Firm environmental performance under scrutiny: The role of strategic and organizational orientations

A revised version of the paper has been accepted for publication in *Corporate Social Responsibility and Environmental Management*
It can be cited as follows: Ardito, L., and Dangelico, R. M. (2018) Firm Environmental Performance under Scrutiny: The Role of Strategic and Organizational Orientations. Corp. Soc. Responsib. Environ. Mgmt., 25: 426– 440. https://doi.org/10.1002/csr.1470.
Link to publisher version: https://onlinelibrary.wiley.com/doi/10.1002/csr.1470

Firm environmental performance under scrutiny: The role of strategic and organizational orientations on energy, carbon, waste, and water productivity

ABSTRACT

Improving firm environmental performance is getting a key target for most managers. However, achieving this target is not easy. Several studies investigated the antecedents of good firm environmental performance, however providing contrasting results, focusing on specific categories of antecedents, and often relying on subjective measures of environmental performance. This study is the first one to jointly consider different firm strategic orientations (market and technology) and organizational orientations (supply chain and environmental management) and their effect on several dimensions of environmental performance, objectively measured. Through the analysis of a sample of 269 large US companies included in the Newsweek Green Ranking, we found that: both market and environmental management orientation have a positive effect on carbon, energy, and water productivity; supply chain orientation has a positive influence on waste and water productivity; technology orientation negatively affects carbon and waste productivity. This study has important theoretical and managerial implications for the growing number of scholars and practitioners that are interested in the topic.

Keywords: environmental performance; market orientation; technology orientation; environmental management orientation; supply chain orientation; environmental sustainability

Introduction

Nowadays most companies have become conscious of the need to drive their business in a sustainable way, hence attempting to implement environmental initiatives; however, most of them fail to do that (Bhattacharya & Polman, 2017). Bhattacharya & Polman (2017) found that, in order to succeed, companies should recognize that environmental sustainability is not just another change-management initiative, and that it requires board engagement, looking at the whole value chain, and involving the whole organization. Accordingly, prior research contends that specific strategic and organizational orientations may help companies to achieve sustainability objectives such us better environmental performance (Adams et al., 2016).

In terms of strategic orientation, relying on general management studies, two main approaches can be distinguished: technology and market orientation (e.g., Hurley & Hult, 1998; Luukkonen, 2002). Technology orientation refers to the tendency to support new ideas and the adoption of new technology (Chen et al., 2014b; Hurley & Hult, 1998). In the environmental management domain, it means supporting new environmentally-friendly ideas, conducting environmental R&D, and developing new green products and processes (Varadarajan, 2017).

Instead, market orientation refers to company attention and responsiveness to evolving customer needs and expectations by delivering high-quality products and services (Jaworski & Kohli, 1993). This, in the domain of environmental sustainability, means understanding and answering to the growing market demand of environmentally-friendly products and to the higher and higher requirements for more sustainable production processes (Ottman, 1997). In terms of organizational orientation, companies may choose two different (although not mutually-exclusive) approaches: internally-oriented or externally-oriented (Eggers & Kaplan, 2009; Florida & Davison, 2001). In the environmental sustainability domain, the internally-oriented approach refers to environmental management practices developed within the firm (EMAS, ISO 14001, etc.) (Martín-de Castro et al., 2015; Testa et al., 2014). The externally-oriented approach refers to the involvement of external actors in the implementation of environmental management practices, as in the case of sustainable supply chains (Gold et al., 2010; Vachon & Klassen, 2008).

So far, several studies have analyzed the influence of different strategic and organizational orientations on firm environmental performance (e.g., Annandale et al., 2004; González-Benito & González-Benito, 2008; Testa et al., 2014; Zhu & Sarkis, 2004; Zobel, 2016). However, a review of these studies highlights some contrasting results. Moreover, no study simultaneously considers the effect of different types of orientations to environmental management on firm environmental performance. This issue is further exacerbated by the fact that most of this research lacks objective measures of environmental performance, and different measures of environmental performance (ranging from specific dimensions to composite indicators) are used in each study. These shortcomings prevent us from having a clear and robust picture of the effect of strategic and organizational orientations on firm environmental performance.

In order to overcome previous studies limits and provide a more comprehensive overview of the topic, this study aims at:

- understanding the influence of different types of strategic and organizational orientations on firm environmental performance;
- understanding whether this influence changes based on the type of environmental performance that is measured.

Specifically, this study will analyze technology and market orientations as strategic orientations, supply chain and environment management as organizational orientations, and four different dimensions of environmental performance (namely, carbon, energy, waste, and water productivity).

A sample made of 269 large US companies, included in the Newsweek Green Ranking (NGR) 2014, is analyzed. Data for environmental performance have been collected from the NGR

database, whereas data for strategic and organizational orientations have been collected through the content analysis of firms' environmental/sustainability/corporate social responsibility reports.
A series of regression analyses have been conducted to test the effect of different types of strategic and organizational orientations on different dimensions of environmental performance of firms.

The paper is structured as follows. In the next section, the theoretical framework is reported, with a review of the most important studies on the links between firm strategic and organizational orientations and environmental performance, and the research model is presented. Then, methodological details are provided and results described. Finally, discussions and conclusions are reported.

Theoretical framework and research model

Strategic orientation

Technology orientation and environmental performance

Technology orientation is the tendency to support new ideas and the adoption of new technology (Chen et al., 2014b; Hurley & Hult, 1998). It fosters the use of the latest technological advancements in new products and processes (Zhou et al., 2005). Therefore, strong emphasis is posed on R&D activities, the support for innovative ideas, and the rapid integration of new methods and solutions into a firm's procedures (Ardito et al., 2015; Gatignon & Xuereb, 1997). Thus, prior research (Chen et al., 2014b; Horbach, 2008) argued that firms with an environmental focus can achieve better environmental performance if they pursue a technology-oriented strategy. Indeed, the transition towards environmentally-friendly corporations requires firms to shift away from practices that are not resource-efficient and design eco-friendly products (e.g., Adams et al., 2016; Dangelico, 2016). However, this goal is achievable only if companies own the technical and knowledge resources needed to find alternative solutions in designing new products, operations, and industrial processes related to green initiatives (Dangelico et al., 2016; Varadarajan, 2017). For instance, Arora & Cason (1996) and Cole et al. (2005) revealed that R&D intensive firms more easily meet environmental regulations and reduce pollution emissions. Similarly, Rennings & Rammer (2009) found that firms developing product/process innovations also achieve energy and/or material savings by reaping the benefits deriving from the most recent technological advancements (Etzion, 2007). In addition, as a kind of strategic orientation, technology orientation, together with environmental responsiveness, affects corporate culture (Adams et al., 2016), thus favoring an environment conducive to learning and the implementation of innovative ideas into standard operational use, with the goal of drastically cutting the impact of firms' activities on the natural environment and stimulating sustainable practices among organizational members (Varadarajan, 2017).

However, some studies went against the notion that the higher the technology orientation the better firm environmental performance. They postulated about a negative relationship between an environmental technology-oriented strategy and the achievement of good environmental performance. This can be explained by the fact that technology orientation is a continuous process of selection and implementation of the most recent technological solutions (Zhou et al., 2005). That is, firms repeatedly move into new technological domains and engage in organizational renewal as the new technical solutions are integrated within the firms' processes (Costa et al., 2015). This means that even though less inputs are required, the achievement of more sustainable production processes may not occur because those processes never stabilize due to the fast pace of technological change and limitations in the learning capabilities of the firms' employees (Oltra & Saint Jean, 2009; Sagar & van der Zwaan, 2006). Accordingly, Sagar & van der Zwaan (2006) proved that it is not uncommon that developing and implementing new technologies come with some failure effects on the companies' performance. These include higher resource depletion during the trial-and-error process characterizing uncertain innovative efforts.

Furthermore, it is worth mentioning that private returns of eco-innovative activities are often lower than the social benefits they provide due to market failure effects (Rennings, 2000), whereby firms loose the incentives to direct their R&D efforts towards environmental initiatives. This implies that technology generation and utilization may be hampered, so more time is needed to actually see the results of technology-oriented strategy on environmental performance (Alkemade & Suurs, 2012).

Market orientation and environmental performance

Market orientation means tracking and responding to the continuously evolving customer needs and expectations (Jaworski & Kohli, 1993). It refers to "the organization-wide generation of market intelligence, dissemination of the intelligence across departments, and organization-wide responsiveness to it" (Jaworski & Kohli, 1993, p. 53). According to extant research, in todays' economic landscape market orientation will likely represent a key determinant of positive environmental performance. Indeed, customers' concerns about the environment is growing, and so their demand for environmentally-friendly business practices (e.g., Dangelico & Pujari, 2010; Oltra & Saint Jean, 2009). In turn, customers' pressure towards the reduction of firms' environmental impacts is rising and manifests through behaviors like boycott of perceived "grey" products and public campaigns against companies. Consequently, market-oriented firms tend to implement proactive environmental practices and establish new cultural and operational values in order to avoid building a negative image with respect to their customers and, hence, incurring in disadvantageous selective shopping and boycott (Darnall et al., 2010). Accordingly, González-Benito & González-Benito (2008) revealed that a high market orientation is conductive to practices aimed at limiting energy consumption and fostering recycling, among others; Kammerer (2009) also revealed that firms that care about customer benefits from environmentally-friendly products (i.e., those more energy and material efficient and less toxic) actually engage in environmental innovations. In addition, Chen et al. (2014a) and Green et al. (2015) postulated that a market-oriented strategy can help companies to comply with environmental regulations on emissions and reduce waste.

Furthermore, Boons et al. (2013) highlighted that a market-oriented strategy may let companies identify novel green niches. This may in turn represent an opportunity to increase environmental awareness, with the aim of establishing a solid market leadership. The automotive industry is a very-well known example of a sector that is under the pressure of customers for more eco-friendly attitudes, and whose companies consider market information as a key to be more receptive to the demand of customers and enhance their market position by improving process efficiency and cut water and energy consumption and pollution emissions (Segarra-Oña et al., 2014).

Organizational orientation

Supply chain orientation and environmental performance

Supply chain orientation (SCO) has been defined as *"the recognition by a company of the systemic, strategic implications of the activities and processes involved in managing the various flows in a supply chain"* (Mentzer, 2001, p.14). SCO has been recognized as a needed antecedent for effective supply chain management (SCM) (Esper et al., 2010; Min & Mentzer, 2004). Lorenzoni & Lipparini (1999) showed that, over time, companies are able to develop a specialized network of suppliers and build a more focused and competitive set of core competencies. The authors also highlighted that integrating knowledge both internal and external to the firm is an important organizational capability. As such, this capability can lead to competitive advantage (Collis, 1994). In the environmental sustainability domain, it can be expected that companies with a higher SCO will be more capable to direct their supply chain efforts/practices on exchanging knowledge and building core competencies related to green materials, components, packaging, and processes. These knowledge and competencies will lead to improved environmental performance.

Accordingly, several studies in the literature highlighted that adopting a SCO and including environmental issues into supply chain practices are positively linked to environmental performance. Diniz & Fabbe-Costes (2007) argued that SCM and SCO are key success factors in sustainable development projects in developing countries. Zhu & Sarkis (2004) found that external green supply chain management practices (including cooperation with suppliers for environmental objectives and cooperation with customers for eco-design or green packaging) lead to better environmental performance (including reduction of air emission, waste water, and solid wastes). Vachon & Klassen (2008) found that collaborations with suppliers on environmental issues lead to improved manufacturing performance (in terms of quality, delivery, and flexibility) and environmental performance (one factor made of solid waste disposal, air emissions, and water emissions). Vachon & Klassen (2006) showed that supply chain integration is beneficial for environment management in operations. Albino et al. (2012b) revealed that environmental collaborations along the supply chain lead to better firm environmental performance, in terms of management of its environmental footprint and environmental reputation. Green supply chain practices are also positively linked to green product development (Albino et al., 2009; Albino et al., 2012a).

Environmental management orientation and environmental performance

Environmental management orientation can be conceived as a proactive approach to environmental management and has been defined as an orientation that includes "*system analysis and planning, organizational responsibility, and management controls*" (Klassen, 2001, p. 257). These elements roughly correspond to the parts of an environmental management system, such as the policy and planning, implementation and operations, and checking and correction elements of ISO 14000 (Clements, 1997; Klassen, 2001). Given the widespread diffusion of environmental management systems (EMSs), over the past few years many studies have focused on understanding effects on firms' environmental performance, providing contrasting results. Due to these inconsistent results, as recently highlighted by Zobel (2016), many scholars called to deepen this area of research in order to find possible explanations for that (Gomez & Rodriguez, 2011; Heras-Saizarbitoria & Boiral, 2013; Testa et al., 2014). To this aim, Zobel (2016) conducted a study on the influence of ISO 14001 certified EMS on the rate of improvement of environmental performance in different areas (air emissions, water emissions, resource use, energy use, and waste), finding no statistically significant difference between certified and non-certified firms. However, results suggest that EMS adopting firms perform better in energy use and waste production, while non-adopting firms seem to perform better in air emissions (without statistical significance probably due to the use of a limited data set). Daddi et al. (2011), studying the effects of EMAS certification on different areas of environmental performance (water consumption, electric energy, total energy, and waste) in Italian firms belonging to different industries, found that EMAS certification in most cases leads to overall positive effects on environmental performance, even in the short term.

Testa et al. (2014) analyzed the effect of EMAS and ISO 14001 certifications on the reduction of CO_2 emissions in Italian energy intensive plants, finding that having a certified EMS has a positive impact on environmental performance both in the short and in the long run, even though in the short term weaker benefits derive from EMAS than ISO 14001. Zhu & Sarkis (2004) found that internal environmental management (including ISO 14001 certification or the existence of an environmental management system) lead to better environmental performance (including reduction of air emission, waste water, and solid wastes). Hertin et al. (2008) showed that the link between EMS certification and environmental performance is weak, since the adoption of EMS has a positive effect only on the performance trend of a small minority of environmental performance indicators. Adding a time perspective to the relationship between EMS and environmental performance, Russo (2009) investigated the effects of an ISO 14001 certified EMS on the reduction of toxic emissions by electronic manufacturing facilities, finding that early adoption of ISO 14001 and experience with this standard are positively linked to lower emissions. Even with regards to the effect of environmental management systems on green product innovation there are some contrasting results in the literature. On the one hand, some studies highlighted that the existence of an EMS (Albino et al., 2009; Albino et al., 2012a; Leenders & Chandra, 2013; Rehfeld et al., 2007) and the learning processes activated by the EMS (Rennings et al., 2006) positively impact on the development of green products, while other studies find that having an EMS di per se is not significant (Rennings et al., 2006; Wagner, 2008; Wagner, 2009).

In this study the effect of each type of strategic and organizational orientations on several measures of environmental performance will be investigated. In Figure 1, the research model of this study is depicted.

<Insert Figure 1 about here>

Figure 1. Research model

Methods and data

The NGR is the data source used to select the companies to include in our study. We considered the 2014 NGR, which measures the environmental performance of the 500 largest US companies over the period 2010-2012. The NGR provides information about firms’ carbon productivity, energy productivity, waster productivity, and water productivity. However, the NGR does not include data about the four factors under investigation (i.e., technology orientation, market orientation, supply chain orientation, and EMS). In order to collect these data, we used content analysis of firms' environmental/sustainability/corporate social responsibility reports (e.g., Albino et al., 2009; Albino et al., 2012b; Dangelico, 2015). Accordingly, we searched for the 2011 reports of all the companies in our initial sample, since we focus on the environmental performance of firms for the year 2012 (which is the most recent period considered by the NGR), and it is reasonable to assume that 2012 performance are the result of actions made early in time; thus, we looked one year backward respect to 2012. Only for 269 companies the 2011 report was available. These firms constituted our final sample. For each of them, we also collected some additional information (i.e., year of incorporation, profits, revenues, and number of employees) from the reports or supplementary sources such as the Financial Times, Fortune 500, Forbes Global 2000, and firms' balance sheets. Moreover, since for some companies the NGR does not provide one or more environmental performance, in our analyses (see Section 4), the sample size changes according to the availability of the environmental performance under consideration.

Variables

Dependent Variables

We considered a set of four dependent variables (DVs), each of which represents a different type of environmental performance. The four DVs are *Carbon productivity*, *Energy productivity*, *Waste productivity*, and *Water productivity.* All the DVs are provided by the NGR and measured, for each firm, as follows:

$$Carbon\ productivity = \frac{\text{Revenue (\$US)}}{\text{Total greenhouse gas emissions (CO2e)}};$$

$$Energy\ productivity = \frac{\text{Revenue (\$US)}}{\text{Total energy consumption (CO2e)}};$$

$$Waste\ productivity = \frac{\text{Revenue (\$US)}}{Total\ water\ use\ (m3)};$$

$$Water\ productivity = \frac{\text{Revenue (\$US)}}{\text{Total greenhouse gas emissions (CO2e)}}.$$

The values are corrected and normalized with respect to the sector each firm belongs to[1]. Each metric can thus assumes continuous values between zero and one. Thus, the DVs range between zero and one.

Independent variables

The four independent variables (IVs) of this study (i.e., *Technological Orientation, Market Orientation, Supply Chain Orientation, and Environmental Management Orientation*) are computed all in the same way. For the sake of brevity, we explain the general process to operationalize them. First, we defined a set of keywords representing each IV (see the Appendix). Second, for each firm and for each IV, we counted the number of times each keyword related to the IV under consideration is present in the firm's report and, then, we calculated the sum (e.g., (Albino et al., 2009). Finally, we divided this sum over the total number of words of the firm's sustainability report and multiplied by 100, thus having a percentage measure. This allowed us to get measures that are not influenced by the total length of the reports and that reflect the level of relevance given by each company to the specific dimension.

Control variables

Other variables were in included to increase the reliability of our model. First, we controlled for the firm age (*Age*), measured as the difference in years between 2011 and the year of incorporation. Since the skewness and kurtosis for this variable indicated a significant departure from normality we performed a logarithmic transformation, which allowed us to correct for this issue. Second, we included the variables *Employees* and *Revenues* to account for company size in 2011. Specifically, *Employees* is the natural logarithm of the number of employees working for a company, and *Revenues* is the natural logarithm of company sales. Third, we added the variable *Profits*¸ measured by normalizing a firm's profits in 2011 with respect to the sample mean, so that risks of violating normality assumption are reduced (e.g., Chang, 1995). Finally, industry dummies were included to control for sectorial effects.

Model specification

The DVs of this study range between zero and one, hence falling into the category of limited dependent variables (LDVs) (Long, 1997). In this case, the Tobit model is considered the best econometric approach to obtain reliable results. Indeed, other econometric approaches (e.g., OLS) generate inconsistent parameter estimates, thus being considered as less than ideal (e.g., (Long,

[1] More details about the methodology and how each metric is computed are available at http://www.newsweek.com/2014-newsweek-green-rankings-243744.

1997; Wiersema & Bowen, 2009; Wooldridge, 2012). Furthermore, the IVs, as well as the variables *Profits* and *Employees*, presented some severe outliers, which may undermine the consistency of results. Therefore, following previous studies (e.g., Bromiley & Harris, 2014; Castellaneta & Gottschalg, 2016), we managed outliers by winsorizing (see Wilcox, 2012) at the 4% (2% from the bottom and 2% from the top) and so run Tobit regressions with the winsorized variables.

Results

Table 1 shows descriptive statistics and pairwise correlations, with values below 0.70, hence limiting multicollinearity concerns (Cohen et al., 2013). Table 2 presents results of the Tobit regression. Each model in Table 2 refers to one of the defined DVs (*Carbon productivity*, *Energy productivity, Waste productivity, and Water productivity*).

<Insert Table 1 and Table 2 about here>

According to Model 1, technology orientation is negatively related to carbon productivity (β=-0.511, p<0.05), as opposed to market orientation and environmental management orientation, which both have a positive effect (β=0.190, p<0.01 and β=1.826, p<0.01, respectively). Instead, supply chain orientation seems not to have a significant influence on carbon productivity. Model 2 reveals that energy productivity is only affected by market orientation and environmental management orientation, as their coefficients are positive and significant (β=0.164, p<0.01 and β=1.006, p<0.10, respectively). Differently, Model 3 provides evidence that market orientation and environmental management orientation do not predict waste productivity; rather, this is sustained by supply chain orientation (β=0.197, p<0.05) and lessened by technology orientation (β=-0.039, p<0.10). Finally, results from Model 4 show that water productivity is positively influenced by market orientation (β=-0.185, p<0.01), environmental management orientation (β=2.111, p<0.01), and supply chain orientation (β=0.187, p<0.05), whereas technology orientation does not have a significant effect. Regarding the control variables, companies with a higher number of employees show negative performance with regard to carbon and water productivity (β=-0.049, p<0.05; β=-0.076, p<0.01). Instead, firms' profits appear to positively affect waste productivity (β=0.265, p<0.05).

Discussion and conclusions

To the best of our knowledge, this study is the first one to jointly consider different company's orientations (both strategic and organizational) and their effect on several dimensions of environmental performance.

Previous studies have generally considered the effect of one type of firm orientation on specific dimensions of environmental performance: e.g. supply chain orientation and waste (Zhu & Sarkis (2004), technology orientation and pollution emissions (Arora & Cason, 1996; Cole et al., 2005), technology orientation and energy and material efficiency (Rennings & Rammer, 2009), market orientation and air emissions and waste (Chen et al., 2014a; Green et al., 2015). Other studies have focused on aggregate measures of environmental performance, so making it impossible to understand the effect on single dimensions of environmental performance. For example, Zhu & Sarkis (2004) analyzed the effect of internal environmental management on a composite measure of environmental performance (made of reduction of air emission, waste water, and solid wastes), while Vachon & Klassen (2008) studied the effect of supply chain orientation on a composite measure of environmental performance (made of solid waste disposal, air emissions, and water emissions).(Green et al., 2015) In addition, there are several studies simultaneously analyzing the effect of having a certified EMS and several dimensions of environmental performance. However, these studies lead to contrasting or inconsistent findings. For example, Zobel (2016) found no statistical difference between ISO 14001 certified and non-certified companies on the rate of improvement of environmental performance in different areas (air emissions, water emissions, resource use, energy use, and waste); Hertin et al. (2008) highlighted that the adoption of EMS has a positive effect only on few environmental performance indicators. Similarly, contrasting thoughts exist regarding the role of technology orientation (Alkemade & Suurs, 2012; Rennings & Rammer, 2009).

The present study overcomes the limits of previous studies by simultaneously considering the effect of different types of strategic and organizational orientation and different dimensions of environmental performance. Furthermore, some of the measures of environmental performance used in previous studies (e.g., Zhu and Sarkis 2004; Vachon & Klassen, 2008; Green et al., 2015) origin from a qualitative self-assessment of environmental performance, with questions like "Please indicate the extent to which you PERCEIVE *(emphasis added)* that your plant has achieved each of the following during the past year: reduction of air emission, reduction of effluent waste, …" (Green et al., 2015):238). By contrast, since we use secondary data reported in the NGR for measuring environmental performance, our operationalization of DVs is objective (Vachon & Klassen, 2008) and provides a greater robustness to results.

In detail, we found that having a strong market orientation is very important for firms that aim to achieve high environmental performance. In fact, this type of strategic orientation displays a positive and significant impact on all types of considered performance, except waste, for which there is a non-significant, however positive, effect. This study also shows that technology orientation has a non-significant effect on energy and water productivity and a negative effect on carbon and waste productivity. This result recalls studies against the (probably over-simplistic) notion that more technological knowledge directly leads to better environmental performance (Oltra & Saint Jean, 2009; Sagar & van der Zwaan, 2006). Indeed, more time is likely needed to fully appreciate the beneficial effect of investments in innovation and R&D on environmental performance (Alkemade & Suurs, 2012). Or, extensive endeavor on the development and utilization of the latest technologies ultimately reduce the possibility to achieve efficiency in firm procedures. Another possible explanation could be that innovative efforts by companies may have been devoted mainly to product rather than process innovations, so not directly impacting on processes' environmental performance. In any case, future studies should delve into the role of technology orientation by analyzing potential moderating or mediating effect on its relationship with environmental performance (e.g., focus on product vs. process innovation and R&D strategies). With regards to the effect of environmental management orientation, we found that it is positive and significant on all types of environmental performance, except waste, for which there is a non-significant effect. Owing to the use of more objective data for a given type of environmental performance, this finding may highlight that inconsistences of previous studies on the effect of EMS may be due to the self-assessment bias or different dimensions of environmental performance that are considered simultaneously.

Finally, concerning the effect of supply chain orientation, this study found that it has a positive and significant effect on waste and water productivity, so highlighting that investing in green supply chain practices leads to improved environmental performance in the areas of water and waste, even in the short term. Conversely, the effect of supply chain orientation on both carbon and energy productivity is non-significant. This may occur because more time could be needed to fully appreciate the benefits deriving from green supply chain practices on carbon and energy footprints. It should be noticed that each type of strategic and organizational orientation has similar effects on both carbon and energy productivity, confirming that these two dimensions are strictly related. This suggests that, when formulating strategies for environmental management, companies should jointly consider these two areas of environmental performance to create synergies among planned actions.

From an managerial point of view, this research further advises managers that they should invest in both environmental activities internal to the firm (implementing environmental management systems) and external to the firm (developing green supply chain practices), since these affect different dimensions of environmental performance. Regarding strategic orientation, results are mixed. While market orientation shows a clear positive influence on three out of four environmental performance dimensions, hence suggesting that managers constantly invest in understanding market needs, technology orientation displays a negative effect on two of them. This counterintuitive result calls for caution when investing in green innovation, since it is very important to invest in the right direction, and managers should be aware that the positive effects of investments are not displayed in the short term.

This study has some limitations that should be acknowledged. First of all, while measures for environmental performance are secondary data, we created our own measures for strategic and organizational orientations collecting data from sustainability reports, through the use of keywords. Although this could seem to provide measures that are highly dependent on what companies want to communicate to stakeholders, it is coherent with what we aim to measure: “orientation”. Further, normalizing collected keywords for each type of orientation per the total number of words allowed us to shed light on the relative importance given by the company to the investigated type of orientation. Second, we study causal relationships between variables considering a one year time lag. This may have affected the obtained results, since for some variables to have an effect more time could be needed. In fact, this study results suggest that the beneficial effects of firm orientation may not be fully appreciated or are counterintuitive in the short term, future studies could explore the effect of firm orientations on environmental performance considering different time lags. Finally, since this study focused on US large companies, future studies should consider different samples, in terms of firm size or country, in order to understand whether the obtained results can be generalized to other populations.

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APPENDIX

<Insert Table A about here>

Figures

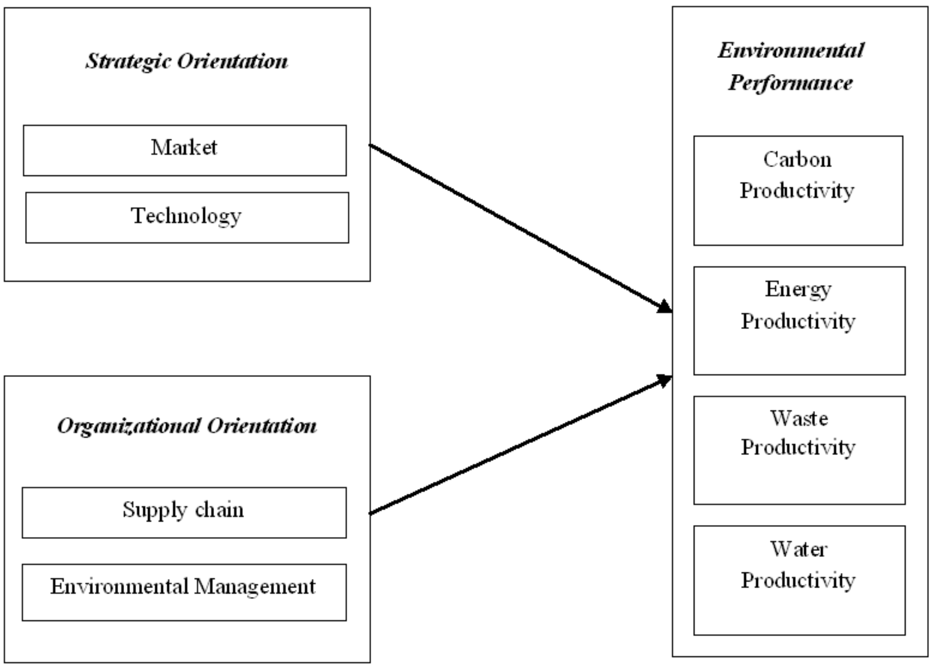

Figure 1. Research model

Tables

Technology orientation	Market orientation	Environmental management orientation	Green supply chain management orientation
Research and	*Market*	*EMS*	*Supply*
Development	*User*	*Environmental Management*	*Buyer*
R&D	*Consumer*	*System*	*Retailer*
Innovation	*Customer*	*ISO 14001*	*Supplier*
New Product		*Environmental Management*	
New Process		*and Audit Scheme*	
New Technology		*EMAS*	
Patent			

Table 1. List of keywords for each type of orientation

	Min	Max	Mean	S.D.	1	2	3	4	5	6	7	8
1-Age	0	5.20	3.53	1.08	1							
2-Employees	8.26	12.93	10.95	1.16	0.145*	1						
3-Revenues	8.23	12.80	10.33	1.01	0.064	0.676**	1					
4-Profits	0	.564	.111	0.126	0.097	0.350**	0.577**	1				
5-Technology orientation	0	.289	.081	0.076	0.024	0.088	0.069	0.063	1			
6-Market orientation	.04	1.13	.428	0.273	-0.030	0.096	-0.066	-0.143*	-0.104	1		
7-Environmental Management orientation	0	.086	.018	0.022	-0.008	-0.028	-0.005	-0.127*	0.100	-0.108	1	
8-Green Supply Chain Management orientation	0	.854	.208	0.187	0.069	0.219**	0.111	0.008	0.236**	0.085	0.140*	1

Table 2. Descriptive statistics and pairwise correlations
N=269; *p<0.05; **p<0.01

	Model 1 (Carbon productivity)	Model 2 (Energy productivity)	Model 3 (Waste productivity)	Model 4 (Water productivity)
Firm age	-0.001	0.006	0.024	0.002
	(0.013)	(0.014)	(0.016)	(0.014)
Employees	-0.049**	0.008	0.016	-0.076***
	(0.020)	(0.019)	(0.021)	(0.025)
Revenues	0.033	-0.016	-0.062	0.050*
	(0.023)	(0.025)	(0.027)	(0.028)
Profits	0.170	-0.010	0.265**	0.217
	(0.133)	(0.157)	(0.153)	(0.159)
Technology orientation	-0.511**	-0.315	-0.039*	-0.254
	(0.225)	(0.261)	(0.258)	(0.218)
Market orientation	0.190***	0.164***	-0.042	0.185***
	(0.052)	(0.052)	(0.070)	(0.050)
Environmental management	1.826***	1.006*	-0.401	2.111***
orientation	(0.513)	(0.591)	(0.660)	(0.705)
Green supply chain	0.039	-0.012	0.197**	0.187**
management orientation	(0.085)	(0.092)	(0.089)	(0.087)
Consumer discretionary	0.834	0.070	0.087	0.131*
	(0.055)	(0.059)	(0.056)	(0.067)
Healthcare	0.106	0.080	-0.119*	0.040
	(0.073)	(0.078)	(0.064)	(0.074)
Industrials	0.106**	-0.013	0.046	0.231***
	(0.051)	(0.056)	(0.064)	(0.066)
Information technology	0.148**	0.141*	0.073	0.143*
	(0.066)	(0.075)	(0.074)	(0.085)
Materials	0.046	0.023	0.065	0.080
	(0.068)	(0.068)	(0.084)	(0.077)
Telecommunication services	0.043	0.118**	0.042	0.064
	(0.051)	(0.059)	(0.070)	(0.063)
Utilities	-0.110*	-0.12*	-0.039	-0.184***
	(0.058)	(0.063)	(0.080)	(0.052)
Consumer staples	0.002	-0.032	-0.170	0.055
	(0.049)	(0.055)	(0.061)	(0.063)
Constant	0.512***	.386**	.766***	0.522**
	(0.179)	(0.169)	(.228)	(0.216)
F	3.07***	2.45***	2.41***	6.32***
Log pseudolikelihood	41.33	18.00	8.90	23.37
Observations	255	251	196	211

Table 3. Tobit results (with robust standard errors)
*p<0.10; **p<0.05; ***p<0.01