Electronic Working Paper Series
ESDES-Recherche

Do non-technological innovations and CSR matter for environmental innovation? An empirical analysis of a sample of innovators

Christian Le Bas et Nicolas Poussing

n° 2014-04

ESDES - Université catholique de Lyon
23, rue Carnot
69286 Lyon Cedex 02

Université Catholique de Lyon

Tél : 04.72.32.58.96
Fax : 04.72.32.51.58
www.esdes-recherche.net
esdes.recherche@univ-catholyon.fr

Do non-technological innovations and CSR matter for environmental innovation? An empirical analysis of a sample of innovators.

Christian Le Bas
ESDES School of Management

Nicolas Poussing
CEPS/INSTEAD – CREM

Abstract

This paper aims to fill a gap in the field of determinants of environmental innovation by investigating whether non-technological innovations and Corporate Social Responsibility matter for environmental innovation. Our empirical analysis studies a sample of innovators from Luxembourg. We draw on the Community Innovation Survey 2008 and a Corporate Social Responsibility survey specific to this country carried out the same year. Our econometric exercises show that organizational innovation and marketing innovation are positively and significantly linked to environmental innovation. The result holds when product and process innovations are included as independent variables. Corporate Social Responsibility plays a role as well.

Keywords: Environmental innovation, non-technological innovation, corporate social responsibility, determinants, survey, empirical analysis.

Biographical notes

Christian Le Bas is Full Professor of Economics at ESDES School of Management, Université Catholique de Lyon. He works in the fields of economics of innovation and knowledge. He is head of the master Management of Innovation and Intellectual Property (MIPI, University Lyon 2) and the collection W at Economies et Sociétés. He has published numerous papers in academic journals and several books such as *The Economics of Persistent Innovation: an Evolutionary View*, Springer, 2006 (with W. Latham).

Nicolas Poussing is Research Fellow at CEPS/INSTEAD, a public research institution located in Luxembourg (http://www.ceps.lu). He is also an associate fellow at CREM (Centre de Recherche en Économie et Management) at the University of Rennes 1 (France). He received a PhD in Economics and the French accreditation to supervise research (HDR). His research interests are broadly concerned with analysing the link between Corporate Social Responsibility and innovation (technological innovation, environmental innovation, Green IT). He also analyses the adoption and the effects of the Internet, in particular on social capital and happiness.

Do non-technological innovations and CSR matter for environmental innovation? An empirical analysis of a sample of innovators.

Abstract

This paper aims to fill a gap in the field of determinants of environmental innovation by investigating whether non-technological innovations and Corporate Social Responsibility matter for environmental innovation. Our empirical analysis studies a sample of innovators from Luxembourg. We draw on the Community Innovation Survey and a Corporate Social Responsibility survey specific to this country. Our econometric exercises show that organizational innovation and marketing innovation are positively and significantly linked to environmental innovation. The result holds when product and process innovations are included as independent variables. Corporate Social Responsibility plays a role as well.

Keywords
Environmental innovation, non-technological innovation, corporate social responsibility, determinants, survey, empirical analysis.

Environmental concerns and climate change present a crucial research topic for experts and economists. Environmental innovation is often presented as one among other means of solving environmental deterioration and degradation (Aghion et al., 2013; Veugelers, 2012; Ghisetti and Quatraro, 2014). It is a big challenge for the economics of determinants and consequences of environmental innovation (EI hereafter) that is becoming a fast-growing field of scholarship (see the survey by Laurens et al., 2014; Mazzanti and Zoboli, 2009; Triguero et al., 2013; Ziegler, 2013). To a large extent, the analysis of EI drivers is at the heart of the paper at hand. There is a certain consensus for considering that environmental innovation matches the "production, assimilation or exploitation of product, production process, service or management or business methods that is novel to the organization (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives" (Kemp and Foxon, 2007). By contrast, the issue of its determinants is less consensual.

The question we want to deal with in this paper is basically related to the firm determinants of EI. We raise the question: does an innovating firm necessarily innovate with environmental benefits? We remark empirically that not all the firms that innovate in their technological or organizational systems always direct their innovative efforts towards the improvement of the environment. For instance, in Luxembourg nearly 30% of innovating firms declare that their actions have no environmental benefits. As a consequence, the basic issue we want to address is the following: for a population of innovating firms (that is to say, firms considered as innovating *in general*), what are the factors explaining that some of them implement types of innovations with environmental benefits (i.e. EI) and others do not? Are they related to some characteristics of their innovations? For instance, is a product innovator more prone to innovate with environmental benefits than a process innovator? Is a complex innovator (product and process innovator) more environmentally friendly than a single innovator? Does implementing non-technological innovation (in relation or not to technological innovations) help to achieve EI? Does corporate social responsibility play a role in the adoption of EI? Do other factors impact on the decision to direct innovative efforts towards EI?

Up to now, the literature is rather silent on the types of innovation driving environmental innovation. In fact, we suspect that two sets of factors have an impact and we want to test whether this is the case. Pieces of literature on innovation show the economic and strategic importance of non-technological innovations (Mothe and Nguyen, 2012). We expect these types of innovations matter. Thanks to recent innovation surveys it is now possible to study the issue we raise. Does a firm that innovates in *organizational devices or in marketing concepts* increase its own capacity to implement environmental innovation? Is a firm combining product innovation and non-technological innovation increasing its probability of performing EI. The other aspect to be considered is the firm's own attitude to environmental concerns. In this context, Corporate Social Responsibility (CSR hereafter) presents a well-known phenomenon that takes into account a firm's positive voluntary attitude in favour of the environment (Poussing and Le Bas, 2013; Bohas et al., 2014). A firm having a CSR attitude is responsible as far as the environment is concerned. A crucial assumption we make is that CSR certainly matters as well as the type of innovation implemented.

The paper is organized as follows. In section 1 we review the recent literature dealing with the determinants of environmental innovation and the role of non-technological innovations and CSR. We conclude it with a summary of our research questions. The data set, the description of the sample of firms and the definition of variables are set out in section 2. In section 3 we present our empirical models and estimation. The results are also discussed.

1. The determinants of environmental innovation and the role of non-technological innovations and CSR: from survey to research questions

1.1. Environmental innovation determinants

Literature provides several determinants for explaining technological change dedicated to environmental targets. To account for the production of new pro-environment technologies, a lot of contributions suggest energy price as a main driver of directed technical change (Popp, 2002). The factors of prices play a significant role in directing technological progress towards greener technological systems (Acemoglu, 2002). It matches the induced technological change hypothesis put forth among others by Newell et al. (1999) (see in the same vein Jaffe et al., 2000). Taxes and subsidies can have the same effect in pushing environmental innovations (Acemoglu et al., 2012). According to Porter and Van der Linde (1995), environmental regulations can encourage innovations. For Chassagnon and Haned (2014), regulations and cost saving have a strong impact on eco-innovation adoption. They trigger the invention and the introduction of environmental improvements. They argue that achieving the highest efficiency compensates for both the compliance costs linked to environmental regulations and the innovation costs. Finally it gives the firms opportunities to build up new internal (to the firm) *competences* in green/clean technological activity considered as crucial for acknowledging the potential economic benefits.

A significant part of the literature considers investment in R&D activity, the accumulation of knowledge in environmental technologies and the absorption of external knowledge to be powerful drivers of environmental innovation. R&D activity is a factor pulling green innovation (Horbach, 2008; De Marchi and Grandinetti, 2012; Ziegler, 2013). Aghion et al. (2013) and Stucki and Woerter (2012) find that the accumulated stock of competences in clean technologies has an effect on the firm's current capacity to produce clean (and green) innovations. The work by Piscitello et al. (2012) on renewable energy inventions shows that the effect of international knowledge spillovers is significant and comparable to the effect of domestic R&D, even though it is smaller. For Galliano and Nadel (2013), *investing persistently* in R&D has a positive impact on the *intensity* of eco-innovation with the exception of consumer goods sectors (see also Chassagnon and Haned, 2013). R&D expenditures aimed at the invention of green technologies are often triggered by the environmental compliance costs (Nameroff et al., 2004). Another important factor is firm size (see De Marchi and Grandinetti, 2012; Ziegler, 2013). Larger firms are more likely to be engaged in environmental management practices than smaller firms (Petts, 1999; Worthington and Patton, 2005; Lepoutre and Heene, 2006; Perrini et al., 2007; Williamson et al., 2006; Lynch-Wood et al., 2009). But this variable is likely to interact with capacities to carry out different research projects in green technology fields. Openness on the international market (Brunnermeier and Cohen, 2003) and access to diverse resources (Jakobsen and Clausen, 2013) play a role. Drivers considered at the industry or nation level should work as drivers for environmental innovation as the intensity of competition (although this factor is controversial) and public policies appears the more important. In the same vein, Lazaric et al. (2014) focus on the pulling role of the final users. The work by Triguero et al. (2013) appears to be as a good example of an economic frame for EI drivers. They explicitly consider as economic determinants of EI: firm's market share, market demand for green products, technological capabilities and prices related to energy or raw materials. Our approach does not include these because it is focused on the possible impact of non-technological innovation and CSR. It appears rather complementary.

1.2. Non-technological innovation

Non-technological innovation can be defined as being in contrast to technological innovation which affects a firm's products and processes. Two kinds of non-technological innovation are particularly studied by the literature: organizational innovation and marketing innovation. Thanks to the CIS 2008 survey we greatly improved our knowledge about them. Organizational innovation is a very general term. Lam (2005) also pointed out that the phenomenon of "organizational innovation" is subject to different interpretations. The relationship between organizational innovation and technological innovation is far from clear. For instance, Edquist et al. (2001) suggested differentiating process innovation into two types: "technological process innovation" (for instance, a new type of machine) and "organizational process innovation" (for instance, a new type of work organization). Organizational innovation and process innovation clearly interplay. It is also acknowledged that radical technological innovation must be accompanied by substantial changes in the organization (Fagerberg, 2005). Damanpour (1992) emphasized a phenomenon of this kind. Some organizational innovations are firmly built on the technologies available (IT in particular). Here we draw on the definition given by the CIS 2008 survey: "An organizational innovation is a new organizational method in …. enterprise's business practices (including knowledge management), workplace organization or external relations that has not been previously used by the enterprise". It appears they are diverse in nature and their positive effects on firm performance must be different with respect to their intensity and their timing. Recently Polder et al. (2010) expressed the idea that organizational innovation had the strongest effects on firm productivity.

Marketing innovation has been studied rather recently. For instance, Rust et al. (2004) consider marketing innovation in relation to firm product strategy aiming to increase the firm market share or to enter a new market. The OSLO manual (see OECD, 2005) set up a very first step for rigorously defining it. We draw on CIS 2008 for our empirical analysis. In this survey a marketing innovation is the implementation of a new marketing concept or strategy that differs significantly from existing marketing methods and as a consequence has not been used before. This type of innovation "requires significant changes in product design or packaging, product placement, product promotion or pricing" (CIS 2008). It excludes "seasonal, regular and other routine changes in marketing methods". Recently Lhuillery (2014) showed the importance of marketing as a co-specialized asset for firm innovation persistence.

Innovation complementarity is a research perspective that has been dealt with rather rarely by few academics. It draws on the basic idea stemming from Edgeworth's intuition and developed coherently by Milgrom and Roberts (1995) that "doing more of one thing increases the returns of doing more of another" (Milgrom and Roberts, 1995: 181). It consolidates the foundations of the very important notion of synergies in industrial business. As far as innovation is concerned, two (or more) types of innovation jointly performed should have a more positive impact on firm performance (productivity, for instance) than one type of innovation performed alone. A recent paper by Le Bas and Poussing (2014), through a sample of firms from Luxembourg, concludes that complex innovators carrying out jointly product *and* process innovation are more persistent in their innovative activity than single innovators (achieving product *or* process innovation). A complex innovator that jointly achieves product and process innovation has one advantage in terms of potential for creativity and new ideas in comparison with a firm that is more specialized (product or process). Moreover, it may be that there are *synergetic relations* between improvements to the products and improvements to the processes. As argued by Flaig and Stadler (1994), the new knowledge generated through research carried out looking for product improvements can spill over into research projects aimed at improving processes and vice versa. Polder et al. (2010) used sourced from different data surveys from the Netherlands that show that there is evidence that organizational innovation is complementary to process innovation. Mothe et al. (2014) using French CIS data confirm the crucial role of organizational innovation in increasing firms' innovation and delineate patterns of complementarity among differing organizational practices according to the type of innovation. We think that performing different types of innovations jointly should have an effect on a firm's environmental performance. In this study we do not want to study per se the economic benefits stemming from innovation complementarity. We wish to test the potential impact of non-technological innovation complementarity on a firm's performance in terms of environmental innovation. For instance, as noted in the literature, a firm producing green innovation has to consider giving their product a new design (eco-design) or adding different packaging. The same kind of reasoning holds for the complementarity between process and organizational innovation. For instance, the implementation of clean-up technologies very often involves process and organizational innovation. As a consequence, in our empirical exercise we include variables of interaction between process and organizational innovation and product innovation and marketing innovation.

1.3. Voluntary measures for environmental changes and CSR

We define voluntary measures for environmental changes as "programs, codes, agreements and commitments that encourage organizations to voluntarily reduce their environmental impact beyond the requirements established by the environmental regulatory system" (Darnall and Sides, 2008). This implies a clear strategic commitment. The literature delineates a large variety of situations of this kind, such as private agreements or collaborations between organizations, public voluntary environmental programmes, agreements between private firms and public agencies and so on.[1] Since 1996, the ISO 14001 norm has been sponsored by the International Organization for Standardization (ISO) and matches standards for the environment management system EMS (Potoski and Prakash, 2005; Ziegler and Nogareda, 2009). In Europe, the Eco-Management and Audit Scheme (EMAS) is a management tool for companies to assess, report and improve their environmental performance.

Voluntary environmental measures are sometimes considered in relation to corporate social responsibility (Antonioli and Mazzanti, 2009). Corporate social responsibility (hereafter CSR) is also an important aspect of our study. Although this notion means different things to different people (Lyon and Maxwell, 2008), it means a set of rules organizing the process by which companies "integrate social and environmental concerns to their business operations and in their interactions with stakeholders on a voluntary basis" (according to the definition provided by the Commission of the European Communities (2001, p. 6). CSR practices clearly address environmental issues on a voluntary basis. If *firms implement according to their values* it may be that actions undertaken on a voluntary basis are also economically effective for the firm, according to a win-win hypothesis put forth by Porter and Van Der Linde (1995).

We basically think the main drivers of CSR are the firm's values as far as social or societal issues are concerned. It may be that the consequences of CSR practices have positive effects on a firm's economic performance, but the latter is not in any case the main factor inducing CSR behaviour.

It is very important for us to characterize different types of CSR responses that firms adopt. We use the taxonomy provided by Burke and Logsdon (1996), which is not very far from the analysis by Porter and Kramer (2006, 2011). They retain two types of CSR: strategic CSR, or proactive CSR, and responsive CSR, or reactive CSR. Strategic CSR requires an alignment between CSR and the firm's growth strategy, which then creates a virtuous circle that allows innovation activities to develop. By contrast, responsive CSR corresponds to the most basic level of CSR "acting as a good corporate citizen, attuned to the evolving social concerns of stakeholders, and mitigating existing or anticipated adverse effects from business activities" (Porter and Kramer, 2006). Here CSR contributes to minor improvements. Bocquet et al. (2013) emphasize the relevance of this taxonomy by showing that firms with a strategic CSR profile are more likely to innovate in both products and processes. The two types of CSR profiles matter in explaining a firm's innovation behaviour. Not all voluntary measures can be considered as related to CSR. Some of them are driven by the search for better technological performance or better competitive positions linked to cost reduction. Poussing and Le Bas (2013), using a

[1] See among others the contributions by Khanna (2001), Koehler (2007), and Henriques and Sadorsky (2008).

sample of firms from Luxembourg and estimating a probit model, find that CSR is an important factor in explaining environmental innovation.

Finally, the literature tells us only a little about the impact of non-technological innovation on a firm's capacity to achieve innovations with environmental benefits. We want to fill that gap in this paper. Of course, all the studies reviewed consider relevant factors pulling or pushing EI. We acknowledge their importance but our perspective is a little different. Here the emphasis is placed on the role that is played by the innovative conduct of the firm in terms of non-technological improvements. In fact, we believe that behind the different types of innovations there is an important supply side factor: a firm's technological capability. A firm's capacity to produce and master knowledge or to access and absorb external (to the firm) knowledge is of great importance. With the capacity to implement non-technological innovation (organizational and marketing innovation) the firm may shows dynamic capabilities, according to Teece (2007).[2] As a consequence, we can infer that a firm with this level of capacity may more easily launch EI.

2. Data sets, sample description and variables definition.

2.1. Data sets and sample description

To conduct our empirical analysis we used two Luxembourgish data sets. The first data set comes from a survey of CSR practices by firms. The second data set comes from the Community Innovation Survey (CIS 2008), which is the first survey on a European scale addressing environmental innovation. The CSR survey was conducted by CEPS/INSTEAD (Luxembourg) in 2008. This survey gives details about the CSR activities of firms in 2008. We also have details about the implementation of their CSR activities: the existence a CSR department, allocation of a CSR budget, definition of measurable objectives, creation of a reporting system, training of the staff, etc. From this survey we know whether firms adopt CSR in its three dimensions: economic, social and environmental. The Community Innovation Survey was conducted by CEPS/INSTEAD in 2008, on behalf of STATEC (the National Statistics Institute of Luxembourg). This survey describes firms' innovation behaviour. It aims to give information about firm conduct in terms of product, process, organizational and marketing innovation for the period 2006–2008. In particular, it tells us whether the firm innovates in each of these four technological and non-technological dimensions. In CIS 2008 a specific part of the survey is dedicated to environmental innovation. When a firm declares introducing EI the questions introduced in the questionnaire don't allow us to know what kind of environmental innovation is implemented (product and/or process, technological or non-technological).

These two surveys followed exactly the same methodology for the sampling process: a stratified random sample of firms from the national database of companies located in Luxembourg, available from STATEC. In consequence, using an identification number for the companies, it is possible to merge the two data sets. We obtain a data set containing 162 innovative firms. With the aim of making our results representative of the studied population, we use a weighting system based on the sampling probability and the

[2] "Dynamic capabilities relate to high-level activities that link to management's ability to sense and then seize opportunities, navigate threats, and combine and reconfigure specialized and cospecialized assets to meet changing customer needs, and to sustain and amplify evolutionary fitness, thereby building long-run value for investors" (Teece, 2007, p. 1344).

rate of response. In the sample the enterprises with 250 employees and more represent 18.5% of the sample. The proportion of industrial firms is 35.2%. Around one firm in four (25.9%) adopts CSR practices in the environmental area. With regard to innovation, 57.4% of firms implement a product innovation or a process innovation; 67.9% implement an organizational innovation; 53.1% a marketing innovation. The proportion of firms that adopts an environmental innovation is 26.6%. Among firms that implement environmental innovation, 28.5% declare participation in CSR practices in the environmental area. In this subsample, 63.0% of the firms implement a product innovation, 59.6% a process innovation, 72.2% implement an organizational innovation and 57.9% a marketing innovation.

2.2. Definition of variables

Our only dependent variable is the dummy variable INNO_ENV, which takes into account the probability of implementing environmental innovation (see the list of variables in Table 1). It takes the value 1 if firms introduce an innovation with any environmental benefit and 0 if not.

The main independent variables are first related to the firm's conduct in terms of innovation. Innovation practices are introduced in our models by dummy variables. Four dummy variables are related to every type of innovation activity. The variable PDT takes the fact that a firm introduces new or significantly improved goods. The variable PCS takes into account process innovation, the variable ORGA concerns an organizational innovation and MARK is related to marketing innovations. In addition, four other dummies cover different interactions of innovation conducts. On the one hand, we combine the different technological innovation practices and then the different non-technological innovation practices through interaction. We build up interactions between variables as follows. We focus on enterprises that carried out product and process innovation activities (variable: PDT*PCS) and enterprises that carried out organizational and marketing innovation activities (variable: ORGA*MARK). Lastly we analyse the combination between technological and non-technological innovation activities. To do so, we consider firms that implemented product and marketing innovation activities (variable PDT*MARK), and firms that carried out process and organizational innovation practices (variable PCS*ORGA). All these variables of interaction are dummy variables.

We also take into account CSR practices in two different ways. First, a dummy variable (CSR_ENV) indicates whether firms adopt CSR in the environmental area. In accordance with Porter and Kramer (2006), we distinguish between strategic and responsive CSR. Strategic CSR is part of business strategy and creates a competitive advantage for the firms that implement it; responsive CSR corresponds to a lower level of CSR commitment. Bocquet et al. (2013), using the methodology suggested by Burke and Logsdon (1996), performed a cluster analysis on our sample of firms in order to differentiate firms according to their implementation of CSR. Here we use their data set. This means we know whether a firm develops a strategic CSR (dummy variable: CSR_STRA) or a responsive CSR (dummy variable: CSR_RESPONS). Some firms, of course, have no CSR conduct.

We put in our regressions control variables that make sense as potential factors affecting a firm's propensity to innovate. According to Dosi (1997), technological opportunities and firm capabilities set up important innovation drivers. We have to take these into account. Technological opportunities (dummy variable PRODPER) are measured by the speed in which products and services become old-fashioned. Firm capabilities, which are the most important driver of innovative performance in the evolutionary tradition (Nelson and Winter, 1982; Teece and Pisano, 1994), are assessed by taking into account the proportion of employees with a higher education degree (EMPHI). Firm size is usual in this type of exercise. Firm size likely matters in terms of innovation performance (Wagner, 2010). For instance, large firms have more resources to invest in technological activities and a higher capacity to exploit external opportunities. In general, small firms are less innovative. But some of them can also be very innovative, particularly in high-technology sectors (Cohen, 1995). The size of firms is dealt with by using three dummy variables that summarize the total number of a firm's employees: SMALL (from 10 to 49 employees), MEDIUM (from 50 to 249 employees) and LARGE (250 or more employees). The business sector has been used as control variable for the analysis of the adoption of eco-innovations (Bocquet et al., 2013; Molla et al., 2009; Poussing and Le Bas, 2013). A control variable (INDUS) has been added. The type of sector (industry versus services) matters here (Gallego-Alvarez et al., 2011; Husted and Allen, 2007). If the company belongs to a group, this is indicated via the variable GROUP. According to Mohnen and Mairesse (2010), belonging to an industrial group modifies R&D conduct and gives more stability to the amount of R&D expenditure.

Table 1. List of variables

Label	Definition
INNO_ENV	Firm implements an environmental innovation that is a new or significantly improved product (good or service), process, organizational method or marketing method that creates environmental benefits compared to alternatives (dummy variable)
PDT	Firm implements a product innovation that is a new or significantly improved product (good or service)
PCS	Firm implements a process innovation that is a new or significantly improved process, organizational method or marketing method
PDT*PCS	Firm implements a product innovation and a process innovation
ORGA	Firm implements an organizational method that is a new organizational method in their enterprise's business practices (including knowledge management), workplace organization or external relations that has not been previously used by your enterprise
MARK	Firm implements a marketing innovation that is the implementation of a new marketing concept or strategy that differs significantly from your enterprise's existing marketing methods and that has not been used before
ORGA*MARK	Firm implements an organizational innovation and a marketing innovation
PDT*MARK	Firm implements a product innovation and a marketing innovation
PCS*ORGA	Firm implements a process innovation and an organizational innovation
CSR_ENV	Firms with an environmental CSR profile
CSR_STRA	Firms with a strategic CSR profile

Label	Definition
CSR_RESPONS	Firms with a responsive CSR profile
PRODPER	Products and services become rapidly old-fashioned
EMPHI	Percentage of employees with higher education (incl. post-secondary college and university)
SMALL	Total number of employees is between 10 and 49
MEDIUM	Total number of employees is between 50 and 249
LARGE	Total number of employees is more than 249
INDUS	Belongs to the manufacturing sector
GROUP	Firm is part of a group

Note: All variables are dummies (except EMPHI) and related to the period 2006–2008 (except CSR variables related to 2008). The main independent variables are in bold

It is important to note that all our variables are contemporaneous since they relate to the same time period, 2006–2008. Appendix 1 gives descriptive statistics related to our variables.

3. Models, estimation, results

Our research aims to identify the factors explaining why firms innovate in environmental change (environmental innovation). In order to achieve this goal, we use multivariate models that allow us to have a *ceteris paribus* approach. We are basically in a situation where two alternatives occur. The dependent variable is binary: it is equal to 1 if the firm implements innovations with environmental benefits and 0 if not. Simple dichotomous models (Thurstone, 1927) are appropriate. The logit and probit models are candidates for delineating such choices. They generally give very similar results (Morimune, 1979; Davidson and MacKinnon, 1984). We consider here logit models. The decision on whether to implement an innovation with environmental benefits or not is defined by yi, where yi = 1 when the company adopted this practice and yi = 0 when it did not. The probability of adopting an innovation with environmental benefits is conditional upon a series of exogenous variables:

$$\text{Prob}(y_i = 1) = F(\beta' x_i)$$

where F(.) indicates a cumulative distribution function, x_i the explanatory variables and β the vector of the parameters to be estimated. Due to the small number of firms in our sample we cannot estimate models with a large number of variables (Appendix 2 gives the correlation matrix of the variables).

We build up five logit models where innovation is introduced in five different ways. In the first model (Model 1) we put as main independent factors all the variables related to a firm's innovation conduct: product, process, organization and marketing. It is designed to inform us about the possible impact of each type of innovation. Model 2 aims to evaluate the impact of technological innovations only (product and process), including the expected effect of their interaction, and Model 3 the effects of *non-technological innovations* only (organization and marketing), including a variable of interaction between the two. With the two last models we want to examine whether interactions between technological and non-technological innovation have synergetic effects on the probability of implementing environmental innovation (as explained by the model of complementarity delineated above). Two approaches have been chosen. The first is based on the idea that complementarity is mainly linked to product and marketing innovations (Model 4) and the second that it would be embedded into process and organizational innovations (Model 5). Some pieces of the literature give relevance to this perspective (Milgrom and Roberts, 1995; Polder et al., 2010). For each of the five models we test the impact (supposed positive) of the firm's CSR attitude. We do so by putting in the equation two kinds of variables: either a variable picturing the environmental concerns dimension of CSR (option A) or variables related to the strategic/responsive approach of CSR (option B).

The estimation results are set out in Table 2. As far as the goodness of fit is concerned, we found rather similar percentages of concordance. In order to shed light on these findings, we calculated the Cox and Snell pseudo R square. The results this provides do not change significantly.

Table 2. The determinants of environmental innovation behaviours (logit model)

	Estimated coefficient (standard error)									
	MODEL 1		MODEL 2		MODEL 3		MODEL 4		MODEL 5	
	A	B	A	B	A	B	A	B	A	B
PDT	1.266*** (0.173)	1.317*** (0.176)	1.500*** (0.282)	1.620*** (0.233)	/	/	1.172*** (0.226)	1.090*** (0.224)	/	/
PCS	-0.093 (0.181)	0.089 (0.177)	-0.247 (0.225)	0.002 (0.220)	/	/	/	/	-0.744*** (0.246)	-0.670*** (0.245)
ORGA	0.715** (0.177)	0.906** (0.198)	/	/	0.673*** (0.224)	0.663*** (0.224)	/	/	-0.166 (0.248)	-0.076 (0.247)
MARK	0.889*** (0.168)	0.971** (0.167)	/	/	0.749*** (0.238)	0.661*** (0.237)	0.870*** (0.221)	0.779*** (0.225)	/	/
PDT*PCS	/	/	-0.342 (0.353)	-0.497 (0.354)	/	/	/	/	/	/
ORGA*MARK	/	/	/	/	0.074 (0.321)	0.361 (0.315)	/	/	/	/
PDT*MARK			/	/	/	/	0.089 (0.311)	0.431 (0.320)	/	/
PCS*ORGA			/	/			/	/	1.754*** (0.333)	2.028*** (0.347)
CSR_ENV	0.694*** (0.239)		1.304*** (0.222)	/	0.755*** (0.221)	/	0.899*** (0.219)	/	0.660*** (0.228)	/
CSR_STRA	/	0.459* (0.263)	/	1.058*** (0.254)	/	0.382 (0.252)	/	0.757*** (0.256)	/	0.102 (0.268)
CSR_RESPONS	/	-0.292 (0.248)	/	0.318 (0.223)	/	0.016 (0.227)	/	0.008 (0.236)	/	-0.379 (0.247)
PRODPER	0.387* (0.225)	0.349 (0.221)	0.484** (0.214)	0.315 (0.209)	0.484** (0.221)	0.483** (0.222)	0.176 (0.215)	0.107 (0.212)	0.788*** (0.221)	0.759*** (0.221)
EMPHI	-0.536** (0.242)	-0.550** (0.251)	-0.635*** (0.236)	-0.701*** (0.244)	-0.160 (0.232)	-0.097 (0.236)	-0.707*** (0.237)	-0.735*** (0.243)	-0.444* (0.240)	-0.382 (0.244)
SMALL	0.295 (0.191)	0.242 (0.190)	0.440** (0.181)	0.394** (0.179)	0.311* (0.188)	0.241 (0.187)	0.206 (0.189)	0.146 (0.187)	0.630*** (0.181)	0.595*** (0.181)
MEDIUM	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
LARGE	0.267 (0.378)	0.288 (0.379)	0.479 (0.365)	0.467 (0.361)	0.526 (0.357)	0.541 (0.355)	0.283 (0.378)	0.291 (0.375)	0.696* (0.359)	0.797** (0.365)
INDUS	1.296*** (0.216)	1.268*** (0.219)	1.190*** (0.212)	1.014*** (0.212)	1.185*** (0.208)	1.151*** (0.210)	1.173*** (0.211)	1.077*** (0.212)	1.131*** (0.207)	1.134*** (0.210)
GROUP	0.372** (0.167)	0.427** (0.170)	0.641*** (0.161)	0.704*** (0.163)	0.447*** (0.164)	0.494*** (0.167)	0.444*** (0.166)	0.504*** (0.169)	0.554*** (0.160)	0.642*** (0.163)
CONST	-1.317*** (0.276)	-1.455*** (0.276)	-0.630*** (0.236)	-0.617*** (0.233)	-0.883*** (0.282)	-0.815*** (0.281)	-0.803*** (0.248)	-0.671*** (0.242)	-0.253 (0.289)	-0.297 (0.290)
Sample size	162	162	162	162	162	162	162	162	162	162
Sum of Weights used	1022	1022	1022	1022	1022	1022	1022	1022	1022	1022
-2Log-likelihood	1030.635	1033.181	1074.443	1241.859	1091.494	1101.122	1048.835	1057.318	1086.047	1091.273
Per cent Concordant	73.0	73.5	70.4	70.3	70.9	70.8	71.0	71.2	72.5	72.6
Cox-Snell R square[3]	0.728	0.724	0.644	0.599	0.604	0.580	0.696	0.679	0.617	0.605

Standard error in parentheses. * Coef. significant at the threshold of 10%, ** 5%, *** 1%.
Source: Community Innovation Survey 2008 and CSR Survey (Luxembourg)

The coefficients estimated from Model 1 tell us that product innovation on the one hand and the two non-technological innovations on the other are significant variables pulling EI. With respect to technological innovation we get a robust result: the coefficient related to product innovation is always significantly positive (Models 1, 2 and 4). As a consequence, a product innovator has a higher probability of implementing an environmental innovation. This trend confirms the importance of eco-design as a natural driver of environmental innovation (Vernier, 2013).

[3] Following Allison (2013), we give the value of Cox and Snell (1989) R square that is the best R-Squared for Logistic Regression. Moreover it takes into account the sample size.

By contrast, we point out a surprising result: being a process innovator has no impact on the probability of implementing environmental innovation (Models 1, 2 and 5). This is a little contradictory with the evidence that many environmental innovations are "end-of-pipe improvements" affecting industrial processes (Brouillat et al., 2013). In Model 5, the coefficient related to process innovation is even negative (and significant), but a variable of interaction is put in the model that would greatly affect the sign of this coefficient.

With respect to non-technological innovation impacts, Models 1 and 3, focusing on organization or marketing innovations, tell us that organizational innovators and marketing innovators are more prone to innovate with benefits for the environment. Our results are in line with Ziegler (2013) showing the importance of a certified environmental management system and specific environmental organizational measures as determinants of EI.

The interaction variable between organization and marketing does not give any result. In other words, an innovator carrying out the two types of non-technological innovation together does not improve its probability of innovating for a better environment. Model 4 confirms the positive importance of marketing innovation and Model 5 that of organizational innovation, but in interaction with process innovation. At this stage we find out a crucial result: *non-technological innovations are effective for improving a firm's environmental context*. This is not, properly speaking, new, but had not been evidenced in a coherent manner until now. Of course, it does not mean that a technological innovator has no incentive to implement EI (on the contrary, see the estimated coefficients of Modes 1 and 3), but non-technological innovations seem to stimulate EI strongly as well.

With regard to the impact of CSR, the four models indicate that firms that have environmental concerns implement environmental innovations. This result was expected and in line with our previous findings (Poussing and Le Bas, 2013). If now we address the strategic dimension of CSR, our findings show that responsive CSR has no impact on the probability of innovating in environmental areas. By contrast, the results related to firms developing strategic CSR are mitigated. The coefficient of the variable related to strategic CSR is always positive but not always statistically significant. We observe that it has a significant effect when the firm is a product innovator. It is difficult to find a relevant interpretation in the analytical frame delineated in this paper. Further theoretical and empirical works would be necessary.

The signs of coefficients related to control variables are not always stable. The variable deemed taking into account the technological opportunities is positive but sometimes non-significant. Amazingly the variable measuring firm technological capacity (EMPHI) often has a negative impact on the probability of undertaking EI. In fact, we have to bear in mind that we are studying a population of innovators, which always have naturally large capacities. We do not find a stable effect of firm size. We cannot show evidence that large firms are more environmentally friendly. On the contrary, small firms seem to innovate more in EI. The sign of coefficients of INDUS and GROUP are always significantly positive, meaning that industrial firms and firm members of a group have a larger propensity to produce EI.

As far as interpreting the results is concerned, there are several possibilities. It may be that the effects on the environment are direct. For instance, new organizational practices can be designed for saving paper or for cleaning up the manufacturing. But it may be that indirect effects also exist but are difficult to capture with our data. For instance, marketing and organizational innovations increase the likelihood of implementing technological product innovations (Mothe and Nguyen, 2012), and a technological product innovator is well placed to achieve EI. We now turn to the variables of interaction delineating the complementarity between different types of innovations.[4] The estimations tell us there is no effect on environmental innovation production when a firm implements jointly product and process innovations, marketing and organizational innovations, and, contrary to our expectations, product and marketing innovation. The only significant positive complementarity that emerges concerns process and organization: a firm implementing jointly the two tends to increase the probability of performing environmental innovation.

Conclusion

- Our main results.

Our empirical analysis highlights the importance of non-technological innovation as a potential driver of environmental innovation. We basically show that:

a. Organizational innovation and marketing innovation are positively and significantly linked to EI. This holds when product and process innovations are included as independent variables.

b. Process innovation is not a significant positive driver of EI (by contrast, product innovation is). This amazing finding conflicts somewhat with the literature emphasizing that end-of-pipe process innovations are very numerous (Brouillat et al., 2013).

c. The tests for innovation complementarity as a potential driver of EI do not give clear positive results. Our analysis does not support in general the idea of a complementarity excepted for firms implementing jointly process and organizational innovations (see Model 5).

d. CSR plays a role. When an innovating firm declares taking actions for a better environment it innovates with environmental benefits. This result is in line with what all the literature tells us about a firm’s voluntary measures for environmental changes (see the survey provided by Poussing and Le Bas, 2013; Bohas et al., 2014). This is not systematically the case when it has strategic CSR.

- Limitations

The study has some limitations. Our work is based on a sample of innovators, and as a result our predictions only make sense for this category of firms. We simply have all the environmental innovators and all the technological innovators. It is not large enough to undertake all the tests we wanted to do.

- Future research

Further research is necessary for to better understand what type of EI is implemented in the spirit of the paper by Ziegler (2013). Moreover, trying to assess the technological

[4] Generally we have to be cautious in interpreting the sign, the value and the significance of coefficients related to interaction variables. As stated by Hoetker (2007), if the interaction term is significant there may not be a significant effect from some observations. Moreover, the sign of the coefficient may not indicate the direction of the interaction effect. The entire interaction effect must be calculated at a given value (Hoetker, 2007: 336).

value of EI (incremental and radical) would set up an interesting challenge for explaining firms' environmental performance.

References

Acemoglu, D. (2002) 'Directed technical change', *Review of Economic Studies,* Vol. 69 No. 4, pp. 781-810.

Acemoglu, D., Aghion, P., Bursztyn, L. and Hemous, D. (2012) 'The environment and directed technical change', *American Economic Review,* Vol. 102 No. 1, pp. 131-66.

Aghion, P., Dechezleprêtre, A., Hemous, D., Martin, R. and Van Reenen J. (2013) *Carbon taxes, path dependency and directed technical change: Evidence from the auto industry*. Fondazione Eni Enrico Mattei Working Papers.

Allison, P. (2013) What's the best R-Squared for Logistic Regression? Statistical Horizons. February 13 [online] http://www.statisticalhorizons.com/r2logistic (Accessed 26 September 2014).

Antonioli, D. and Mazzanti, M. (2009) 'Techno-organisational strategies, environmental innovations and economic performances. Micro-evidence from an SME-based industrial district', *Journal of Innovation Economics,* Vol. 3 No. 1, pp. 145-168.

Bocquet, R., Le Bas, C., Mothe, C. and Poussing, N. (2013) 'Are firms with different CSR profiles equally innovative? An empirical analysis with survey data', *European Management Journal*, Vol. 31 No. 6, pp. 642-654.

Bohas, A., Dagorn, N. and Poussing, N. (2014), 'Responsabilité sociale de l'entreprise: Quels impacts sur l'adoption de pratiques de Green IT?', *Système d'Information et Management*, Vol. 19 No. 2, pp. 9-43.

Brouillat, E., Oltra, V. and Saint-Jean, M. (2013) 'Les trajectoires de l'éco-innovation dans l'industrie. Un premier bilan des recherches', *Economie Appliquée,* Vol. LXVI No. 4, pp. 83-115.

Brunnermeier, S. B. and Cohen, M. A. (2003) 'Determinants of environmental innovation in US manufacturing industries', *Journal of Environmental Economics and Management,* Vol. 45 No. 2, pp. 278-293.

Burke, L. and Logsdon, M. (1996) 'How corporate social responsibility pays off', *Long Range Planning*, Vol. 29 No. 4, pp. 495-502.

Chassagnon, V. and Haned, N. (2014) 'The relevance of innovation leadership for environmental benefits: A firm level empirical analysis on French firms', *Technological Forecasting and Social Change,* [online] http://www.sciencedirect.com/science/article/pii/S0040162514000614 (Accessed 14 October 2014).

Chassagnon, V. and Haned, N. (2013) ‘PME et innovation environnementale: Une étude empirique sur données d’entreprises françaises’, *Economie Appliquée*, Vol. LXVI No. 4, pp. 117-140.

Cohen, W. (1995) Empirical studies of innovative activity. In P. Stoneman (Ed.), *Handbook of the Economic of Innovation and Technological Change*. Oxford: Blackwell.

Commission of the European Communities (2001). *Green Paper “Promoting a European Framework for Corporate Social Responsibility”*. COM 366 final, Brussels [online] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2001:0366:FIN:en:PDF (Accessed 26 September 2014).

Cox, D.R. and E.J. Snell (1989) *Analysis of Binary Data*. Second Edition. Chapman & Hall.

Damanpour, F. (1992) ‘Organizational size and innovation’, *Organization Studies*, Vol. 13 No. 3, pp. 375-402.

Darnall, N. and Sides, S. (2008) ‘Assessing the performance of voluntary environmental programs: Does certification matter?’, *The Policy Studies Journal*, Vol. 36 No. 1, pp. 95-117.

Davidson, R. and MacKinnon, J.G. (1984) ‘Convenient tests for logit and probit models’, *Journal of Econometrics*, Vol. 25 No. 3, pp. 241-262.

De Marchi, V. and Grandinetti, R. (2012) ‘Who are the green innovators? An empirical analysis of firm’s level factors driving environmental innovation adoption’. Paper presented at the *2012 DRUID Conference*. 19-21 June 2012. Copenhagen, Denmark.

Dosi, G. (1997) ‘Opportunities, incentives and the collective patterns of technological change’, *Economic Journal*, Vol. 107 No. 444, pp. 1530-1547.

Edquist, C., Hommen, L. and McKelvey, M. (2001). *Innovation and Employment*. Cheltenham and Northampton: Edward Elgar.

Fagerberg, J. (2005). Innovation, a guide to the literature. In J. Fagerberg, D.C. Mowery, & R.E. Nelson (Eds.), *The Oxford Handbook of Innovation* (pp. 1–28). New York: Oxford University Press.

Flaig, G. and Stadler, M. (1994) ‘Success breeds success. The dynamics of the innovation process’, *Empirical Economics*, Vol. 19 No. 1, pp. 55-68.

Gallego-Alvarez, I., Prado-Lorenzo, J.M. and Garcia-Sanchez, I.M. (2011) ‘Corporate social responsibility and innovation: A resource-based theory’, *Management Decision*, Vol. 49 No. 10, pp. 1709-1727.

Galliano, D. and Nadel, S. (2013) ‘Les déterminants de l’adoption de l’éco-innovation selon le profil stratégique de la firme: Le cas des firmes industrielles françaises’, *Revue d’Economie Industrielle*, Vol. 142. pp. 77-110.

Ghisetti, C. and Quatraro, F. (2014) *Is green knowledge improving environmental productivity? Sectoral evidence from Italian regions*, Working Papers series 11/14. Department of Economics and Statistics “Cognetti de Martiis”.

Henriques, I. and Sadorsky, P. (2008), ‘Voluntary environmental programs: A Canadian perspective’, *Policy Studies Journal*, Vol. 36 No. 1, pp. 143-166.

Hoetker, G. (2007) ‘Do modular products lead to modular organizations?’, *Strategic Management Journal*, Vol. 27 No. 6, pp. 501-518.

Horbach, J. (2008) ‘Determinants of environmental innovation – New evidence from German Panel data sources’, *Research Policy*, Vol. 37 No. 1, pp. 163-173.

Husted, B.W. and Allen, D.B. (2007) ‘Corporate social strategy in multinational enterprises: Antecedents and value creation’, *Journal of Business Ethics*, Vol. 74 No. 4, pp. 334-361.

Jaffe A.B., Newell, R.G. and Stavins, R.N. (2000) *Technological change and the environment*, NBER Working Papers 7970, National Bureau of Economic Research, Inc.

Jakobsen, S. and Clausen, T.H. (2013) ‘Comparing the innovation process in green and non-green firms: A look at barriers to innovation?’, Paper Presented at the *DRUID Academy 2013*. 16-18 January 2013. Aalborg, Denmark.

Kemp, R. and Foxon, T. (2007) ‘Typology of eco-innovation’, European Project ‘Measuring eco-innovation’ (Call FP6-2005-SSP-5A, Area B, 1.6, Task 1).

Khanna, M. (2001) ‘Non-mandatory approaches to environmental protection’, *Journal of Economic Surveys*, Vol. 15 No. 3, pp. 291-324.

Koehler, G. (2007) ‘The use of logit and probit models in strategic management research: critical issues’, *Strategic Management Journal*, Vol. 28 No. 4, pp. 331-343.

Lam, A. (2005) Organizational innovation. In J. Fagerberg, D.C. Mowery and RR Nelson (Eds.),*The Oxford Handbook of Innovation*, pp. 1–26. Oxford, England: Oxford University Press.

Laurens, P., Le Bas, C., Schoen, A., Villard, L. and Larédo, P. (2014) ‘Internationalisation of large firms R&D: Is the increase trend levelling off?’, Paper presented at *Geography of Innovation 2014*. Utrecht 23-25 Jan.

Lazaric, N., Jin J., Doual, A. and Ayerbe C. (2014) ‘Rôle des utilisateurs dans le développement de l'éco-innovation: Une recherche comparative en Chine et en France’, *Economies et Sociétés,* série W. No. 15, pp. 455-476.

Le Bas, C. and Poussing, N. (2014) ‘Are complex innovators more persistent than single innovators? An empirical analysis of innovation persistence drivers’, *International Journal of Innovation Management*, Vol. 18 No. 1, pp. 1-21.

Lepoutre, J. and Heene, A. (2006) 'Investigating the impact of firm size on small business social responsibility: A critical review', *Journal of Business Ethics,* Vol. 67 No. 3, pp. 257-273.

Lhuillery, S. (2014) 'Marketing and persistent innovation success', *Economics of Innovation and New Technology*, Vol. 23 No. 5-6, pp. 517-543.

Lynch-Wood, G, Williamson, D. and Jenkins, W. (2009) 'The over-reliance on self regulation in CSR policy', *Business Ethics: A European Review*, Vol. 18 No. 1, pp. 52-65.

Lyon, T.P. and Maxwell, J.W. (2008) 'Corporate social responsibility and the environment: A theoretical perspective', *Review of Environmental Economics and Policy,* Vol. 2 No. 2, pp. 240-260.

Mazzanti, M. and Zoboli, R. (2009) 'Environmental efficiency and labour productivity: Trade-off or joint dynamics? A theoretical investigation and empirical evidence from Italy using NAMEA', *Ecological Economics*, Vol. 68 No. 4, pp. 1182-1194.

Milgrom, P. and Roberts, J. (1995) 'Complementarities and fit: Strategy, structure, and organizational change in manufacturing', *Journal of Accounting and Economics*, Vol. 19 No. 2-3, pp. 179-208.

Mohnen, P. and Mairesse, J. (2010) *Using innovations surveys for econometric analysis*. Working Paper 15857. Cambridge, Mass: National Bureau of Economic Research.

Molla, A., Pittayachawan, S., Corbitt, B. and Deng, H. (2009) 'An international of green IT diffusion', *International Journal of e-Business Management*, Vol. 3 No. 2, pp. 3-23.

Morimune, K. (1979) 'Comparisons of normal and logistic models in the bivariate dichotomous analysis', *Econometrica*, Vol. 47 No.4, pp. 957-975.

Mothe, C. and Nguyen, U. (2012) 'Non-technological and technological innovations: Do services differ from manufacturing? An empirical analysis of Luxembourg firms'. *International Journal of Technology Management, Vol.* 57 No. 4, pp. 227-244.

Mothe, C., Nguyen, P. and Nguyen, U. (2014) 'Complementarities in organizational innovation practices: Evidence from French industrial firms', *Economics of Innovation and New Technology*, forthcoming.

Nameroff, T.J., Garant, J. and Albert, M.B., (2004) 'Adoption of green chemistry: An analysis based on US patents', *Research Policy,* Vol. 33 No. 6-7, pp. 959–974.

Nelson, R.R. and Winter, S.G. (1982) *An evolutionary theory of economic change.* Cambridge, Mass: Harvard University Press.

Newell, R.G., Jaffe, A. B. and Stavins, R.N. (1999) 'The induced innovation hypothesis and energy-saving technological change', *The Quarterly Journal of Economics*, Vol. 114 No. 3, pp. 941-975.

OECD (2005). *The Measurement of Scientific and Technological Activities: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data*. Oslo Manual.

Perrini, F., Russo, A. and Tencati, A. (2007) 'CSR strategies of SMEs and large firms. Evidence from Italy', *Journal of Business Ethics,* Vol. 74 No. 3, pp. 285-300.

Petts, J. (1999) *Handbook of Environmental Impact,* volume 1-2. Wiley-Blackwell.

Piscitello, L., Garrone, P. and Wang, Y. (2012) 'Cross-country spillovers in the renewable energy sector'. Paper presented at *DRUID 2012*. 19-21 June 2012. Copenhagen, Denmark.

Polder, M., Van Leeuwen, G., Mohnen, P. and Raymond, W. (2010). *Product, Process and Organizational Innovation: Drivers, Complementarity and Productivity Effects*. UNU-MERIT Working Paper Series 035, Maastricht Economic and Social Research and Training Centre on Innovation and Technology [online] http://www.merit.unu.edu/publications/publications-search/ (Accessed 26 September 2014).

Popp, D. (2002) 'Induced innovation and energy prices'. *The American Economic Review,* Vol. 92 No. 1, pp. 160-180.

Porter, M.E. and Van Der Linde, C. (1995) 'Toward a new conception of the environment–competitiveness relationship', *Journal of Economic Perspectives*, Vol. 9 No. 4, pp. 97-118.

Porter, M.E. and Kramer, M.R. (2006), 'Strategy and society', *Harvard Business Review*, December, pp. 77-92.

Porter, M.E. and Kramer, M.R. (2011) 'The big idea. Creating value. How to reinvent capitalism -- and unleash a wave of innovation and growth', *Harvard Business Review*, January-February.

Potoski, M. and Prakash, A. (2005) 'Green clubs and voluntary governance: ISO 14001 and firm's regulatory compliance', *American Journal of Political Science,* Vol. 49 No. 2, pp. 235-248.

Poussing, N. and Le Bas, C. (2013) 'Firm voluntary measures for environmental changes, eco-innovations and CSR: Empirical analysis based on data surveys', *Economie Appliquée,* Vol. 4, pp. 41-166.

Rust, R.T., Ambler, T., Carpenter, G.S., Kumar, V. and Srivastava, R.K. (2004) 'Measuring marketing productivity: Current knowledge and future directions', *Journal of Marketing,* Vol. 68 No. 4, pp 76-89.

Stucki, T. and Woerter, M. (2012), *Determinants of green innovation: The impact of internal and external knowledge*. KOF Working Papers n° 314. Sept.

Teece, D. (2007) 'Explicating dynamic capabilities: The nature and micro-foundations of (sustainable) enterprise performance', *Strategic Management Journal*, Vol. 28 No. 3, pp 1319-1350.

Teece, D.J. and Pisano, G. (1994) 'The dynamic capabilities of firms: An introduction', *Industrial and Corporate Change*, Vol. 3 No. 3, pp. 537-556.

Thurstone, L. (1927) 'A law of comparative judgment', *Psychological Review*, Vol. 34 No. 4, pp. 273-286.

Triguero, A., Moreno-Mondéjar, L. and Davia, M.A. (2013) 'Drivers of different types of eco-innovation in European SME', *Ecological Economics*, Vol. 92, pp. 25-33.

Vernier, M.F. (2013) 'Les facteurs clefs de succès de l'éco-conception. Leçons tirées de quelques cas d'entreprises', *Gestion : Revue Internationale de Gestion*, Vol. 38 No. 3, pp. 67-74.

Veugelers, R. (2012) 'Which policy instruments to induce clean innovating?', *Research Policy*, Vol. 41 No. 10, pp. 1770-1778.

Wagner, M. (2010) 'Corporate social performance and innovation with high social benefits: A quantitative analysis', *Journal of Business Ethics*, Vol. 94 No. 4, pp. 581-594.

Williamson, D., Lynch-Wood, G. and Ramsay, J. (2006) 'Drivers of environmental behaviour in manufacturing SMEs and the implications for CSR', *Journal of Business Ethics*, Vol. 67 No. 3, pp. 317-330.

Worthington, I. and Patton, D. (2005) 'Strategic intent in the management of the green environment within SMEs: An analysis of the UK screen-printing sector', *Long Range Planning*, Vol. 38 No. 2, pp. 197-212.

Ziegler, A. (2013) 'Disentangling technological innovations: A micro-econometric analysis of their determinants', *Journal of Environmental Planning and Management* [online].
http://www.tandfonline.com/doi/abs/10.1080/09640568.2013.855180#.VClKoEDuBf8
(Accessed 29 September 2014).

Ziegler, A. and Nogareda, J.S. (2009) 'Environmental management systems and technological environmental innovations: Exploring the causal relationship', *Research Policy*, Vol. 38 No. 5, pp. 885-893.

Appendix 1. Summary statistics of the variables for the full sample and the subsample of firms that implement environmental innovation

	Firms implementing at least one type of innovation (N=162)	Firms implementing environmental innovation (N=119)
Variable	Means (Std deviation)	Means (Std deviation)
INNO_ENV	0.7345 (0.4429)	1 (0)
PDT	0.5740 (0.4960)	0.6302 (0.4847)
PCS	0.5740 (0.4960)	0.5966 (0.4926)
ORGA	0.6790 (0.4683)	0.7226 (0.4495)
MARK	0.5308 (0.5005)	0.5798 (0.4956)
PDT*PCS	0.4135 (0.4940)	0.4621 (0.5006)
ORGA*MARK	0.3703 (0.4844)	0.4285 (0.4969)
PDT*MARK	0.3395 (0.4750)	0.3949 (0.4909)
PCS*ORGA	0.3765 (0.4860)	0.4369 (0.4981)
CSR_ENV	0.2592 (0.4395)	0.2857 (0.4536)
CSR_STRA	0.1481 (0.3563)	0.1680 (0.3755)
CSR_RESPONS	0.1666 (0.3738)	0.1680 (0.3755)
PRODPER	0.1419 (0.3501)	0.1512 (0.3598)
EMPHI	0.3733 (0.3463)	0.3499 (0.3301)
SMALL	0.3703 (0.4844)	0.3529 (0.4799)
MEDIUM	0.4444 (0.4984)	0.4369 (0.4981)
LARGE	0.1851 (0.3896)	0.2100 (0.4090)
INDUS	0.3518 (0.4790)	0.4033 (0.4926)
GROUP	0.6419 (0.4809)	0.6806 (0.4681)

Appendix 2. Correlation matrix of the variables

Pearson Correlation Coefficients, N=162								
Prob > |r| under H0: Rho=0								
	INNO_ENV	PDT	PCS	ORGA	MARK	PDT*PCS	ORGA*MARK	PDT*MARK
INNO_ENV	100.00	0.189 0.016	0.075 0.337	0.155 0.048	0.163 0.037	0.164 0.036	0.200 0.010	0.194 0.013
PDT		100.00	0.343 <.0001	0.022 0.773	0.140 0.073	0.723 <.0001	0.221 0.004	0.617 <.0001
PCS			100.00	-0.057 0.467	-0.034 0.665	0.723 <.0001	0.014 0.856	0.169 0.031
ORGA				100.00	0.042 0.591	0.120 0.125	0.527 <.0001	0.157 0.044
MARK					100.00	0.061 0.440	0.721 <.0001	0.673 <.0001
PDT*PCS						100.00	0.160 0.041	0.403 <.0001
ORGA*MARK							100.00	0.610 <.0001
PDT*MARK								100.00

Pearson Correlation Coefficients, N=162							
Prob > |r| under H0: Rho=0							
	PCS*ORGA	CSR_ENV	CSR_STRA	CSR_RESPONS	NO_CSR	PRODPER	EMPHI
INNO_ENV	0.207 0.008	0.100 0.203	0.093 0.237	0.006 0.937	-0.076 0.334	0.044 0.576	-0.113 0.151
PDT	0.385 <.0001	0.082 0.297	0.007 0.921	0.117 0.137	-0.1000 0.205	0.064 0.416	0.187 0.016
PCS	0.669 <.0001	0.167 0.032	0.078 0.323	0.150 0.055	-0.180 0.021	0.028 0.719	0.080 0.311
ORGA	0.534 <.0001	0.195 0.012	0.137 0.080	0.130 0.099	-0.209 0.007	-0.212 0.006	-0.038 0.623
MARK	0.066 0.398	0.076 0.334	0.043 0.579	0.055 0.484	-0.077 0.324	0.134 0.088	0.015 0.842
PDT*PCS	0.640 <.0001	0.103 0.188	0.073 0.354	0.128 0.102	-0.159 0.042	0.017 0.824	0.091 0.244
ORGA*MARK	0.327 <.0001	0.217 0.005	0.111 0.156	0.137 0.081	-0.195 0.012	-0.055 0.482	-0.045 0.563
PDT*MARK	0.276 0.0004	0.170 0.029	0.031 0.692	0.169 0.031	-0.159 0.042	0.119 0.130	0.060 0.447
PCS*ROGA	100.00	0.237 0.002	0.177 0.023	0.199 0.011	-0.296 0.0001	-0.133 0.090	0.129 0.101
CSR_ENV		100.00	0.506 <.0001	0.604 <.0001	-0.872 <.0001	-0.119 0.129	0.020 0.797
CSR_STRA			100.00	-0.186 0.017	-0.615 <.0001	-0.070 0.375	0.015 0.844
CSR_RESPONS				100.00	-0.659 <.0001	-0.039 0.617	0.065 0.406
NO_CSR					100.00	0.08533 0.2803	-0.064 0.414
PRODPER						100.00	0.161 0.040
EMPHI							100.00

Pearson Correlation Coefficients, N=162					
Prob > |r| under H0: Rho=0					
	SMALL	MEDIUM	LARGE	INDUS	GROUP
INNO_ENV	-0.060 0.447	-0.025 0.752	0.106 0.176	0.17944 0.0223	0.134 0.088
PDT	-0.063 0.424	-0.133 0.089	0.249 0.001	-0.045 0.569	0.137 0.080
PCS	-0.063 0.424	-0.083 0.289	0.185 0.018	-0.018 0.811	0.085 0.277
ORGA	-0.239 0.002	0.082 0.295	0.191 0.014	-0.047 0.551	0.148 0.059
MARK	0.106 0.178	-0.204 0.009	0.129 0.099	-0.058 0.459	0.123 0.117
PDT*PCS	-0.099 0.210	-0.095 0.227	0.245 0.001	-0.067 0.393	0.156 0.046
ORGA*MARK	-0.005 0.940	-0.171 0.029	0.226 0.003	-0.029 0.707	0.172 0.027
PDT*MARK	-0.036 0.640	-0.169 0.031	0.262 0.0007	-0.036 0.641	0.100 0.203
PCS*ROGA	-0.226 0.003	0.022 0.773	0.252 0.001	-0.039 0.621	0.155 0.048
CSR_ENV	-0.307 <.0001	0.122 0.119	0.225 0.003	-0.052 0.507	0.177 0.023
CSR_STRA	-0.139 0.075	0.046 0.555	0.114 0.147	-0.016 0.838	0.057 0.465
CSR_RESPONS	-0.171 0.029	0.033 0.673	0.170 0.030	-0.052 0.510	0.161 0.040
NO_CSR	0.244 0.001	-0.062 0.430	-0.224 0.004	0.054 0.494	-0.173 0.027
PRODPER	0.127 0.105	-0.043 0.582	-0.102 0.192	-0.151 0.054	-0.028 0.721
EMPHI	0.018 0.816	-0.023 0.762	0.007 0.922	-0.424 <.0001	0.065 0.404
SMALL	100.00	-0.685 <.0001	-0.365 <.0001	-0.029 0.707	-0.333 <.0001
MEDIUM		100.00	-0.426 <.0001	0.095 0.227	0.175 0.025
LARGE			100.00	-0.085 0.282	0.190 0.015
INDUS				100.00	-0.015 0.8401
GROUP					100.00