The effect of Environmental Corporate Social Responsibility on industrial SMEs' innovation

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Abstract

This article analyses how Environmental Corporate Social Responsibility (ECSR) strategies may help to enhance innovation among small and medium-size enterprises (SMEs). We test our hypotheses over a large sample of 2,620 industrial SMEs in Spain. We find empirical support for ECSR driving innovation as measured by the innovative effort or R&D and its outcomes in terms of product and process innovation. In addition, we distinguish the effect of ESCR on innovation among innovative and non-innovative SMEs. The effect is more intense for the later, suggesting an important role of ECSR on firms' transformation. Our study contributes to the literature by analyzing the effect of ECSR in promoting innovation, as opposed to most studies that examine only on green-innovation. Besides, we examine the neglected research area of SMEs environmental strategies. Our findings on the instrumental value of ECSR related to innovation strengthen the business case of pro-environmental strategies, specifically for SMEs.

Keywords: Environmental Corporate Social Responsibility; Innovation; Process Innovation; Product Innovation; R&D; SMEs; Sustainability

INTRODUCTION

Environmental deterioration constitutes the largest externality ever (Stern, 2007). Therefore, internalizing companies' environmental externalities becomes increasingly critical (Babiak and Trendafilova, 2011; Lyon and Maxwell, 2008; Weyzig, 2009). In this context, firms progressively perceive environmental protection as strategic, trying to convert a grand challenge into a business opportunity (Tang et al, 2018; Sharma and Vredenburg, 1998; Shu et al, 2016). These firms conceive environmental protection as a source of competitiveness instead of a costly trade-off (Hart, 1995; Porter and van der Linde, 1995). This implies proactive management of the environmental issues (Severo et al, 2017) beyond legal compliance, under the umbrella of environmental business management, environmental protection or Environmental Corporate Social Responsibility (ECSR) strategies. Therefore, ECSR reflects the incorporation of environmental awareness into corporate decisions (Chuang and Huang, 2018) to limit their adverse environmental impact (Rahman and Post, 2012).

Literature has proved extensively that by implementing ECSR, firms can improve their economic performance (i.e., Chuang and Huang, 2018; Liou and Sharma, 2012), stock performance (Flammer, 2013), international expansion (Xu et al, 2018), customer loyalty (Rashid et al, 2015) and deliver green innovations (Brunnermeier and Cohen, 2003), in particular SMEs (Bos-Brouwers, 2010; Noci and Verganti, 1999). However, an important gap in this literature remains unexplored. The relationship between ECSR and organizational innovation, beyond green innovation, has been started to analyze recently (Yang et al, 2019), and not specifically for SMEs. This relationship becomes critical for a comprehensive understanding of the potential effects of environmental efforts over innovation. The unexplored link between ECSR and innovation can further strengthen the business case of pro-environmental strategies suggested by Hart (1995) and by Porter and Van der Linde (1995). Innovativeness is the result of the efforts made to achieve an invention and the ability to introduce new products or processes (Miller and Friesen, 1983; Ozsomer et al, 1997). The fourth industrial revolution has changed the way companies do business (Schwab, 2016) by creating shorter product cycles, disruptive new entrants and changing customer behavior. This new competitive landscape accentuates the crucial role of innovation in creating value and sustaining competitive advantages (Baregheh et al, 2009).

In addition, recent literature on environmental sustainability and innovation focuses on large companies, where there is a wider availability of environmental indicators (Bos-Browers, 2010), and because smaller firms are perceived to develop reluctant attitude towards the environment (Leonidou et al, 2017). Nevertheless, initiatives such as The European Green Deal, or the UN's Sustainable Development Goals (UE, 2019; UN, 2015) underline the importance of SMEs in building a sustainable environment. Thus, it becomes essential to understand the role of SMEs, and not only that of large companies, in the process towards sustainability. SMEs represent more than 90% of businesses and more than 50% employment worldwide (World Bank, 2020). Furthermore, SMEs make a significant contribution to environmental issues, with important implications on corporate innovation (Noci and Verganti, 1999). In order to contribute to cover that important gap, our goal is to empirically analyze the effect that ECSR exercises on SMEs innovativeness.

In particular, we explore the effect of ECSR across three types of innovation, namely technological effort (i.e. R&D intensity) and product and process innovations. By doing so, we contemplate innovation from two different angles that concern, on the one hand, to the innovative efforts (R&D intensity) and on the other hand, to its results (product and process innovations). We estimate a two-stage Probit and Tobit models over a non-balanced panel that includes 2,620 Spanish SMEs. We use data from the Survey on Business Strategies (SBS hereafter) (e.g., Alonso and Forcadell, 2010; Esteve-Pérez and Rodríguez, 2013; García, Avella and Fernández, 2012; Golovko and Valentini, 2011, 2014; Salomon, 2006; Salomon and Jin, 2008, 2010) for the period 2009-2016.

We find that ECSR stimulates firm innovation, in both innovative and non-innovative SMEs. Therefore, our models confirm that ECSR constitutes an effective tool for stimulating innovation. This is especially important for those non-innovating firms, which can find ECSR as the pivotal factor that switches on the process of innovation. These results contribute to the literature in several ways. First, we extend the analysis of the effect of ECSR beyond green innovation. Second, we analyze the effect of ECSR on the innovation inception of non-innovative SMEs and on the enhancement of innovation in already innovative SMEs. Third, we examine the effects of ECSR on innovation from two different angles, related to both the technological effort and to the product and process innovation. Literature has investigated separately product innovation (Frondel et al, 2008; Luo and Du, 2015) or process innovation (Asongu, 2007). Fourth, we focus on SMEs, which, despite their economic relevance, have been under-researched in the environmental sustainability and innovation literatures, with some exceptions (i.e. Aragón-Correa et al, 2008; del Brio and Junquera, 2003; Bos-Brouwers, 2010; Cuerva et al, 2014; Leonidou et al, 2017). And fifth, we offer a longitudinal firm-level econometric study covering a large sample of 2,620 industrial SMEs over eight years. This largely exceeds other studies such as Kesidou and Demirel (2012) on a sample of 1,566 UK firms over one year, cross-sectional studies (e.g. Kammerer, 2009; Mazzanti and Zoboli, 2009) and sector-level data (del Rio et al., 2011).

This paper is structured as follows. Section 2 critically assesses the literature on ECSR and innovation and the ongoing debate. Section 3 presents the empirical framework and describes the sample, variables and methods developed. Section 4 shows the empirical results. The final section discusses the findings, clarifies why ECSR may have instrumental value for SMEs in fostering their innovation levels, and concludes the paper.

THEORY AND HYPOTHESES

Innovation is a driver of economic growth as well as firm competitiveness (Porter, 1985). Porter and van der Linde (1995) pioneer this line of thought, suggesting that environmental regulation triggers innovation, and thus, fosters firm competitiveness. These hypotheses were empirically tested by Jaffe and Palmer (1997). Another related stream of literature considers the effect that proactive -and not compulsory- environmental protection strategies (i.e. ECSR) has on the emergence of unique organizational capabilities that enhance firms' competitiveness (Hart, 1995; Orlitzky et al, 2003; Rahman and Post, 2012; Russo and Fouts 1997; Sharma and Vredenburg, 1998; Shrivastava, 1995) and corporate performance (Aragón-Correa et al, 2008; Dixon-Fowler et al, 2013; González-Benito and González-Benito, 2005; Heras-Saizarbitoria et al, 2011; Link and Naveh, 2006; Russo and Fouts, 1997; Wagner, 2005). Firms may engage in voluntary environmental strategies to reduce the cost of adapting to existing or future regulation, to improve the perception of their stakeholders, to build corporate reputation and as a response to competitive pressures (Anton et al, 2004; Khanna, 2001; Khanna and Anton, 2001).

ECSR as a trigger of innovation

Studies linking Corporate Social Responsibility (CSR) and green and non-green (organizational) innovations are common. For instance, Halme and Laurila (2008) examined the effect that CSR has on social and environmental innovations, and Wagner (2010) concluded that corporate social performance can drive such innovations. In addition, Bocquet et al (2013) studied the effect of CSR on firms' propensity to innovate in both products and processes, concluding that businesses that engage in strategic CSR are more innovative in products and processes than those where the intensity of CSR adoption is lower or responsive. Nidumolu et al (2009: 57) even state explicitly that CSR and sustainability are ''key drivers for innovation''. In the same vein, Wagner (2010) found that CSR, conceptualized as a multi-dimensional appraisal of a firms' responsible performance, leads to innovation. Similarly, CSR has been associated to sustainable innovations that deliver and enhance economic, social and environmental performance (Alakeson and Sherwin, 2004; Biondi and Iraldo, 2002; Bos-Brouwers, 2010; Von Weizsacker et al, 1997).

ECSR constitutes a relevant and distinct sub-construct of the CSR concept (Rahman and Post, 2012). Prior studies on ECSR as a driver of innovation focus on specific innovation types such as eco-innovation. For example, Cai and Zhou (2014) examined the factors that influence eco-innovative processes concluding that these are both external-driven by regulation, clients, suppliers and other stakeholders- and internal, whereas Frondel et al (2008) concluded that internal company factors are the main drivers. Moreover, Brunnermeier and Cohen (2003) found that environmental innovation is positively correlated with expenditures on pollution control, but, and increased enforcement of existing environmental protection regulations do not derive in additional motivation to innovate. Nevertheless, extant literature is focused on the analysis of ECSR on environmental innovation, as opposed to overall firm innovation. In the particular case of SMEs, del Brio and Junquera (2003) studied the positive influence of ECSR on SMEs' eco-innovation, but there is an absence of studies that explore SMEs' ECSR effects over non-green innovations.

ECSR constitutes an important driver for innovation (Noci and Verganti, 1999; Severo et al, 2017; Yang et al, 2019). The adoption of environmental practices, going beyond legal requirements, may promote investments in Research and Development (R&D), which in turn can produce both process and product innovations (McWilliams and Siegel, 2001). ECSR may fuel innovation because it seeks to reduce environmental impact and this may require technological changes (Lioui and Sharma, 2012), involving R&D (Bansal, 2005). Finally, ECSR efforts can contribute to develop innovative organizational capabilities (Sharma and Vredenburg, 1998).

ECSR and innovation at SMEs

As mentioned above, literature linking ECSR and organizational innovation is scarce (Yang et al, 2019), and absent in the case of SMEs. SMEs are characterized by resource constraints, flexible organizational structure, low degree of formalization as management style, and strong customer needs orientation (Bos-Browers, 2010; Leonidou et al, 2012). These characteristics may lead to differences between SMEs and large companies in how ECSR is converted into innovation. In addition, SMEs committed to ECSR tend to develop several organizational capabilities or soft skills (Kesidou and Demirel, 2008) that in turn can be crucial drivers of innovation. First, SMEs engaged in ECSR are prone to implement green strategies beyond compliance as a consequence of their more flexible organizational structures. These structures facilitate employees to proactively seek new solutions in terms of products, processes or technologies that improve specific environmental metrics (Shu et al, 2016; Yang et al, 2019). Second, SMEs engaged in ECSR present a culture that fosters employee motivation, creativity, brainstorming and transformative ideas, promotes the development of innovations (Hurley and Hult, 1998). Therefore, flexible structures and a culture that fosters creativity may provide a suitable framework to promote innovativeness (Shu et al, 2016; Yang et al, 2019).

Third, CSR in general, and ECSR in particular, are associated to long-term managerial decisions as opposed to short-term views. This long-term orientation is common to innovative firms (Aragón-Correa, 1998; Dixon-Fowler et al, 2013; Hart, 1995; Sharma, 2000; Russo and Fouts, 1997; Sharma and Vredenburg, 1998; Shrivastava, 1995). Finally, the implementation of an ECSR strategy can save costs (Aragón-Correa, 1998; Judge and Douglas, 1998; Russo and Fouts, 1997; Shrivastava, 1995) which liberates corporate funds that can be used to more productive and long-term orientated activities, such as R&D. In the case of SMEs, this can compensate for their limited resources when compared to large firms and prompt innovation investments. These additional resources liberated by ECSR activities may even turn a non-innovative firm into an innovative one.

As a consequence of the above reasoning, we argue the organizational factors associated with ECSR may derive in enhanced innovation in the context of SMEs. These factors include a flexible organizational structure, a firm culture that promotes employees' creativity, a long-term oriented managerial style and increased availability of funds liberated as a consequence of costs saved by ECSR. For example, SMEs tend to have flexible organizational structures (del Brio and Junquera, 2003), which can enhance ECSR and, subsequently innovation. In addition, SMEs resource constraints are a common problem (Bos-Brouwers, 2010), which may be partially palliated by cost savings from ECSR implementation. For these reasons, we posit that ECSR may lead to enhanced innovation in SMEs.

Hypotheses

As a result of the above, we propose the following hypotheses:

H1. SME's ECSR promotes technological effort

H2. SME's ECSR promotes product innovation.

H3. SME's ECSR promotes process innovation.

DATA AND METHODS

Data and Sample

For all variables, we have used data from the Survey on Business Strategies (SBS) for the period from 2009 to 2016. The reference population of the survey covers Spanish manufacturing firms with ten or more employees. This is a well-known database as it has been previously used by multiple studies in the analysis of firm strategy (e.g., Esteve-Pérez and Rodríguez, 2013; García, Avella and Fernández, 2012; Golovko and Valentini, 2011, 2014; Salomon, 2006; Salomon and Jin, 2008; Shaver, 2011). Our sample is a non-balanced panel that includes 2,620 firms and 11,726 observations.

Variables

Dependent Variables

The three dependent variables that we use as different proxies of innovation are: *technological effort* (TE_{it}) measured as the ratio of R&D expenditures over total sales (Horbach, 2008; Jaffe and Palmer, 1997), divided by the average R&D expenditures in the sector. Based on the Oslo-Manual of the OECD/Eurostat (2005) we have distinguished between product and process innovations. Therefore, we have used two variables: the variable *product innovation* ($ProdInn_{it}$), that takes the value of one if the firm has achieved at least one product innovation in the period and zero otherwise (Rehfeld, Rennings and Ziegler, 2007), and the variable *process innovation* ($ProcInn_{it}$), that takes the value of one if the firm has achieved at least one innovation in process in the period and zero otherwise (Rennings, Ziegler, Ankele and Hoffmann, 2006).

Most studies on innovation are limited to the means, i.e. technological efforts devoted to innovation, typically measured by R&D investment (Lai et al, 2015; Lioui and Sharma, 2012; Luo and Du, 2015; Hull and Rothenberg, 2008; McWilliams and Siegel,2000; Mithami, 2016; Padget and Galan, 2010; del Río et al, 2011; Scott, 2005; Shen et al, 2016). However, these efforts do not necessarily guarantee an improvement in products or processes (Anton et al, 2004; Frondel et al, 2008). Therefore, we analyze the impact of ECSR on innovation from these two different perspectives: First, the technological effort committed to innovate, and second, its results or appropriability in terms of both product and process innovation (Arundel and Kabla, 1998; Boer and During, 2001).

Independent Variables

We measure ECSR based on SMEs' expenditures on environmental protection. In particular, the variable $ECSR_{it}$ takes the value 1 when the firm invests in equipment and facilities related to the control of environmental pollution, and/or incurred in expenses related to environmental protection, and zero otherwise (Frondel et al., 2008). We have used the contemporaneous $ECSR_{it}$ and the variable lagged one period $ECSR_{it-1}$.

Control Variables

In order to reduce the risk of omitted variable bias, we incorporate a set of control variables. *Export intensity* is defined as the ratio of export sales to total sales (EXP_{it}) (Rennings, et al., 2006). *Age* (A_{it}) is computed as the difference between the current year and the firm's year of foundation (Berrone, et al., 2010, Horbach, 2008; Rehfeld, et al., 2007). *Size* is defined as the logarithm of the total number of a firm's employees ($Size_{it}$) (Horbach, 2008; Rehfeld, et al., 2007; Rennings, et al., 2006). *Group membership* (GM_{it}) is a dummy variable that takes the value of one if the firm is independent and zero otherwise (i.e., the firm is a subsidiary, or it is integrated into a corporate group). *Advertising* (AD_{it}) is defined as advertising and public relations expenses over sales. *Slack* (SL_{it}) is measured as the firm's ratio of assets to liabilities (Baysinger and Hoskisson, 1989, Gómez-Mejia et al., 2014). *ROA* is defined as the EBIT over total assets (Horbach, 2008; Rennings, et al., 2006), we have standardized this variable by the sectoral ROA. We control for industry membership at the two-digit SIC code level using dummy variables (Horbach, 2008; Jaffe and Palmer, 1997; Rennings, et al., 2006). The inclusion of time effects (year dummies) allow us to control the time-dependent determinants of innovation (Jaffe and Palmer, 1997). We have lagged one period the control variables to mitigate a potential endogeneity bias.

Empirical model

We apply two different methodologies given the different nature of our three dependent variables. The technological effort (TE_{ijt}) is a variable limited and censored, since it does not take negative values and contains numerous observations with values equal to zero. Hence, a Tobit panel data methodology appears as the most appropriate to test our hypotheses. In addition, since product and process innovation are binary variables, we use Probit panel data model which would account for the probability of a firm implementing each of the decisions. Since the fixed effects model is an inconsistent estimator of unobserved effect for short time panel (Cameron and Trivedi, 2005), we use a random effect maximum likelihood (Gómez-Mejia et al., 2014).

Table 1 about here

The assumptions of normality and homoskedasticity are key for the validity of Tobit model. The test by Cameron and Trivedi (2005) rejects the null hypothesis of homoscedasticity, and the test by Skeels and Vella (1999) rejects the null hypothesis of normality. This entails serious consequences for a censored-data regression[1], that we solve by applying a type-2 Tobit model, which has been estimated by the two-step method. This approach decomposes the technical effort (TE_{ijt}) in two different decisions. The first is the decision to perform a technological activity, defined as a binary variable, taking the value of one if the R&D expenditure is greater than zero, and taking the value 0 if the firm does not make any technological effort over the period. We have applied a Probit model to identify the determinants of this decision. The second decision determines the R&D expenditure. To do this, we define a truncated variable that is valued only when R&D expenditure is greater than zero. In the second step, we use a linear regression to analyze the determinant factor of the technological effort (TE_{ijt}).

RESULTS

We find no multicollinearity problems for all regression performed. All the explanatory variables show VIFs below the rule of thumb cut-off of 10 for regression models (Kutner et al., 2004), and the condition number obtained is also substantially below the rule of thumb of 30 (Belsley, 1991; Pesaran, 2015).

Model 1 in Table 2 is a panel Tobit with random effect. The coefficient of contemporaneous environmental corporate social responsibility $ECSR_{it}$ is positive and significant, which indicates that the ECSR fosters technological effort. In Model 2 the sample-selection model in two-stage is applied to a pooled sample, and in Model 3, the unobserved heterogeneity is controlled with random effect in both stages. Both models allow us to analyze separately the decision to invest in R&D (Model 2.1 and 3.1) and the R&D effort (models 2.2 and 3.2). In models 2.1 and 3.1, the environmental corporate social responsibility lagged one period ($ECSR_{it-1}$) is positive and significant. In the same line, in Model 2.2 and 3.2 the coefficients of contemporaneous environmental corporate social responsibility ($ECSR_{it}$) are positive and significant. These indicates that ECSR contributes to improving the technological effort of firms, which entails

[1] The maximum likelihood estimator is inconsistent if the errors are not normally distributed or if they are heteroskedastic (Cameron and Trivedi, 2005).

the decision to invest in R&D, and the amount invested in R&D[2]. These findings confirm the hypothesis 1.

Table 2 about here

The results of innovation have been analyzed by a panel Probit model with random effects. In Model 4 and 5 in Table 3, the coefficients of contemporaneous $ECSR_{it}$ and lagged one period $ECSR_{it-1}$, are positive and significant. Therefore, ECSR fosters product and process innovation. These findings support hypotheses 2 and 3.

Table 3 about here

The coefficients of the variables: size ($Size_{t-1}$), advertising expenditure (AD_{it-1}), export propensity (EXP_{it-1}), and age (A_{it}) are positive and significant in nearly all models, indicating that these factors contribute positively to innovation. The coefficients of ROA (ROA_{it-1}) are significant and negative in Model 1, 2 and 3.1, and significant and positive in Model 5. Therefore, a return above industry average reduces the R&D expenditure and increases the probability to generate process innovation. The coefficients of group membership (GM_{it}), are negative and significant in Model 1 and 4, and positive and significant in models 2 and 3. Therefore, the group membership facilitates the technological effort, however, it reduces product innovation.

Robustness Test

Firms innovate in order to improve performance (Frondel et al., 2008; Levinthal and March 1993; Zahra 1996). The same logic is applied to expenditure or investment in ECSR (Frondel et al., 2008). Formally, a firm invests in innovation if $TI_{it}^{*} > 0$, where TI_{it}^{*} is a latent and unobservable variable that measures the improvement in corporate performance derived from innovation (Equation 1). Therefore, a firm would only engage in ECSR if $ECSR_{it}^{*} > 0$, where $ECSR_{it}^{*}$ activities are latent variables that measure the improvement in firms' performance from ECSR (Equation 2).

[2] The lambdas of models 2.2 and 3.2 are significant, which confirms the dependence between the decision to perform R&D and the R&D intensity.

$$TI_{it} > 0, if \ TE^{*}_{it} = X'_{it}\alpha - \eta_{it} > 0, TI_{it} = 0 \ otherwise \ (1)$$

$$ECSR_{it} = 1, if \ ECSR^{*}_{it} = Z'_{it}\beta - \xi_{it} > 0, ECSR_{it} = 0 \ otherwise \ (2)$$

The two unobservable performance improvements $(TE^{*}_{it}, EP^{*}_{it})$ depend on observable factors collected respectively in X'_{it-1}, and Z'_{it}, as well as the unobservable variables summarized in η_{it} and ξ_{it}. These “disturbances may capture unobserved variables, such as “green” preferences of the management (ξ_{it}) and its attitude towards innovation (η_{it})” (Frondel et al., 2008: 156, brackets not in the original version). It is, therefore, to be expected that η_{it} and ξ_{it} are correlated. These common unobservable factors may create a simultaneity problem. We have applied the Full-Information-Maximum-Likelihood (FIML). This method permits the simultaneous estimation of the Tobit and the Probit model, when innovation is measured as R&D effort, and two simultaneous Probit when the innovation is measured as product or process innovation. Finally, the FIML allows us to use $ECSR_{it}$ as an exogenous variable.

The results of the simultaneous-equations models are presented in Table 4. In the three recursive model systems, the correlations between the residuals are significant, which confirms the endogeneity of environmental protection. The new findings confirm a positive impact of ECSR on technological efforts (Model 6), product and process innovations (respectively Model 7 and Model 8). These results confirm the robustness of prior findings after controlling the endogeneity.

Table 4 about here

An alternative methodology to solve the problem of potential endogenous explanatory variables is the control function method. This approach requires fewer assumptions than the maximum likelihood (Wooldridge, 2015). In this sense, we have applied a control function (Imbens and Wooldridge, 2007). In the first step, we apply a Probit model to estimate the reduced form of environmental protection. In the second step, we include in the error terms obtained in the reduced forms $(\hat{v}_{ij})$ in the Tobit and Probit models. The results (Table 5) are equivalent to those obtained in previous specifications, therefore providing additional robustness to our findings.

Table 5 about here

CONCLUSIONS

Our empirical study based on 2,620 Spanish SMEs indicates that ECSR is a relevant antecedent of firms' innovativeness. SMEs that promote ECSR positively transform their innovative profile in terms of input (R&D) and output (product and process innovation). Therefore, our findings suggest that having an environmental commitment by investing in ECSR entails greater innovation levels in SMEs. This article contributes to extend the literatures on innovation, environmental sustainability and SMEs. Although SMEs may suffer from some disadvantages, as compared to large companies, they have several organizational characteristics that can compensate for their limitations and allow them to leverage their ECSR strategies to enhance their innovativeness.

By looking at ECSR as a particular feature within CSR, our findings contribute to the literatures that jointly analyzes CSR and innovation (McWilliams and Siegel, 2000; Ratajczak and Szutowski, 2016). In addition, this study enriches the literature on innovation, since we provide empirical evidence on the drivers of innovation, including those related to environmental behavior derived from ECSR. A distinct and novel contribution of this research is that we examine the effect of ECSR on organizational innovation as opposed to most studies that offer a narrower view by focusing on eco-innovations. Furthermore, our study contributes to enrich the business ethics literature on environmental management by suggesting how ECSR strategies can develop organizational capabilities or soft skills already present at SMEs that foster their degree of innovation. Overall our findings suggest the importance of ECSR in SMEs, as opposed to extant literature that overlooks SMEs environmental strategies.

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Table 1. Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
TE_{it}	11,726	1.004	2.953	0.000	62.985
$Size_{it}$	11,726	4.044	1.441	0.000	9.479
AD_{it}	11,726	0.961	2.637	0.000	37.400
EXP_{it}	11,726	0.252	0.303	0.000	1.000
ROA_{it}	11,726	1.301	1.278	-0.895	19.495
SL_{it}	11,726	1.984	3.188	1.000	166.667
A_{it}	11,726	31.006	18.704	1.000	175.000

Table 2. Tobit model estimation

	(1)	(2)		(3)	
		Sample-Selection		Sample-Selection	
	TOBIT	Two-Step estimation		Two-Step estimation	
	RE	**(2.1)** Pooled	**(2.2)** Pooled	**(3.1)** RE	**(3.2)** RE
VARIABLES	*TE*	*TE-Binary*	*TE>0*	*TE-Binary*	*TE>0*
$ECSR_{it}$	2.241***	-0.033	1.253***	-0.099	0.885***
	(0.182)	(0.039)	(0.200)	(0.071)	(0.179)
$ECSR_{it-1}$	-0.053	0.333***	0.485**	0.164**	-0.104
	(0.183)	(0.039)	(0.208)	(0.071)	(0.159)
$Size_{t-1}$	1.844***	0.319***	0.609***	0.608***	0.359***
	(0.109)	(0.013)	(0.080)	(0.042)	(0.067)
AD_{it-1}	0.093***	0.053***	0.120***	0.056***	0.067***
	(0.033)	(0.006)	(0.024)	(0.013)	(0.019)
EXP_{it-1}	2.549***	0.257***	1.249***	0.403***	0.931***
	(0.364)	(0.052)	(0.259)	(0.153)	(0.276)
ROA_{it-1}	-0.164 *	-0.100 ***	-0.296 ***	-0.116 ***	-0.110
	(0.088)	(0.014)	(0.081)	(0.032)	(0.080)
SL_{it-1}	-0.009	-0.016*	0.001	-0.011	0.002
	(0.034)	(0.008)	(0.044)	(0.018)	(0.014)
GM_{it}	-2.173***	0.971***	0.847***	2.952***	0.840***
	(0.235)	(0.035)	(0.223)	(0.102)	(0.240)
A_{it}	0.0178**	0.003***	0.012***	0.007***	0.009
	(0.007)	(0.001)	(0.003)	(0.003)	(0.006)
Constant	-14.375***	-0.033	1.253***	-4.170***	-2.994***
	(0.570)	(0.035)	(0.200)	(0.307)	(0.563)
$Lambda_{it}$			5.218***		2.597***
			(0.336)		(0.270)
Temporal Dummies	Yes	Yes	Yes	Yes	Yes
Sectorial Dummies	No	Yes	No	Yes	No
Max. VIF	2.040	3.350	3.050	3.350	3.050
Conditional Number	14.880	22.915	25.508	22.915	25.508
Observations	11,726	11,726	4,617	11,726	4,617
Number of Firms	2,620	2,620	1,596	2,620	1,596
R^2/pseudo-R^2		0.359	0.151	0.347	0.263

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3. Probit model estimation

VARIABLES	(4) RE $ProdInn_{it}$	(5) RE $ProcInn_{it}$
$ECSR_{it}$	0.701***	0.346***
	(0.070)	(0.057)
$ECSR_{it-1}$	0.160**	0.208***
	(0.070)	(0.056)
$Size_{t-1}$	0.344***	0.339***
	(0.034)	(0.027)
AD_{it-1}	0.042***	0.025**
	(0.011)	(0.010)
EXP_{it-1}	0.405***	0.415***
	(0.130)	(0.105)
ROA_{it-1}	-0.029	0.063***
	(0.030)	(0.019)
SL_{it-1}	-0.035	-0.018
	(0.023)	(0.015)
GM_{it}	-0.708***	-0.114
	(0.089)	(0.081)
A_{it}	0.003	-0.001
	(0.002)	(0.002)
Constant	-3.915***	-3.194***
	(0.266)	(0.199)
Temporal Dummies	Yes	Yes
Sectorial Dummies	Yes	Yes
Max. VIF	2.040	2.040
Conditional Number	14.880	14.880
Observations	11,726	11,726
Number of Firms	2,620	2,620
R^2/pseudo-R^2	0.173	0.240

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4. FIML estimation results for the recursive model systems

	(6) TE_{it}/ $ECSR_{it}$ (FIML)		**(7)** $ProdInn_{it}$/ $ECSR_{it}$ (FIML)		**(8)** $ProdInn_{it}$/ $ECSR_{it}$ (FIML)	
	TE_{it} **(6.1)**	$ECSR_{it}$ **(6.2)**	$ProdInnn_{it}$ **(7.1)**	$ECSR_{it}$ **(7.2)**	$ProcInnn_{it}$ **(8.1)**	$ECSr_{it}$ **(8.2)**
$ECSR_{it}$	11.178***		2.058***		1.917***	0.885***
	(0.289)		(0.041)		(0.031)	(0.179)
$ECSR_{it-1}$	-0.388*		0.001		0.013	-0.104
	(0.200)		(0.032)		(0.016)	(0.159)
TE_{it-1}		0.127***		0.009***		0.004*
		(0.004)		(0.003)		(0.002)
$ProdInn_{it-1}$				2.010***		
				(0.040)		
$ProcInn_{it-1}$						1.923***
						(0.029)
$Size_{t-1}$	0.271***	0.375***	-0.115***	0.219***	-0.072***	0.107***
	(0.068)	(0.012)	(0.014)	(0.011)	(0.012)	(0.011)
AD_{it-1}	0.176***	-0.014***	0.034***	-0.032***	0.020***	-0.020***
	(0.026)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
EXP_{it-1}	1.420***	0.332***	-0.151***	0.276***	-0.037	0.077
	(0.267)	(0.050)	(0.050)	(0.048)	(0.047)	(0.047)
ROA_{it-1}	-0.154 **	-0.042 ***	0.009	-0.033 ***	0.053 ***	-0.055 ***
	(0.077)	(0.010)	(0.012)	(0.010)	(0.009)	(0.009)
SL_{it-1}	0.044	-0.012 *	-0.005	-0.000	0.001	-0.004
	(0.043)	(0.007)	(0.011)	(0.007)	(0.009)	(0.007)
GM_{it}	0.251	-0.615***	0.096***	-0.279***	-0.093**	0.082**
	(0.199)	(0.035)	(0.037)	(0.034)	(0.038)	(0.039)
A_{it}	0.010**	0.002**	0.000	0.000	-0.002**	0.002***
	(0.004)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-11.814***	-1.556***	-1.550***	1.253***	-1.434***	-2.994***
	(0.421)	(0.084)	(0.095)	(0.200)	(0.086)	(0.563)
Temporal Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Sectorial Dummies	No	Yes	Yes	Yes	Yes	Yes
Max. VIF	2.040	3.350	2.040	3.350	2.040	3.39
Conditional Number	14.880	21.152	14.880	21.510	14.880	21.758
Observations	11,726	11,726	11,726	11,726	11,726	11,726
Number of Firms	2,620	2,620	2,620	2,620	2,620	2,620
ρ_{12}	-0.7696***		-0.999 ***		-0.999 ***	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5. Estimation results for Tobit and Probit models with control function

	(9)	**(10)**	**(11)**
	RE	RE	RE
VARIABLES	TE_{it}	$ProdInnn_{it}$	$ProcInnn_{it}$
$ECSR_{it}$	2.258***	0.677***	0.333***
	(0.181)	(0.069)	(0.057)
$ECSR_{it-1}$	-0.052	0.125*	0.193***
	(0.183)	(0.069)	(0.056)
$Size_{t-1}$	1.799***	0.081***	0.049***
	(0.107)	(0.010)	(0.008)
AD_{it-1}	0.016	0.336***	0.336**
	(0.034)	(0.034)	(0.027)
EXP_{it-1}	2.248***	0.074***	0.044***
	(0.364)	(0.015)	(0.012)
ROA_{it-1}	-0.229***	0.421	0.439***
	(0.085)	(0.128)	(0.105)
SL_{it-1}	-0.121***	0.026	0.106
	(0.037)	(0.032)	(0.023)
GM_{it}	-2.243***	-0.009	0.006
	(0.234)	(0.025)	(0.021)
A_{it}	0.014**	-0.661***	-0.087
	(0.007)	(0.088)	(0.002)
Constant	-16.143***	-2.552***	-2.358***
	(0.658)	(0.440)	(0.328)
$\hat{v}_{ij}$	15.021***	-7.011***	-4.598***
	(2.250)	(1.946)	(1.457)
Temporal Dummies	Yes	Yes	Yes
Sectorial Dummies	No	Yes	Yes
Max. VIF	4.630	2.040	2.040
Conditional Number	22.686	14.880	14.880
Observations	11,726	11,726	11,726
Number of Firms	2,620	2,620	2,620

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1