stakeholders or express different channels through which environmental performance affect financial performance (Iwata and Okada, 2011). Table 7 shows the results of applying our main specification to ROE, ROS, and ROA. Model 1 shows the usual inverse U-shaped relationship between *Carbon performance* and ROE while no effect is discernible for *Environmental management*. Magnitude and statistical significance of the coefficients decrease sharply when ROE is lagged forward by one year (Model 2). Qualitatively, the same results are obtained for ROA (Models 5 and 6). In contrast, the results for ROS closely mirror those obtained with Tobin's *q*, with statistically significant effects for both *Carbon performance* and *Environmental management*, and for both non-lagged and lagged ROS.

These findings corroborate previous research in which carbon emissions were more strongly linked to Tobin's *q* than to accounting measures (Busch and Hoffmann, 2011; Fujii et al., 2013). Tobin's *q* incorporates investor estimates about a firm's future performance; therefore, it is more probable than accounting measures to reflect regulatory risks, emerging climate scenarios, or the benefits of long-term investments in emission reduction. Among the accounting measures we considered, ROS is the only one that does not depend on financial structure. Therefore, it directly reveals internal efficiency, the amount of transaction costs, or the extent of differentiation advantages, which are areas in which firms may reap the benefits from better stakeholder management or increased stakeholder influence.

Insert Table 7 about here

----

4. Conclusion

This paper investigates the different effects of the outcome and process dimensions of firms' environmental performance on Tobin's *q*. We focus on an outcome—carbon emissions—that is highly relevant in a global context in which climate change poses unique challenges to all organizations (Howard-Grenville et al., 2014). We argue that there is a U-shaped relationship between carbon performance and Tobin's *q*, and that environmental processes positively moderate this relationship, through their effects on stakeholder management and influence. To test our hypotheses, we use unbalanced panel data taken from a sample of 127 firms in carbon-intensive industries, observed over a seven-year period.

The findings partially support our hypotheses. The U-shape is negative, in opposition to our expectations, meaning that carbon performance improves financial performance up to a certain point, after which the marginal benefits (in terms of internal efficiency or improved reputation and legitimacy) of further reduction of carbon emissions do not offset the marginal cost. Our hypothesis that environmental processes positively moderate the relationship between carbon performance and Tobin's *q* is confirmed. This suggests that investors and other stakeholders simultaneously assess a firm's carbon performance and the firm's efforts to reduce its environmental impact. Firms with high carbon performance that demonstrate a willingness to deal with environmental issues are rewarded with an increase in Tobin's *q*. Therefore, for this limited set of firms the U-shape is positive, as predicted. Firms with high carbon performance and inadequate processes are negatively evaluated. An additional implication is that environmental performance at the process level adds to Tobin's *q* only when a firm's carbon performance is high or low, but not when its carbon performance falls into the intermediate range.

Our results are robust to using a forward one-year lag for the dependent variable and to replacing Tobin's *q* with ROS, while the moderation effect of *Environmental management* disappears with ROA and ROE. Splitting the sample at the geographical-region level shows a contrast between US and UK (where Tobin's *q* mainly depends on *Carbon performance*) and the other countries (where it mainly depends on *Environmental management*). While this result needs further study, it confirms that unraveling the outcome and the process dimensions of environmental performance is a promising avenue of future research. Our analysis fails to find any significant difference between Annex B countries (or Europe) and other countries, which suggests that investors do not believe that costs or benefits coming from participation to Kyoto Protocol are sizeable.

Our results have important implications. Understanding whether and when firms' efforts to control their environmental impacts generate financial returns is clearly relevant for both business and policy makers. While our study highlights the financial benefits for firms that are responsive to climate change, it also suggests that they do not usually internalize poor carbon performance. The average firm can be interested in improving its carbon performance up to a certain level, due to internal savings and benefits linked to improved relationships with stakeholders, but further abatement of emissions may need to be incentivized by policy measures. Differently, the firms with the best environmental processes are rewarded by the market for carbon reduction even without external stimulus. Therefore, policy makers should take into account firm differences in environmental processes in order to adjust incentives for carbon reduction.

As with any empirical work, our study has some limitations that should be addressed in future research. Our sample focuses on carbon-intensive industries for which reduction of GHG emissions is a highly material issue; we expect that our findings could not generalize to industries with lower average levels of emissions. Moreover, our measure of environmental processes could be refined through the addition of a more precise division between process and outcome scores. Research that considers the effects of specific regulatory contexts in more depth should also be pursued, as the extent to which the costs of carbon emissions is internalized is highly dependent on historical and institutional conditions.

Acknowledgements

We would like to thank Carbon Disclosure Project (CDP) for providing access to data. We also greatly benefited fromthe constructive feedback of two anonymous reviewers who helped reshape and improve the quality of the paper. All remaining errors are ours.

References

Aguinis, H., Gottfredson, R.K. 2010. Best-practice recommendations for estimating interaction effects using moderated multiple regressions. Journal of Organizational Behavior 31 (6), 776-786.

Albertini, E. 2013. Does environmental management improve financial performance? A meta-analytical review. Organization & Environment 26 (4), 431-457.

Ambec, S., Lanoie, P. 2008. Does it pay to be green? A systematic overview. Academy of Management Perspectives 22 (4), 45-62.

Bansal, P., Clelland, I. 2004. Talking trash: Legitimacy, impression management, and unsystematic risk in the context of the natural environment. Academy of Management Journal 47 (1), 93-103.

Barnett, M. L. 2007. Stakeholder influence capacity and the variability of financial returns to corporate social responsibility. Academy of Management Review 32 (3), 794-816.

Barnett, M. L., & Salomon, R. M. 2012. Does it pay to be really good? Addressing the shape of the relationship between social and financial performance. Strategic Management Journal 33 (11), 1304-1320.

Bedeian, A.G. 2014. “More than meets the eye”: A guide to interpreting the descriptive statistics and correlation matrices reported in management research. Academy of Management Learning and Education 13 (1), 121-135.

Berrone, P., Fosfuri, A., Gelabert, L., Gomez-Mejia, L.R. 2013. Necessity as the mother of ‘green’ inventions: Institutional pressures and environmental innovations. Strategic Management Journal 34 (8), 891-909.

Blacconiere, W.G., Patten, D.M. 1994. Environmental disclosure, regulatory costs, and changes in firm value. Journal of Accounting and Economics 18 (3), 357-377.

Brammer, S. J., Millington, A. I. and Rayton, B. A. 2007. The contribution of corporate social responsibility to organizational commitment. International Journal of Human Resource Management 18, 1701-1719.

Brammer, S., Millington, A. 2008. Does it pay to be different? An analysis of the relationship between corporate social and financial performance. Strategic Management Journal 29 (12), 1325-1343.

Brown, T. J., Dacin, P. A. 1997. The Company and the Product: Corporate Associations and Consumer Product Responses. Journal of Marketing 61, 68-84.

Busch, T., Hoffmann, V.H. 2011. How hot is your bottom line? Linking carbon and financial performance. Business & Society 50 (2), 233-265.

Castaldo, S., Perrini, F., Misani, N., & Tencati, A. 2009. The missing link between corporate social responsibility and consumer trust: The case of fair trade products. Journal of business ethics 84 (1), 1-15.

CDP. 2013. Global 500 Climate Change Report 2013. Carbon Disclosure Project, https://www.cdp.net/CDPResults/CDP-Global-500-Climate-Change-Report-2013.pdf (last accessed on April 20, 2014).

Cheng, B., Ioannou, I., Serafeim, G. 2014. Corporate social responsibility and access to finance. Strategic Management Journal 35 (1), 1-23.

Choi, J., Wang, H. 2009. Stakeholder relations and the persistence of corporate financial performance. Strategic Management Journal 30 (8), 895-907.

Christmann, P. (2004). Multinational companies and the natural environment: Determinants of global environmental policy. Academy of Management Journal 47 (5), 747-760.

Cordeiro, J.J., Sarkis, J. 1997. Environmental proactivism and firm performance: evidence from security analyst earnings forecasts. Business Strategy and the Environment 6 (2), 104-114.

Darnall, N., Henriques I., Sadorsky, P. 2010. Adopting proactive environmental practices: The influence of stakeholders and firm size. Journal of Management Studies 47 (6), 1072-1094.

Delmas, M. A., Toffel, M. W. 2008. Organizational responses to environmental demands: Opening the black box. Strategic Management Journal 29 (10), 1027-1055.

Delmas, M.A., Etzion, D., Nairn-Birch, N. 2013. Triangulating environmental performance: What do corporate social responsibility ratings really capture? Academy of Management Perspectives 27 (3), 255-267.

DeMaris, A. 2004. Regression With Social Data: Modeling Continuous and Limited Response Variables, John Wiley & Sons, Hoboken (NJ).

Doh, J. P., Howton, S. D., Howton, S. W., Siegel, D. S. 2010. Does the market respond to an endorsement of social responsibility? The role of institutions, information, and legitimacy. Journal of Management 36 (6), 1461-1485.

Donaldson, T., Preston, L. E. 1995. The stakeholder theory of the corporation: Concepts, evidence, and implications. Academy of management Review 20 (1), 65-91.

Eccles, R.G., Serafeim, G., Krzus, M.P. 2011. Market interest in nonfinancial information. Journal of Applied Corporate Finance 23 (4), 113-127.

European Patent Office (EPO), 2014. About searching in Espacenet. http://www.epo.org/searching/free/espacenet/about.html (last accessed on April 21, 2014).

Freeman R.E. 1984. Strategic Management: A Stakeholder Approach. Pitman: Boston, MA.

Fujii, H., Iwata, K., Kaneko, S., Managi, S. 2013. Corporate environmental and economic performance of Japanese manufacturing firms: Empirical study for sustainable development. Business Strategy and the Environment 22(3), 187-201.

Griliches, Z. 1981. Market value, R&D, and patents. Economics Letters 7 (2), 183-187.

Hart, S.L., Ahuja, G. 1996. Does it pay to be green? An empirical examination of the relationship between emission reduction and firm performance. Business Strategy and the Environment 5 (1), 30-37.

Hatakeda, T., Kokubu, K., Kajiwara, T., Nishitani, K. 2012. Factors influencing corporate environmental protection activities for greenhouse gas emission reductions: The relationship between environmental and financial performance. Environmental and Resource Economics 53 (4), 455-481.

Hillman, A. J., Keim, G. D. 2001. Shareholder value, stakeholder management, and social issues: What's the bottom line? Strategic Management Journal 22 (2), 125-139.

Hoffmann, V., Busch, T. 2008. Corporate carbon performance indicators: Carbon intensity, dependency, exposure, and risk. Journal of Industrial Ecology 12 (4), 505-520.

Horváthová, E. 2010. Does environmental performance affect financial performance? A meta-analysis. Ecological Economics 70 (1), 52-59.

Howard-Grenville, J., Buckle, S. J., Hoskins, B. J., George, G. 2014. Climate change and management. Academy of Management Journal 57 (3), 615-623.

Ioannou, I., Li, S. X., Serafeim, G. 2014. The effect of target difficulty and incentives on target completion: The case of reducing carbon emissions. Harvard Business School Working Paper, No. 13-043.

Ioannou, I., Serafeim, G. 2012. What drives corporate social performance? The role of nation-level institutions. Journal of International Business Studies 43 (9), 834-864.

Iwata, H., Okada, K. 2011. How does environmental performance affect financial performance? Evidence from Japanese manufacturing firms. Ecological Economics 70 (9), 1691-1700.

Jaggi, B., Freedman, M. 1992. An examination of the impact of pollution performance on economic and market performance: Pulp and paper firms. Journal of Business Finance

& Accounting 19 (5), 697-713.

King, A.A., & Lenox, M.J. 2002. Exploring the locus of profitable pollution reduction. Management Science 48 (2), 289-299.

Kolk, A., Pinkse, J. 2005. Business responses to climate change: Identifying emergent strategies. California Management Review 47 (1), 6-20.

Kolk, A., Pinkse, J. 2007. Multinationals political activities on climate change. Business & Society 46 (2), 201-228.

Konar, S., Cohen, M.A. 2001. Does the market value environmental performance? Review of Economics and Statistics 83 (2), 281-289.

Kor, Y.Y., Mahoney, J.T. 2005. How dynamics, management, and governance of resource deployments influence firm-level performance. Strategic Management Journal 26 (5), 489-496.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A. 2006. What works in securities laws? Journal of Finance 61 (1), 1-32.

Lewis, B.W., Walls, J.L., Dowell, G.W.S. 2013. Difference in degrees: CEO characteristics and firm environmental disclosure. Strategic Management Journal 35 (5), 712-722.

Lioui, A., Sharma, Z. 2012. Environmental corporate social responsibility and financial performance: Disentangling direct and indirect effects. Ecological Economics 78, 100-111.

Lu, J.W., Beamish, P.W. 2004. International diversification and firm performance: The s-curve hypothesis. Academy of Management Journal 47 (4), 598-609.

Luo, X., Wang, H., Raithel, S., Zheng, Q. 2014. Corporate social performance, Analyst stock recommendations, and firm future returns. Strategic Management Journal, forthcoming.

Marcus, A.A., Fremeth, A.R. 2009. Green management matters Regardless. Academy of Management Perspectives 23 (3),17-26.

Margolis, J. D., Walsh, J. P. 2003. Misery loves companies: Rethinking social initiatives by business. Administrative Science Quarterly 48 (2), 268-305.

McWilliams, A., Siegel, D. 2000. Corporate social responsibility and financial performance: Correlation or misspecification? Strategic Management Journal 21 (5), 603-609.

Neter, J., Wasserman, W., Kutner, M.H. 1990. Applied linear statistical models, Irwin, Homewood (IL).

Orlitzky, M., Schmidt, F.L., Rynes, S. L. 2003. Corporate social and financial performance: A meta-analysis. Organization studies 24 (3), 403-441.

Orsato, R.J. 2006. When does it pay to be green? California management review 48 (2), 128.

Porter, M.E. 1991. America's green strategy. Scientific American 264 (4), 168.

Rasche, A., Waddock, S., McIntosh, M. 2013. The United Nations Global Compact - Retrospect and prospect. Business & Society 52 (1), 6-30.

Reid, E.M., Toffel, M.W. 2009. Responding to public and private politics: Corporate disclosure of climate change strategies. Strategic Management Journal 30(11): 1157-1178.

Reinhardt, F.L. 1998. Environmental product differentiation: Implications for corporate strategy. California Management Review 40 (4), 43-73.

Roberts, M. R., Sufi, A. 2009. Control rights and capital structure: An empirical investigation. Journal of Finance 64 (4), 1657-1695.

Russo, M. V., Fouts, P.A. 1997. A resource-based perspective on corporate environmental performance and profitability. Academy of Management Journal, 40(3): 534-559.

Sarkis, J., Cordeiro, J.J. 2001. An empirical evaluation of environmental efficiencies and firm performance: Pollution prevention versus end-of-pipe practice. European Journal of Operational Research 135 (1), 102-113.

Soleimani, A., Schneper, W.D., Newburry, W. 2014. The impact of stakeholder power on corporate reputation: A cross-country corporate governance perspective. Organization Science, forthcoming.

Tatsuo, K. 2010. An analysis of the eco-efficiency and economic performance of Japanese companies. Asian Business & Management 9 (2), 209-222.

The Economist 2013. Carbon copy. December 14.

Thomson-Reuters 2014. ESG Research Data. http://thomsonreuters.com/esg-research-data/ (last accessed on April 21, 2014).

Veefkind, V., Hurtado-Albir, J., Angelucci, S., Karachalios, K., & Thumm, N. 2012. A new EPO classification scheme for climate change mitigation technologies. World Patent Information 34 (2), 106-111.

Waddock, S.A., Graves, S.B. 1997. The corporate social performance-financial performance link. Strategic Management Journal 18 (4), 303-319.

Wagner, M. 2010. The role of corporate sustainability performance for economic performance: A firm-level analysis of moderation effects. Ecological Economics 69 (7), 1553-1560.

Wagner, M. 2011. Corporate performance implications of extended stakeholder management: New insights on mediation and moderation effects. Ecological Economics 70 (5), 942-950.

Wagner, M., Schaltegger, S., Wehrmeyer, W. 2001. The relationship between the environmental and economic performance of firms. Greener Management International 34, 94-111.

Wagner, M., Van Phu, N., Azomahou, T., Wehrmeyer, W. 2002. The relationship between the environmental and economic performance of firms: an empirical analysis of the

European paper industry. Corporate Social Responsibility and Environmental Management 9 (3), 133-146.

Walley, N., Whitehead, B. 1994. It's not easy being green, Harvard Business Review 72 (3), 46-52.

Walls, J.L., Phan, P.H., Berrone, P. 2011. Measuring environmental strategy: Construct development, reliability, and validity. Business & Society 50 (1), 71-115.

Table 1
Firm classification by sector and by country. Industries are defined according to GICS (Global Industry Classification Standard). Energy, industrials, materials, and utilities are sectors; for each of them we list the corresponding sub-industries in our sample.

Sector	*Country*
Energy: 28	Australia: 8
Integrated Oil & Gas: 15	Brazil: 2
Oil & Gas Exploration & Production: 13	Canada: 19
	Finland: 2
Industrials: 9	France: 5
Airlines: 4	Germany: 6
Marine: 2	Hong Kong: 3
Railroads: 3	India: 1
	Italy: 5
Materials: 49	Japan: 8
Aluminium : 3	Netherlands: 3
Commodity Chemicals: 3	New Zealand: 2
Construction Materials: 5	Norway: 1
Diversified Chemicals: 9	South Africa: 5
Diversified Metals & Mining: 8	Spain: 4
Fertilizers & Agricultural Chemicals: 2	Sweden: 1
Gold: 3	Switzerland: 1
Industrial Gases: 3	United Kingdom: 12
Paper Products: 5	USA: 39
Precious Metals & Minerals: 6	
Steel: 2	
Utilities: 41	
Electric Utilities: 20	
Gas Utilities: 2	
Independent Power Producers & Energy Traders: 5	
Multi-Utilities: 14	
Total: 127	*Total: 127*

Table 2
Descriptive statistics.

	Mean	Median	Std dev	Min	Max	Obs.
Tobin's *q*	1.36	1.18	0.56	0.58	5.36	766
ROS	16.16	13.86	11.01	-0.11	37.21	766
ROE	10.8	9.89	10.97	-12.68	40.53	766
ROA	4.97	4.00	4.81	-2.62	15.71	766
Size	16.95	17.00	1.21	13.17	19.69	766
R&d intensity	0.57	0.00	1.40	0.00	11.71	766
D/E	1.25	0.95	1.10	0.07	16.61	766
Corp. governance score	74.83	84.57	23.88	1.57	96.78	766
UN Global Compact	0.42	0.00	0.49	0.00	1.00	766
Climate change inn.	0.96	0.00	2.69	0.00	35.34	766
Carbon performance	3.36	2.99	1.56	0.20	11.56	766
Env. Management	0.00	0.16	0.98	-4.28	2.10	766

Table 3
Pairwise correlations. N = 766. All correlations above | .07 | are significant at the p = .05 level (2-tailed).

		1	2	3	4	5	6	7	8	9	10	11	12
1	Tobin's *q*	1											
2	ROS	0.42	1										
3	ROE	0.45	0.44	1									
4	ROA	0.54	0.49	0.88	1								
5	Size	-0.18	0.06	0.16	0.12	1							
6	R&d intensity	0.14	-0.09	-0.04	-0.01	-0.03	1						
7	D/E	-0.13	-0.02	0.08	-0.22	0.06	-0.10	1					
8	Corp. governance score	0.18	0.30	0.12	0.14	-0.03	-0.17	0.00	1				
9	UN Global Compact	-0.17	-0.07	-0.04	-0.06	0.34	0.04	-0.05	-0.18	1			
10	Climate change inn.	-0.11	-0.13	-0.06	-0.09	0.08	0.03	0.04	-0.17	0.13	1		
11	Carbon performance	-0.07	-0.10	-0.07	-0.09	-0.11	0.12	0.05	-0.10	0.13	0.03	1	
12	Env. management	-0.02	-0.06	0.12	0.08	0.19	0.03	0.03	0.09	0.14	-0.01	0.00	1

Table 4

Carbon emissions, environmental management, and financial performance. Dependent variable: Tobin's *q*. Year and country dummies included but not reported. Energy is the baseline case for industry dummies. The numbers in parentheses are the heteroskedasticity-robust standard errors. ***, **, *, and † stand for p < .001, p < .01, p < .05, and p < .10, respectively.

	Tobin's *q* (*t*)			Tobin's *q* (*t* + 1)		
	(1)	(2)	(3)	(4)	(5)	(6)
Carbon performance		0.0879* (0.0411)	0.0954* (0.0427)		0.0600† (0.0357)	0.0653* (0.0332)
Quadratic carbon performance		-0.0100** (0.0038)	-0.0108** (0.0038)		-0.0092** (0.0031)	-0.0097*** (0.0029)
Env. management		0.0056 (0.0196)	0.3438** (0.1196)		0.0169 (0.0154)	0.2591*** (0.0734)
Env. man. * Carbon perf.			-0.1785** (0.0672)			-0.1193** (0.0394)
Env. man. * Quad. carbon perf.			0.0200* (0.0092)			0.0118* (0.0050)
Industrials	-0.2012** (0.0759)	-0.2029** (0.0753)	-0.1970** (0.0752)	-0.1184 (0.0820)	-0.1232 (0.0817)	-0.1196 (0.0809)
Materials	0.1020 (0.0703)	0.1076 (0.0697)	0.1079 (0.0696)	0.0863 (0.0652)	0.0863 (0.0639)	0.0838 (0.0633)
Utilities	-0.2400*** (0.0526)	-0.2419*** (0.0520)	-0.2352*** (0.0523)	-0.2561*** (0.0538)	-0.2560*** (0.0536)	-0.2510*** (0.0530)
Size	-0.0070 (0.0248)	-0.0149 (0.0253)	-0.0117 (0.0245)	-0.0103 (0.0222)	-0.0259 (0.0228)	-0.0250 (0.0225)
R&D intensity	0.05966† (0.0309)	0.0563† (0.0303)	0.0551† (0.0300)	0.0675* (0.0263)	0.0672† (0.0260)	0.0663† (0.0254)
D/E	-0.0014 (0.0215)	-0.0000 (0.0212)	-0.0000 (0.0219)	0.0483* (0.0242)	0.0477* (0.0237)	0.0484* (0.0234)
Corp. governance score	-0.0002 (0.0015)	-0.0007 (0.0016)	-0.0011 (0.0016)	0.0013 (0.0012)	0.0003 (0.0012)	-0.000 (0.0012)
UN Global Compact	-0.2103*** (0.0511)	-0.2001*** (0.0521)	-0.2006*** (0.0520)	-0.1813*** (0.0490)	-0.1750*** (0.0493)	-0.1738*** (0.0491)
Climate Change Innovation	-0.0026 (0.0041)	-0.0021 (0.0040)	-0.0028 (0.0044)	0.0003 (0.0036)	0.0009 (0.0035)	-0.0000 (0.0035)
Constant	1.5596** (0.5017)	1.5668** (0.5106)	1.5418** (0.4956)	1.4255*** (0.4233)	1.672*** (0.4285)	1.6883*** (0.4211)
No of firms	127	127	127	127	127	127
Observations	766	766	766	690	690	690
R-squared	0.3273	0.3326	0.3408	0.3004	0.3130	0.3203
F	10.80***	10.01***	9.50***	10.74***	10.67***	9.83***

Table 5

Carbon emissions, environmental management, and financial performance by different levels of Environmental management. Dependent variable: Tobin's q. Subsamples: (1) Environmental management $\leqslant$ median; (2) Environmental management > median. Number of firms do not add up because the same firm can figure in the two groups in different years. Year and country dummies included but not reported. Energy is the baseline case for industry dummies. The numbers in parentheses are the heteroskedasticity-robust standard errors. ***, **, *, and † stand for $p < .001$, $p < .01$, $p < .05$, and $p < .10$, respectively.

	Env. management $\leqslant$ median		Env. management > median	
	Tobin's q (t)	Tobin's q ($t + 1$)	Tobin's q (t)	Tobin's q ($t + 1$)
	(1)	(2)	(3)	(4)
Carbon performance	0.1615** (0.0545)	0.0633 (0.0549)	0.0148 (0.1037)	0.0091 (0.0635)
Quadratic carbon performance	-0.0161*** (0.0045)	-0.0084† (0.0046)	-0.0006 (0.0146)	-0.0007 (0.0075)
Industrials	-0.3566*** (0.0881)	-0.2102* (0.0985)	-0.0027 (0.1063)	0.0496 (0.1349)
Materials	0.0282 (0.0764)	-0.0455 (0.0729)	0.4269** (0.1413)	0.4517** (0.1234)
Utilities	-0.2811*** (0.0721)	-0.2749*** (0.0804)	-0.1665* (0.0737)	-0.1630† (0.0908)
Size	-0.0380 (0.0335)	-0.0359 (0.0371)	0.0580 (0.0425)	0.0568 (0.0365)
R&D intensity	0.1360*** (0.0348)	0.1437*** (0.0252)	-0.0689* (0.0289)	-0.0356 (0.0287)
D/E	0.0106 (0.0337)	0.0480 (0.0472)	0.0224 (0.0386)	0.0468 (0.0305)
Corp. Gov. Performance Score	0.0019† (0.0017)	0.0024 (0.0017)	-0.0056† (0.0033)	-0.0011 (0.0030)
UN Global Compact	-0.2530*** (0.0670)	-0.2453*** (0.0660)	-0.1985* (0.0873)	-0.1954** (0.0734)
Climate Change Innovation	0.0059 (0.0048)	0.0027 (0.0044)	-0.0109 (0.0105)	0.0052 (0.0129)
Constant	1.6196** (0.6034)	1.4512* (0.6257)	0.7098 (0.9359)	0.3389 (0.7467)
No of firms	96	96	99	99
Observations	383	345	383	345
R-squared	0.5326	0.5101	0.3320	0.3788
F	9.34***	8.21***	4.98***	7.08***

Table 6

Carbon emissions, environmental management, and financial performance by region. Dependent variable: Tobin's *q*. The "English legal origin" region is based on La Porta et al. (2006) and includes Australia, Canada, Hong Kong, India, New Zealand, South Africa, United Kingdom and USA. The "Annex B" region consists in Australia, Japan, Switzerland and all the current EU countries. "Europe" includes UK. Year dummies included but not reported. Energy is the baseline case for industry dummies. The numbers in parentheses are the heteroskedasticity-robust standard errors. ***, **, *, and † stand for p < .001, p < .01, p < .05, and p < .10, respectively.

	US and UK	Others	English legal origin	Others	Annex B	Others	Europe	Others
	Tobin's *q* (*t*)	Tobin's *q* (*t*)	Tobin's *q* (*t*)	Tobin's *q* (*t*)	Tobin's *q* (*t*)	Tobin's *q* (*t*)	Tobin's *q* (*t*)	Tobin's *q* (*t*)
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)
Carbon performance	0.1623**	0.0021	0.1158*	0.0715	0.0151	0.1000*	-0.1094	0.0535
	(0.0560)	(0.0567)	(0.0466)	(0.0722)	(0.1077)	(0.0487)	(0.0897)	(0.0488)
Quad. carbon performance	-0.0166**	-0.0019	-0.0158***	-0.0053	-0.0031	-0.0130**	0.0063	-0.0096*
	(0.0052)	(0.0046)	(0.0041)	(0.0054)	(0.0078)	(0.0041)	(0.0065)	(0.0043)
Env. management	0.0697	0.5050*	0.1488	0.3472	0.4632	0.1821	-0.2096	0.2557†
	(0.2021)	(0.2068)	(0.1421)	(0.3237)	(0.4832)	(0.1229)	(0.5480)	(0.1369)
Env. man. * Carbon perf.	-0.0122	-0.2903*	-0.0394	-0.2285	-0.2895	-0.0832	-0.0980	-0.1414†
	(0.1249)	(0.1166)	(0.0884)	(0.1623)	(0.2322)	(0.0742)	(0.2535)	(0.0844)
Env. man. * Quad. carb. perf.	-0.0039	0.0390*	-0.0021	0.0351†	0.0343	0.0145	0.0248	0.0184
	(0.0183)	(0.0154)	(0.0132)	(0.0197)	(0.0274)	(0.0109)	(0.0294)	(0.0125)
Industrials	-0.6993***	-0.2011**	-0.3818***	-0.1761*	-0.4691***	-0.2481*	-0.6481***	-0.1226
	(0.1203)	(0.0638)	(0.0883)	(0.0791)	(0.1060)	(0.1028)	(0.1094)	(0.0790)
Materials	-0.1440	0.2781***	0.1921*	-0.0879	-0.0706	0.2161**	-0.3292**	0.2858**
	(0.1135)	(0.0773)	(0.0844)	(0.0886)	(0.1263)	(0.0814)	(0.1144)	(0.0868)
Utilities	-0.5184***	-0.1710***	-0.4062***	-0.1354**	-0.284***	-0.3732***	-0.3209***	-0.2541**
	(0.0932)	(0.0478)	(0.0741)	(0.0508)	(0.0690)	(0.0752)	(0.0787)	(0.0797)
Size	-0.0536†	0.0096	-0.0132	-0.0254	-0.0279	-0.0630*	-0.0397	-0.0119
	(0.0311)	(0.0267)	(0.0270)	(0.0254)	(0.0287)	(0.0302)	(0.0274)	(0.0374)
R&D intensity	0.1162***	-0.0994***	0.0739*	-0.0347	-0.0581*	0.0921**	0.0183	0.0219
	(0.0351)	(0.0202)	(0.0323)	(0.0240)	(0.0281)	(0.0325)	(0.0521)	(0.0343)
D/E	0.0129	0.0442	0.0269	0.0050	0.0085	0.0058	0.0082	0.0060
	(0.0254)	(0.0383)	(0.0316)	(0.0410)	(0.0162)	(0.0531)	(0.0411)	(0.0521)
Corp. governance score	0.0056	0.0008	-0.0019	0.0015†	0.0019	-0.003†	0.0015	0.0030**
	(0.0042)	(0.0009)	(0.0016)	(0.0008)	(0.0012)	(0.0018)	(0.0019)	(0.0011)
UN Global Compact	-0.1996**	-0.2314***	-0.2177***	-0.1534*	-0.1097†	-0.3292***	-0.3165***	-0.0767
	(0.0757)	(0.0522)	(0.0599)	(0.0699)	(0.0606)	(0.0637)	(0.0837)	(0.0583)
Climate Change Innovation	-0.0097	-0.0154**	-0.0051	-0.0045†	-0.0142**	0.0064	-0.0100*	-0.0102
	(0.0115)	(0.0057)	(0.0093)	(0.0025)	(0.0051)	(0.0109)	(0.0045)	(0.0111)
Constant	1.6967*	1.078*	1.5701**	1.5471**	1.8092*	2.5206***	2.6449***	1.0847†
	(0.6648)	(0.4953)	(0.5341)	(0.5269)	(0.7048)	(0.5850)	(0.6681)	(0.6531)
No of firms	51	76	89	38	56	71	40	87
Observations	300	466	524	242	362	404	261	505
R-squared	0.4473	0.2826	0.3135	0.3316	0.2927	0.3936	0.4646	0.2728
F	9.28***	6.87***	10.60***	5.70***	6.47***	8.37***	7.75***	8.28***

Table 7
Carbon emissions, environmental management, and financial performance. Dependent variable: ROE (Return on equity), ROS (Return on sales), ROA (Return on assets). Year and country dummies included but not reported. Energy is the baseline case for industry dummies. The numbers in parentheses are the heteroskedasticity-robust standard errors. ***, **, *, and † stand for p < .001, p < .01, p < .05, and p < .10, respectively.

	ROE (*t*)	ROE (*t* + 1)	ROS (*t*)	ROS (*t* + 1)	ROA (*t*)	ROA (*t* + 1)
	(1)	(2)	(3)	(4)	(5)	(6)
Carbon performance	3.2016***	0.8660	2.2643*	1.7743†	1.4389***	0.7240
	(0.8816)	(1.0967)	(0.9091)	(0.9531)	(0.3362)	(0.4418)
Quadratic carbon performance	-0.3438***	-0.1769†	-0.2199**	-0.1924*	-0.1431***	-0.0970*
	(0.0844)	(0.0996)	(0.0839)	(0.0911)	(0.0311)	(0.0391)
Env. management	0.2187	0.3684	3.4346†	3.7029†	0.8161	0.4015
	(2.0612)	(2.1432)	(2.0685)	(2.1548)	(0.8312)	(0.8262)
Env. man. * Carbon perf.	0.3788	0.2995	-2.5063*	-2.5619*	-0.3021	-0.0354
	(1.2382)	(1.2205)	(1.1227)	(1.2001)	(0.4830)	(0.4591)
Env. man. * Quad. carbon perf.	-0.0313	0.0148	0.2839*	0.2981†	0.0356	0.0114
	(0.1763)	(0.1671)	(0.1425)	(0.1560)	(0.0649)	(0.0600)
Industrials	-3.6471	-5.1107*	-0.8306	-0.4506	-1.667**	-1.7728*
	(2.2729)	(2.1607)	(1.8133)	(2.0337)	(0.6161)	(0.7266)
Materials	0.0690	-1.5063	4.1955**	3.5155*	-0.2292	-0.6043
	(1.4729)	(1.4876)	(1.3338)	(1.4238)	(0.5184)	(0.5967)
Utilities	-4.4924*	-7.6876***	3.0596*	2.3601†	-2.4187***	-2.7955***
	(2.2295)	(1.5235)	(1.2007)	(1.3617)	(0.4553)	(0.5330)
Size	1.8581***	0.8602†	2.1927***	1.8562***	0.6692***	0.4311*
	(0.5229)	(0.4934)	(0.4462)	(0.4932)	(0.1735)	(0.1929)
R&D intensity	-0.0832	0.8394*	-0.1998	-0.0869	-0.0589	0.2308
	(0.3794)	(0.3346)	(0.2584)	(0.2751)	(0.1433)	(0.1536)
D/E	1.5320	4.372***	-0.1546	-0.0021	-0.3909**	0.0964
	(1.4622)	(0.6838)	(0.3327)	(0.5149)	(0.1485)	(0.1970)
Corp. governance score	0.0172	0.0100	0.0836*	0.0717*	0.0087	0.0020
	(0.0361)	(0.0382)	(0.0352)	(0.0343)	(0.0122)	(0.0139)
UN Global Compact	-3.0021**	-2.6463*	-0.9946	-0.9342	-1.0912**	-0.9200*
	(1.0817)	(1.1536)	(1.0076)	(1.1249)	(0.3943)	(0.4379)
Climate Change Innovation	-0.0959	0.0104	-0.1124	-0.0214	-0.0410	0.0077
	(0.1595)	(0.1790)	(0.1125)	(0.1229)	(0.0527)	(0.0605)
Constant	-32.6326**	-10.9244	-35.653***	-24.4598**	-10.3388**	-4.2200
	(9.7785)	(9.6819)	(8.839)	(9.4828)	(3.3726)	(3.7646)
No of firms	127	127	127	127	127	127
Obs	766	690	766	690	766	690
R-squared	0.2477	0.2688	0.3248	0.3047	0.3000	0.235
F	9.02***	8.08***	21.34***	19.29***	11.97***	9.08***

Figure 1
Moderating effect of Environmental management on the relationship between carbon performance and Tobin's *q* (at *t*). The horizontal axis reports standard deviations, covering about 90% of the distribution of the values of *Carbon performance*.