# Overcoming Obstacles to Innovation: Can Environmental Management Practices help?

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**Abstract**

Whereas the majority of research on environmental management practices explores its relationship with innovation performance, this chapter investigates whether those practices can help firms to overcome innovation obstacles. More precisely, the purpose of our article is to empirically investigate the relationship between environmental management practices and three types of innovation obstacles i.e. cost obstacles, knowledge obstacles and market obstacles. The model is tested on a sample of French firms and finds that the adoption of environmental practices reduces significantly cost and knowledge obstacles to innovation but has no significant effect on market obstacles. This study advances research on innovation performance improvement by emphasizing the important role of environmental management practices in overcoming obstacles to innovation.

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# 1 Introduction

In today intensified competitive market, firms need to innovate constantly in order to stay competitive. Actually, innovation plays a pivotal role in all fields of economic activities since it paves the way to competitive advantage in global markets (Montes et al., 2005). Innovation activities are considered consequently as a key tool of firm success in modern economies (Hitt et al., 1997; Encaoua et al., 2000). Although the concept of innovation is difficult to define, it is considered that an innovation presents new product or service, a new production process technology, a new structure or administrative system, or a new plan or program pertaining to organizational members (Damanpour, 1991).

Based on its importance, firms pay a great attention to develop innovation activities and once in place, they try by all means to sustain them (Dougherty, 1992; Bartel & Garud, 2009). For this purpose, they have to coordinate the different members' efforts, to solve problems of time and to know how, to use past experience to construct future ambitions and objectives (Bartel & Garud, 2009). Besides, firms are required to take a close look on factors that constrain innovation activities since sustaining innovation constitutes a central but also a very tough work (Bartel & Garud, 2009). For this reason, a great literature review was devoted to analyze innovation obstacles.

A first set of analysis investigates the effect of innovation obstacles on firms' operations such as R&D activities, types of innovation, intensity of innovation, decision to stop in advance or not beginning projects, a firm's tendency towards innovation and its insight towards barriers assessment (Mohnen & Röller, 2005; Savignac, 2008; Mohnen et al., 2008; Segarra-Blasco et al., 2008; Wziatek-Kubiak & Peczkowski, 2011; D'Este et al., 2012; Blanchard et al., 2013; Costa-Campi et al., 2014; Souto& Rodriguez, 2015).

The second wave of literature discusses also the manner how actually cost, knowledge and market obstacles prevent firms from innovation activities but focuses rather on innovations obstacles' determinants, the relationship between obstacles and firms' characteristics, and complementarities between obstacles (Mohnen & Rosa, 2002; Tourigny & Le, 2004; Galia & Legros, 2004; Hölzl & Janger, 2013; Galia et al., 2012).

Given the importance of innovation for firm performance success, surprisingly little research has gone into explaining how firms can overcome obstacles to innovation, outside of certain studies (Dougherty & Hardy, 1996; Bartel & Garud, 2009). Bartel & Garud (2009) state for example that sustaining innovation requires the harmonized participation of many parties working across different parts of the firm. In the same vein, the research of Dougherty & Hardy (1996) underlined the necessity for firms to characterize clear strategy and specialized management practices that would overcome barriers to innovation activities or at least reduce them. To reach this purpose, Dougherty & Hardy (1996) state that firms have to concentrate efforts on three main strategies: the first is the availability of financial resources for new products, the second is the existence of collaborative structures and processes to solve difficulties creatively and to facilitate the connection between new practices and existing procedures, and the third category is to put emphasis on innovative activities by incorporating innovation as a crucial element of the firm's strategy.

Therefore, this paper puts forward analysis that focus on the mechanisms through which environmental management practices (EMPs) may lower the probability of firm to be confronted to innovation obstacles. The rationale for supporting that environmental management practices lower obstacles to innovation can be traced in the literature that confirms positive relationship between environmental management practices and innovation (Porter & Van Der Linde, 1995; Jaffe & Palmer, 1997; Wagner, 2008; Bouziri & Pekovic, 2014). Additionally, several scholars argue that adoption of these practices improve cost saving strategy (Hart, 1995; Christmann, 2000; Delmas & Pekovic, 2015), enhance knowledge (Brekke & Nyborg, 2008; Delmas & Pekovic, 2013; Lanfranchi & Pekovic, 2014), create new systems for assembling information among employees (Delmas & Pekovic, 2013), boost demand for innovative goods and/or services (Klassen & McLaughlin, 1996) and offer consequently possibility to new firms's establishment.

This research offers several contributions. First, we contribute to environmental management and innovation literature going the step further and focusing to barriers to innovation. Second, we contribute to enhance the understanding about different barriers innovation and way to eliminate them. Third, following the call from (Dougherty

& Hardy, 1996), we identify the way how firms can overcome barriers to innovation. In fact, we argue that environmental management practices adoption has several advantages allowing firms to reduce significantly the obstacles confronted and that are likely to inhibit sustainable innovation activities.

The chapter is structured as follows. In the next section, we provide a literature review concerning the relationship between environmental management practices and innovation obstacles. In section 3 we present data and the econometric method used. Section 4 is devoted to the results and section 5 concludes.

# 2 Literature review

**Innovation obstacles**

Generally speaking, previous literature distinguishes cost, knowledge and market obstacles to innovation (Segarra-Blasco et al., 2008; Wziatek-Kubiak & Peczkowski, 2011; D'Este et al., 2012; Costa-Campi et al., 2014; Souto& Rodriguez, 2015).

Concerning the first category, cost factors can be the consequence of three possibilities that are lack of external funds from affiliated companies (i.e. subsidiaries or associates, loans from financial and non-financial companies, venture capital, public funding through loans or grants, funds from international and supranational organizations), limited internal financial resources (share capital, reserves) and the high cost of innovation (Souto& Rodriguez, 2015). This kind of barrier to innovation can occur in any type of product innovation, process, marketing or organizational activity. Indeed, the coexistence of these factors is considered as a crucial concern for the expansion of new business activities (Falk, 2007).

The second category is linked to knowledge or human obstacles. This kind of barrier arises from the need of skilled staff able to develop and sustain innovation activities, the result of lack in technology's information, lack of information on market (D'Este et al., 2012), and the complexity in identifying partner companies that would collaborate in the development of innovation activities (Souto& Rodriguez, 2015). In this sense, the difficulty to find cooperators may represent a considerable obstacle to innovation

since innovative firms need to collaborate and refresh existing knowledge (Becker & Dietz, 2004) for the purpose of maintaining competitive advantages. Also, the existence of trained employees and scientific experts are regarded as a very significant factor (Souto& Rodriguez, 2015) and is recognized as a prerequisite for innovation (OECD, 2000).

Finally, the third category is devoted to market barriers. The third type of innovation obstacle arises from the dominance of established firms in the market, the uncertain demand for innovative goods and from no requirement for innovation activities due to prior novelties or due to no demand (Segarra-Blasco et al., 2008). This type of obstacles is also important to take in consideration as Galia & Legros (2004) confirm that firms that neglect the precise desires of potential markets and needs of future consumers are likely to fail as innovators.

**Environmental practices and cost obstacles to innovation**

As access to finance constitutes a significant obstruction to innovation activities (Schneider & Veugelers, 2010), an important challenge is to know how firms can bypass or at least reduce it. We argue that the adoption of environmental management practices reduces cost or financial constraints related to innovation through two main mechanisms. Firstly, we underlined the ability of environmental management practices to reduce financial obstacles through cost savings. Actually, a great literature of review stipulates that by implementing environmental management practices, firms will reduce the cost of production by increasing the efficiency of production processes and by reducing input and waste-disposal costs (Hart, 1995; Klassen & McLaughlin, 1996; Christmann, 2000; Delmas & Pekovic, 2015). In fact, lowering expenses can be viewed as a crucial economic objective for adopting environmental management practices since it is argued that environmental practices such as ISO 14001 allows to decrease the cost of regulatory payments and environmental charges what may boost operative effectiveness and innovation performance (Sarkis, 1995; Delmas, 2001). Similarly, Hart (1995) argues that adoption of environmental management practices can create savings in input and energy consumption. It is considered that implementing an environmental standard is likely to lead to a reduction in labor costs. For instance, Brekke & Nyborg (2008) and

Lanfranchi & Pekovic (2014) show that workers are ready to provide a form of labor donation to environmentally responsible employers. Moreover, Ambec & Lanoie (2008) listed seven channels through which environmental management practices may provide benefits to firms or reduce their costs: better access to markets, greater possibilities for product differentiation, commercialization of pollution control technology and savings on regulatory costs, material energy and services, and capital and labor costs.

The second argument supporting the positive effect of green management practices in reducing cost or financial obstacles to innovation is related to investors's confidence. Today, investors are more interested in investigating the social, environmental and ethical dimensions of a firm before investing in it (Jenkins & Yakovleva, 2006). Therefore, as discussed by Jiang & Bansal (2003), beyond environmental considerations, firms gain legitimacy and send a positive signal on the market what enhances investors's confidence as well as faith (Morrow & Rondinelli, 2002; Rondinelli & London, 2003). Similarly, Kirkpatrick & Pouliot (1996) argue that environmental management practices can increase investor confidence and give firm worldwide competitive gains. On the other hand, if a firm does not show environmental commitment, investors may be concerned with ongoing firm operations and withdraw their support for the firm (Bansal & Clelland, 2004). In addition, thanks to corporate social activities, green firms may attract more public funding (Fox et al., 2002) what would have a positive direct influence on innovation by reducing financial obstacles. We therefore hypothesize that the adoption of environmental management practices reduces cost/financial obstacles to innovation.

*Hypothesis 1: The adoption of environmental practices lowers the cost obstacles to innovation.*

**Environmental practices and knowledge obstacles to innovation**

We argue in this part, that the adoption of environmental management practices contributes to boost employee involvement, interpersonal contacts, training (Delmas & Pekovic, 2013), all factors that improve human capitals and due reduce knowledge obstacles to innovation (D'Este et al., 2014). Actually scholars demonstrate that the

implementation of environmental management practices impacts organizational side of the firm's management since it implies changes in worker's behavior and attitudes (Florida & Davison, 2001; Delmas & Pekovic, 2013; Lanfranchi & Pekovic, 2014; Pekovic, 2015). We discuss several theoretical rationales that provide the underpinnings for how environmental management practices improves human capital and in turn may decreases knowledge obstacles to innovation. Indeed, to get its employees familiar with environmental management practices, firms implement training programs (Delmas & Pekovic, 2013; Khanna & Anton, 2002) that are considered to improve employee knowledge and experience. Previous scholars confirmed that ISO 14000 certification is an important determinant of training efforts within the organization (Delmas & Pekovic, 2013). Moreover, firms are accenting more and more their ethical and green reputation in order to attract more productive employees (Brekke & Nyborg, 2008; Grolleau et al., 2012; Lanfranchi & Pekovic, 2014). Similarly, Grolleau et al. (2012) demonstrate that social and environmental engagement can help firm to recruit skilled employees. Furthermore, turning to interpersonal contacts improvement, Delmas & Pekovic (2013) demonstrate that the adoption of environmental management practices improves interpersonal contacts which in turn contribute to improved communication among workers with diverse capabilities what leads to knowledge transfer and enhancement.
We therefore hypothesize that the adoption of environmental management practices reduces knowledge innovation obstacles.

*Hypothesis 2: The adoption of environmental practices lowers the knowledge obstacles to innovation.*

**Environmental practices and market obstacles to innovation**

To avoid this market barrier, Galia & Legros (2004) claim that firms have to be aware about the desires of potential consumers and the needs of a possible markets for new products or processes since uncertainty constitutes a substantial risk for innovation activities. Therefore, we argue that since the essential of environmental management practices is to identify customer needs, receive customer satisfaction feedback and decide

on product and service improvements (Darnall et al., 2010), those practices can play as a tool for eliminating market barriers to innovation. Similar argument that goes in favor that EMPs can overcome market barriers is proposed by Parsons (1991) and Pekovic et al. (2016) who argue that investment in green practices are more committed to superior customer value throughout their entire business system and not just in individual products or services. In this sense, Pekovic et al. (2016) stress the need for firms to set up organizational approaches in terms of environmental management practices that are in line with customer expectations in order to ensure demand for innovative goods and build competitive advantage. Additionally, it is considered that green firms experience higher customer demand (Klassen & McLaughlin, 1996). In fact, being environmentally ethically involved, constraint firms to minimize negative impacts of their products, to recycle costumer's waste after usage, and to establish EMPs, what would enlarge their markets and displace rival firms that do not succeed to stimulate sustainable environmental performance. For these reasons, we argue that thanks to environmental involvement, firms avoid problems to market's entry and bypass consequently the problem of market dominated by established companies. Therefore, we hypothesize:

*Hypothesis 3: The adoption of environmental management practices lowers the market obstacles to innovation*

# 3 Data and Model Specification

## 3.1 Data

We employ three French surveys, namely Community Innovation Survey (CIS, 2004-2006), Annual Firm Survey (EAE, 2003) and industry investment in environmental protection survey (ANTIPOL, 2004). The CIS in France was conducted by the institute for statistics and economic studies (INSEE) based on the Oslo Manual drawn up by the OECD. Its objective at firm level is to describe the innovation process, to measure its economic weight, to analyze its effects and to investigate its mechanisms such as coop-

eration, resources, obstacles, etc.

Because of empirical issues, we use the CIS6 edition that covers the period from 2004 to 2006. The EAE survey is a mandatory annual survey established by the institute for statistics and economic studies to collect basic data on the structure of firms. The EAE is the principal source of economic data regarding firmsáctivities, structure and performance. Finally, the Antipol is an annual survey that is focusing on expenditures, investments and types of studies that are carried out for environmental protection. The expenditures are collected every 3 years since 1992. Depending on the type of innovation obstacles (i.e. cost or knowledge or market), the merger of the three data-sets results in 1,043, 1,014 and 665 firms respectively.

Table 1 – Definition of variables and sample statistics

| Variables | Definition | Nb_OBS | Mean | SD | Min | Max |
|---|---|---|---|---|---|---|
| ***Dependent variables*** | | | | | | |
| *Cost_Obstacles_Inno* | Binary variable. (=1 if the composite variable *Cost_Obstacles_Inno_1* is superior than its mean and 0 otherwise). | 1043 | 0.53 | 0.50 | 0 | 1 |
| *Knowledge_Obstacles_Inno* | Binary variable. (=1 if the composite variable *Knowledge_Obstacles_Inno_1* is superior than its mean and 0 otherwise). | 1014 | 0.38 | 0.48 | 0 | 1 |
| *Market_Obstacles_Inno* | Binary variable. (=1 if the composite variable *Market_Obstacles_Inno_1* is superior than its mean and 0 otherwise). | 665 | 0.46 | 0.50 | 0 | 1 |
| ***Main explanatory variable*** | | | | | | |
| *EMP* | The firm has adopted in 2004 an Eco-Management and an Audit Scheme (EMAS) or an ISO 14001 as a mean to care about environmental issues. (=1 if yes) | 2102 | 0.37 | 0.48 | 0 | 1 |
| ***Control variables*** | | | | | | |
| *SIZE* | The number of employees. Continuous variable. | 2102 | 648.38 | 3324.87 | 0 | 107725 |
| *Group* | A firm is part of a holding company. Dummy variable (=1 if yes) | 2102 | 0.80 | 0.40 | 0 | 1 |
| *NET_INCOME* | The logarithm of net income. It is equal to logarithm of entity's income minus cost of goods sold, expenses and taxes for an accounting period. (continuous variable) | 2102 | 5.28 | 3.61 | 0 | 13.75 |
| *R*&D | A firm undertakes its R&D activities internally or externally. Dummy variable (=1 if yes) | 2102 | 0.64 | 0.48 | 0 | 1 |
| *SECT1* | The main activity of the firm is agri-food. (=1 if yes) | 2102 | 0.17 | 0.37 | 0 | 1 |
| *SECT2* | The main activity of the firm is consumption goods. (=1 if yes) | 2102 | 0.16 | 0.37 | 0 | 1 |
| *SECT3* | The main activity of the firm is automotive industry. (=1 if yes) | 2102 | 0.55 | 0.23 | 0 | 1 |
| *SECT4* | The main activity of the firm is equipment industry. (=1 if yes) | 2102 | 0.17 | 0.37 | 0 | 1 |
| *SECT5* | The main activity of the firm is intermediate goods. (=1 if yes) | 2102 | 0.42 | 0.49 | 0 | 1 |
| *SECT6* | The main activity of the firm is energy. (=1 if yes) | 2102 | 0.02 | 0.15 | 0 | 1 |
| *EXPORT: Instrumental Variable* | Logarithm of firm's export in 2003. (Continuous variable) | 2102 | 74306.94 | 713029.3 | 0 | $2.45.10^7$ |

Nb_OBS= Number of observations.

## 3.2 Econometric strategy

The same unobservable factors may have an impact on both environmental management practices and innovation obstacles. Hence, this potential unobserved heterogeneity will result in the correlated error terms of variables that present obstacles to innovation and environmental management practices. Thus, we apply a recursive bivariate probit model in order to correct for endogeneity of the variable EMP (Greene, 2003). The recursive bivariate probit model relies on a simultaneous estimation approach in which the fac-

tors that determine a firm's decision to adopt EMP are estimated simultaneously with the factors that determine obstacles to innovation. The two equations are jointly estimated using maximum likelihood.

Our observed variables, $Y_1$ and $Y_2$, corresponding respectively to EMP and environmental innovation obstacles are defined by:

$$Y_1 = \begin{cases} 1 & \text{if} \quad Y_1^* > 0 \\ 0 & \quad otherwise. \end{cases}$$

$$Y_2 = \begin{cases} 1 & \text{if} \quad Y_2^* > 0 \\ 0 & \quad otherwise. \end{cases}$$

$Y_1^*$ is a latent variable influencing the probability that firms adopt environmental management practices and $Y_2^*$ is also a latent variable that presents firm probability to face innovation obstacles. We consider the following recursive bivariate probit model:

$$\begin{cases} Y_1^* = \alpha_1 + \beta_1 X_1 + \delta Z_1 + \mu_1 \\ Y_{2k}^* = \alpha_2 + \beta_2 X_2 + \gamma Y_1 + \mu_2 \end{cases}$$

Where $X_1$ and $X_2$ are a vector of exogenous variables including firms' characteristics (*SIZE*, *GROUP*, *R*&D, *NET_INCOME* and *SECTOR OF ACTIVITY*).

The vector of variables $Z_1$ represents the instrumental variable which ensures the identification of the model and helps to estimate correlation coefficients (Maddala, 1986). Indeed, in order to identify the recursive bivariate probit, it is required to have a supplementary variable that will impact the probability of environmental management practices implementation but that will not explain obstacles to innovation (Table 8, Table 9 and Table 10 in the Appendix). The problem here is that we can assume very analogous factors that explain both environmental management practices and obstacles to innovation. Furthermore, we are facing the absence of an official econometric test that could provide an accurate specification of the model. For this reason, the choice of the instrumental variable that is expected to influence one equation and not the other, will

be substantively explained and theoretically augmented. In this chapter, we use the export (*EXPORT*) as an instrumental variable.

The choice of the variable *EXPORT* is based on the fact that environmental practices constitute a sort of pass to have business activities with international firms (Delmas, 2002). In fact, firms that have distant customers are more likely to prove their environmental commitment through institutional devices like ISO 14001 since their environmental performance is frequently unobservable, especially to customers located in areas which are institutionally, geographically and culturally different (Grolleau et al., 2012). In addition, many scholars empirically confirmed the positive relationship between environmental management practices and export e.g. (Corbett & Kirsch, 2001; Bansal & Hunter, 2013; Grolleau et al., 2007; Delmas & Montiel, 2009; Grolleau et al., 2012; Delmas & Pekovic, 2013).

$\beta_1, \beta_2$ , $\delta$ and $\gamma$ are slope coefficients to be estimated. $\alpha_1$, $\alpha_2$, $\mu_1$ and $\mu_2$ are the intercepts and disturbance terms for the two equations, respectively. $k$ distinguishes between cost, knowledge and market obstacles to innovation.

*rho* ($\rho$) is the correlation between the error terms of environmental management practices and obstacles to innovation equations. Residuals of the equations above follow a normal bivariate normal distribution (BVN) with zero means and a covariance matrix $\Sigma$.

$$\begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} \sim \mathcal{N}(\mu = 0, \Sigma), \text{ where } \Sigma = \begin{pmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{12} & \sigma_2^2 \end{pmatrix}.$$

It is worth noting that in addition to the necessity of the instrumental variable existence, a second constraint of identification needs to be respected. In fact, in order to estimate all the parameters, the residual variances of the two equations have to be normalized to 1. The correlation matrix is consequently written as follows: $\Sigma = \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix}$.

A Wald test of the significance of *rho* ($\rho$) is a direct test of the endogeneity of $Y_1$ and $Y_2$ (Wooldridge, 2002). When *rho* ($\rho$) is statistically different from zero, that is, the probability that a relationship exists between environmental management practices and innovation obstacles, simultaneous estimation procedures are essential to appropriate estimation.

Noteworthy, in order to overcome this reverse-causality concern, our estimations are performed using lagged information. While the implementation of environmental management practices is observed in 2004, obstacles to innovation are observed between 2004 and 2006.

## 3.3 Dependent and independent variables

*Dependent variables*

As discussed previously, we analyze in this work the impact of environmental management practices on three types of innovation obstacles previously defined in the literature (Galia & Legros, 2004; Segarra-Blasco et al., 2008; D'Este et al., 2012; Hölzl & Janger, 2013; Costa-Campi et al., 2014; Souto& Rodriguez, 2015). The information about innovation obstacles is obtained from CIS 2006.

*Cost_Obstacles_Inno*. To assess innovation obstacles related to cost, we use the sum of three following variables: lack of internal funds, lack of external funds and high innovation cost. Then we make a binary variable that takes value 1 if the sum of these three factors is superior than its mean and 0 otherwise.

*Knowledge_Obstacles_Inno*. To measure innovation obstacles related to knowledge, we construct a variable that takes into account the following: lack of qualified personal, lack of technical information, lack of market information and difficulty in finding partners for innovation. As in previous case, then we make a binary variable that takes value 1 if the sum of these factors is superior than its mean and 0 otherwise.

*Market_Obstacles_Inno*. We construct innovation obstacles related to market as a sum of following variables: market dominated by established firms, uncertain demand for innovative goods or services and no need for innovation, no need for innovation due to prior novelties and inventions and no demand at all for innovation. Then we make a binary variable that takes value 1 if the sum of these factors is superior than its mean and 0 otherwise.

*Independent variable*

*EMP*. We use the EMP variable, which is a binary variable for the firm having implemented the ISO 14001 standard or an environmental management system. The variable is taken from Antipol survey 2004.

*Controls*

*Size*. A great number of empirical studies found that the probability of implementing environmental management practices increase with firm size (Darnall et al., 2010; Delmas & Montiel, 2009; Grolleau et al., 2007). Firm size has also been perceived as a significant determinant in reducing innovation obstacles (Iammarino et al., 2009; D'Este et al., 2012; Galia et al., 2012). Firm size is measured by the number of employees within the firm and taken from CIS 2004.

*Group*. Being part of a group has a positive and significant influence on the probability to adopt environmental management practices (Grolleau et al., 2012). Furthermore, taking part of a holding, allows firms to better assess and to reduce more obstacles to innovation compared to firms that do not belong to a group (Iammarino et al., 2009; Galia et al., 2012). We include a dummy variable that takes a value of 1 if the firm belongs to a holding company. The information is obtained from CIS survey.

*R*&D. Previous literature stipulates that environmental management practices adoption grows with investment in R&D (Arimura et al., 2007). On another hand, it has been shown that the more the firm is involved in R&D and innovative activities, the greater it attaches importance to innovation obstacles (Mohnen & Rosa, 2002; Galia & Legros, 2004; Galia et al., 2012). We argue therefore that investment in R&D may constitute an important driver of innovation obstacles existence. R&D is a binary variable equal to 1 if the firm carries out its R&D growth actions internally or externally. The information on this variable is obtained from CIS4 data.

*Net_Income*. As argued by Darnall & Edwards (2006), we advance a positive and significant link between firm resources and the environmental investment. We argue that *Net_Income* should have a significant impact on reducing innovation barriers since it can be considered as a proxy of the firm financial situation (Dougherty & Hardy, 1996). Therefore, we integrate *Net_Income* among controls as a continuous variable that is

calculated as the entity income minus cost of goods sold, expenses and taxes for an accounting period. This variable is taken from EAE 2003.
*Sector of activity*. We include sector dummy variables generated according to the Nes36 sector classification, made by the French National Institute for Statistics and Economic Studies: agri-food, consumption goods, cars, equipment, intermediate goods and energy.

The variables used in estimation, their definitions and sample statistics are presented in Table 1. No problem of multicollinearity has been detected (Table 5, Table 6 and Table 7 in the Appendix).

# 4 Results

Bivariate probit estimation results are presented in Tables 2, 3 and 4 together with goodness-of-fit measures (Maximum-Likelihood estimation). *rho* ($\rho$) is significantly different from zero (Table 2 ), in the first model analyzing cost obstacles to innovation. The usage of the biprobit model is consequently accurate and well appropriate to avoid the endogeneity problem. However, *rho* ($\rho$) is not significantly different from zero in the models dealing with knowledge and market obstacles (Table 3 and Table 4 ). So a simple univariate probit model would give unbiased results. Nevertheless, implementing the bivariate probit model was necessary to check for the exogeneity of these variables.

Table 2 – Bivariate probit estimates of the effect of environmental management practices on cost obstacles to innovation

| | *EMP* | | *COST_OBSTACLES_INNO* | |
|---|---|---|---|---|
| Variables | Estimate | z-value | Estimate | z-value |
| *INTERCEPT* | $-0.82^{***}$ | −5.92 | $0.78^{***}$ | 6.08 |
| *EMP* | – | – | $-0.74^{**}$ | −2.08 |
| *SIZE* | 0.00 | 0.38 | 0.00 | 1.19 |
| *GROUP* | $0.56^{***}$ | 4.84 | −0.17 | −1.26 |
| *R*&D | $0.30^{***}$ | 2.88 | 0.06 | 0.64 |
| *NET_INCOME* | $0.02^{**}$ | 1.89 | $-0.04^{***}$ | −3.79 |
| *SECT1* | −6.55 | −0.01 | $-0.42^{**}$ | −1.94 |
| *SECT2* | $-0.55^{**}$ | −4.40 | −0.07 | −0.48 |
| *SECT3* | −0.05 | −0.32 | 0.06 | 0.37 |
| *SECT4* | −0.12 | −1.07 | −0.09 | −0.87 |
| *SECT6* | 0.17 | 0.54 | −0.07 | −0.24 |
| *EXPORT* | $1.05.10^{-6**}$ | 2.33 | – | – |
| Likelihood ratio | | | −1255.65 | |
| WaldChi2(20) | | | 187.61 | |
| *rho* ($\rho$) | | | $0.49^{***}$ | |
| Wald test of *rho* ($\rho$)= 0 Chi2(1) | | | $3.37^{*}$ | |
| Number of observations | | | 1,043 | |

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.

Table 3 – Bivariate probit estimates of the effect of environmental management practices on knowledge obstacles to innovation

| | *EMP* | | *KNOWLEDGE_OBSTACLES_INNO* | |
|---|---|---|---|---|
| Variables | Estimate | z-value | Estimate | z-value |
| *INTERCEPT* | $-0.82^{***}$ | −5.82 | 0.14 | 0.86 |
| *EMP* | – | – | $-0.95^{*}$ | −1.82 |
| *SIZE* | $-6.31.10^{-6}$ | −0.16 | −0.00 | −0.84 |
| *GROUP* | $0.53^{**}$ | 4.45 | 0.00 | 0.03 |
| *R*&D | $0.29^{***}$ | 2.76 | 0.15 | 1.42 |
| *NET_INCOME* | $0.02^{*}$ | 1.60 | 0.00 | 0.62 |
| *SECT1* | −6.78 | −0.00 | $-0.69^{**}$ | −2.26 |
| *SECT2* | $-0.42^{***}$ | −3.39 | $-0.28^{**}$ | −1.99 |
| *SECT3* | −0.00 | −0.01 | −0.30 | −1.56 |
| *SECT4* | −0.02 | −0.23 | $-0.27^{***}$ | −2.35 |
| *SECT6* | 0.18 | 0.60 | $0.49^{*}$ | 1.71 |
| *EXPORT* | $1.24.10^{-6***}$ | 3.08 | – | – |
| Likelihood ratio | | | −1206.81 | |
| WaldChi2(20) | | | 127.33 | |
| *rho* ($\rho$) | | | 0.52 | |
| Wald test of *rho* ($\rho$)= 0 Chi2(1) | | | 1.64 | |
| Number of observations | | | 1,014 | |

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.

Looking at factors impacting environmental management practices adoption, our results from the two first models i.e. cost and knowledge obstacles (Tables 2 and 3) indi-

Table 4 – Bivariate probit estimates of the effect of environmental management practices on market obstacles to innovation

| | *EMP* | | *MARKET_OBSTACLES_INNO* | |
|---|---|---|---|---|
| Variables | Estimate | z-value | Estimate | z-value |
| *INTERCEPT* | $-0.95^{***}$ | −5.46 | $0.36^{*}$ | 1.66 |
| *EMP* | – | – | −0.23 | 0.29 |
| *SIZE* | −0.00 | −0.20 | −0.00 | −0.59 |
| *GROUP* | $0.75^{**}$ | 4.97 | −0.01 | −0.05 |
| *R*&D | 0.13 | 1.03 | $-0.54^{***}$ | −4.66 |
| *NET_INCOME* | $0.03^{**}$ | 1.12 | −0.02 | −1.46 |
| *SECT1* | −6.69 | −0.02 | 0.12 | 0.28 |
| *SECT2* | $-0.50^{***}$ | −3.09 | −0.15 | −0.72 |
| *SECT3* | −0.17 | −0.71 | −0.35 | −1.41 |
| *SECT4* | −0.11 | −0.79 | −0.23 | −1.56 |
| *SECT6* | 0.09 | 0.26 | 0.07 | 0.22 |
| *EXPORT* | $1.51.10^{-6**}$ | 2.75 | – | – |
| Likelihood ratio | | | −780.14 | |
| WaldChi2(20) | | | 100.22 | |
| *rho* ($\rho$) | | | 0.00 | |
| Wald test of *rho* ($\rho$)= 0 Chi2(1) | | | 0.00 | |
| Number of observations | | | 665 | |

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.

cate accordance with previous results, that the variables *GROUP*, *R*&D and *NET_INCOME* are significant drivers of environmental management practices adoption. Regarding the model concerning market obstacles to innovation (Table 4), we can notice that *GROUP* and *NET_INCOME* are also important factors but not *R*&D. Interestingly, the variable *SIZE* is not significant in all three models. Finally, as assumed theoretically, our instrumental variable *EXPORT* is positively and significantly associated to environmental management practices implementation.

The pivotal question of the chapter was to see if environmental management practices reduce obstacles to innovation. In light of our results, the answer is positive for cost and knowledge obstacles to innovation (Table 3 and Table 4). Our first outcome is in the line with previous research (Hart, 1995; Delmas, 2001) indicating that green practices adoption allows for more efficiency through cost savings, what allow firms enhancing financial benefits, improving access to finance and reducing accordingly cost obstacles when deciding to engage in innovation. Thus, our findings support Hypothesis 1. Moreover, our second hypothesis is also supported stipulating that working in a green firm

improves knowledge, human potential and employees' degree of commitment (Delmas & Pekovic, 2013; D'Este et al., 2014; Lanfranchi & Pekovic, 2014) what permits firm to overcome knowledge innovation obstacles. However, our third hypothesis is not supported since the coefficient associated to variable *EMP* is not significant (Table 4). We can conclude therefore that environmental management practices do not reduce market obstacles to innovation. A possible explanation for this result can be traced on the basis saying that the impact of environmental management practices on market barriers may differ with the type of innovation studied (environmental, product, organizational etc) and more importantly with the country concerned (culture, habits, consumer needs etc). For Catalonian firms for example, the most important barrier for innovation activities are cost and knowledge while market factors appear to be less important (Segarra-Blasco et al., 2008). At the same time, Costa-Campi et al. (2014) conclude that concerning Spanish firms, the main barrier hampering innovation activities in the energy industry is the market dominance of established firms. Moreover, concerning product innovation, innovative Spanish firms claim that market obstacle is not hampering their innovative activities (Costa-Campi et al., 2014). Accordingly the fact that the obstacles in our research concern general innovation that encompass product, process, marketing, financial, organizational etc., leads to no relationship between EMPs adoption and innovations' barriers.

In addition, our results stipulate that the impact of environmental management practices adoption is different depending on the type of obstacle concerned, since the coefficient as well as the significance degree of the EMP variable is higher for cost obstacles (Table 2) than for knowledge obstacles (Table 3). This outcome highlights the efficiency of the green practices' adoption in reducing costs of innovation that can be encountered more rapidly compared to knowledge obstacles.

Finally, turning to determinants of innovation obstacles, we may conclude that generally good financial performance (measured in our case by net income) reduces the obstacles to innovation.

# 5 Conclusion

This study poses an important question regarding the firm pursuit the competitive advantage: how firms can overcome innovation obstacles? In this vein, the results reported in this chapter extend the literature on the influence of environmental management practices and innovation by looking explicitly whether those practices can help firm to overcome innovation obstacles. Specifically, our model estimates empirically the relationship between environmental management practices and the three types of innovation obstacles i.e. cost obstacles, knowledge obstacles and market obstacles. Therefore, we articulated the mechanism how firms can overcome barriers what would contribute to more innovation activities. The obtained findings provide a complement to the studies establishing the link between environmental management practices and firm performance. Actually, we broaden the scope of investigation from a focus on innovation performance to obstacles to innovation. Accordingly, in this chapter we go beyond the what question in order to arrive to response to :

*How environmental management practices can help firms to become more innovative?*

The results of this study found that environmental management practices adoption decreases cost obstacles to innovation. This finding is consistent with past researches who argued that green firms achieve cost savings by increasing the efficiency of production processes and by reducing input and waste-disposal costs (Hart, 1995; Christmann, 2000; Delmas & Pekovic, 2015). Additionally, investment in environmental practices improves investors' confidence (Kirkpatrick & Pouliot, 1996; Jiang & Bansal, 2003). Turning to knowledge obstacles to innovation, our findings also support the significant role of environmental management practices in reducing knowledge obstacles to innovation. The findings indicate that environmental management practices implementation enhances various factors related to human capital improvement (Brekke & Nyborg, 2008; Delmas & Pekovic, 2013; Lanfranchi & Pekovic, 2014) what decrease knowledge obstacles to innovation. Finally, we did not find a link between environmental management practices and market obstacles to innovation. We support this outcome on the basis of market obstacles-Innovation relationship that is contingent with type of

innovation and culture of the country concerned. In other words, we think we would have different results if we consider separately the impact of EMPs adoption on market obstacles to product innovation, process innovation, marketing innovation etc.

The results also shed light upon several practicalities of how EMPs can enhance firm performance. Actually, managers have to recognize that the adoption of environmental management practices can become an important source of competitive advantage and not simply investment cost. In fact, by implementing green practices, firms benefit from cost savings through reduction in labor costs, better access to market and greater possibilities for product differentiation. Green firms benefit also from investors' confidence and faith what ensures a worldwide competitive gain and accordingly the financial stability in the long run. Moreover, environmental adopter firms benefit from a strong human potential through training programs, interpersonal contacts and communication. This allows the rise of productive employees and facilitates knowledge transfer and enhancement. Environmentally ethically involved firms benefit also from more crucial information and from greater opportunities to find cooperators what ensure long term efficiency.

Although the relevance of our result, our research is not free from limitations that can serve as possibilities for future investigation. First, since our three data bases concern French observations, it would be desirable to replicate the study in cross-cultural contexts since the relationships examined in this study may vary depending on cultural context considered. Second, even though we lagged the variable representing environmental management practices, a bi-probit model is a cross-section method and it is not sufficient to confirm the causal relationships between environmental management practices and obstacles to innovation. Ideally, the issue would be studied in a framework where there is panel data what would allow taking into account unobserved characteristics of firms... Finally, we did not examine how contingency factors affect the impact of environmental management practices and obstacles to innovation. We expect the impact can be significant, as scholars argued that the impact of environmental management practices on innovation performance is contingent by market environment (Grolleau et al., 2015; Delmas & Pekovic, 2015).

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# 6 Appendix

Table 5 – Pearson correlation coefficients (Cost_Obstacles_Inno)

| | *Cost_Obstacles_Inno* | *EMP* | *EXPORT* | *SIZE* | *GROUP* | *R*&D | *NET_INCOME* |
|---|---|---|---|---|---|---|---|
| *Cost_Obstacles_Inno* | 1.00 | – | – | – | – | – | |
| *EMP* | −0.01 | 1.00 | – | – | – | – | – |
| *EXPORT* | −0.07 | 0.17 | 1.00 | – | – | – | – |
| *SIZE* | 0.00 | 0.09 | 0.57 | 1.00 | – | – | – |
| *GROUP* | −0.11 | 0.17 | 0.11 | 0.05 | 1.00 | – | – |
| *R*&D | −0.04 | 0.15 | 0.14 | 0.06 | 0.17 | 1.00 | – |
| *NET_INCOME* | −0.17 | 0.06 | 0.11 | 0.10 | 0.05 | 0.06 | 1.00 |

N=1,043

Table 6 – Pearson correlation coefficients (Knowledge_Obstacles_Inno)

| | *Knowledge_Obstacles_Inno* | *EMP* | *EXPORT* | *SIZE* | *GROUP* | *R*&D | *NET_INCOME* |
|---|---|---|---|---|---|---|---|
| *Knowledge_Obstacles_Inno* | 1.00 | – | – | – | – | – | |
| *EMP* | −0.05 | 1.00 | – | – | – | – | – |
| *EXPORT* | −0.04 | 0.08 | 1.00 | – | – | – | – |
| *SIZE* | −0.04 | 0.09 | 0.69 | 1.00 | – | – | – |
| *GROUP* | −0.06 | 0.17 | 0.04 | 0.05 | 1.00 | – | – |
| *R*&D | 0.00 | 0.16 | 0.06 | 0.06 | 0.18 | 1.00 | – |
| *NET_INCOME* | 0.00 | 0.06 | 0.10 | 0.13 | 0.07 | 0.07 | 1.00 |

N=1,014

Table 7 – Pearson correlation coefficients (Market_Obstacles_Inno)

| | *Market_Obstacles_Inno* | *EMP* | *EXPORT* | *SIZE* | *GROUP* | *R*&D | *NET_INCOME* |
|---|---|---|---|---|---|---|---|
| *Market_Obstacles_Inno* | 1.00 | – | – | – | – | – | – |
| *EMP* | 0.02 | 1.00 | – | – | – | – | – |
| *EXPORT* | −0.02 | 0.19 | 1.00 | – | – | – | – |
| *SIZE* | −0.05 | 0.09 | 0.61 | 1.00 | – | – | – |
| *GROUP* | −0.03 | 0.20 | 0.10 | 0.04 | 1.00 | – | – |
| *R*&D | −0.20 | 0.15 | 0.17 | 0.07 | 0.20 | 1.00 | – |
| *NET_INCOME* | −0.08 | 0.08 | 0.12 | 0.11 | 0.03 | 0.08 | 1.00 |

N=665

Table 8 – Linear regression estimates of the effect of Export on cost obstacles to innovation

| | *COST_OBSTACLES_INNO* | |
|---|---|---|
| Variables | Estimate | z-value |
| *INTERCEPT* | 0.77*** | 0.00 |
| *EXPORT* | −0.01 | 0.81 |
| *SIZE* | 0.00 | 0.33 |
| *GROUP* | −0.11*** | 0.00 |
| *NET_INCOME* | −0.01*** | 0.00 |
| *SECT1* | −0.01 | 0.75 |
| *SECT2* | 0.03 | 0.51 |
| *SECT3* | 0.03 | 0.60 |
| *SECT4* | −0.03 | 0.48 |
| *SECT6* | −0.05 | 0.67 |
| Number of observations | 1,043 | |

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.

Table 9 – Linear regression estimates of the effect of Export on human obstacles to innovation

| | *HUMAN_OBSTACLES_INNO* | |
|---|---|---|
| Variables | Estimate | z-value |
| *INTERCEPT* | $0.51^{***}$ | 0.00 |
| *EXPORT* | 0.00 | 0.95 |
| *SIZE* | 0.00 | 0.17 |
| *GROUP* | −0.06 | 0.12 |
| *NET_INCOME* | −0.00 | 0.21 |
| *SECT1* | $-0.07^{*}$ | 0.10 |
| *SECT2* | −0.05 | 0.30 |
| *SECT3* | $-0.12^{*}$ | 0.07 |
| *SECT4* | $-0.11^{***}$ | 0.00 |
| *SECT6* | $0.18^{*}$ | 0.09 |
| Number of observations | 1,014 | |

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.

Table 10 – Linear regression estimates of the effect of Export on market obstacles to innovation

| | *MARKET_OBSTACLES_INNO* | |
|---|---|---|
| Variables | Estimate | z-value |
| *INTERCEPT* | $0.62^{***}$ | 0.00 |
| *EXPORT* | −0.00 | 0.51 |
| *SIZE* | 0.00 | 0.42 |
| *GROUP* | −0.02 | 0.71 |
| *NET_INCOME* | $-0.01^{**}$ | 0.04 |
| *SECT1* | 0.02 | 0.63 |
| *SECT2* | −0.04 | 0.44 |
| *SECT3* | −0.11 | 0.23 |
| *SECT4* | $-0.09^{*}$ | 0.09 |
| *SECT6* | 0.01 | 0.90 |
| Number of observations | 665 | |

(*), (**), (***) indicate parameter significance at the 10, 5 and 1 per cent level, respectively.