The Role of the University in Eco-Entrepreneurship: Evidence from the Eurobarometer Survey on Attitudes of European Entrepreneurs towards Eco-Innovation

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Abstract

There is an increasing social and political awareness of the importance of sustainable innovations. Strategic partnerships between policy makers, businesses, researchers and citizens are key to developing, implementing and applying eco-innovation, essential for the transition to a competitive green economy. Within this innovation ecosystem, universities can play a central role in creating viable alternative models that are driven by environmental sustainability. Based on evidence from the first survey on Eco-innovation in Europe- 'The Eurobarometer 315 Survey on Attitudes of European Entrepreneurs towards Eco-Innovation', the present paper examines the impact of university collaboration on eco-innovating small firms. It also considers how technology push, demand side factors and the regulatory framework, drive eco-innovation in European SMEs. This paper has several implications for managers, as well as for policy makers. For managers, it should be stressed that collaboration with universities is essential to drive all types of eco-innovations. Our findings also suggest that national government should foster cooperation with universities following EU example (eg. European Innovation Partnership in EcoAP), as national policies based on subsidies and fiscal incentives appear to be ineffective.

Key words: eco-innovation, eco-entrepreneurship, entrepreneur, Eurobarometer, university

1. Introduction

There is an increasing social and political awareness of the importance of sustainable innovations. In December 2011, for example, the European Commission launched the Eco-Innovation Action Plan (EcoAP), moving the EU beyond green technologies and fostering a comprehensive range of eco-innovative processes, products and services.

Eco-innovation is defined as any form of innovation which aims to significantly and demonstrably address the goal of sustainable development, by reducing detrimental effects on the environment or by enabling the more efficient and responsible use of natural resources and energy (EC, 2007).

Companies now have a greater awareness of the impact of their activities on the environment and are increasingly motivated by environmental concerns in their pursuit of innovation. However, research tends to focus on innovation in large companies with formal R&D departments, while overlooking the role of Small and Medium-sized Enterprises (SMEs).

SMEs have often been described as laggards (Revell and Rutherfoord, 2003) and early initiatives to stimulate environmental management among small firms proved ineffective (Friedman and Miles, 2002). Increasingly, governments are looking to universities to build the bridge between SMEs and eco-innovation.

In addition, although entrepreneurship is seen as a "panacea for many social and environmental concerns" (Hall, Daneke and Lenox, 2010), the literature on eco-entrepreneurship is still sparse in mainstream entrepreneurship journals.

The academic literature on the relationship between entrepreneurship and environmental innovations or eco-innovations is still in its infancy. In Google Scholar (Date 23rd August 2013) for example, - a search using the keyword "sustainable entrepreneurship" produced only 2000 results and 733 for "ecopreneurship". The keyword "eco-entrepreneurship" produced only 215 results. Moreover, the term "sustainable entrepreneur" yielded only 254 results, "eco-entrepreneur" 202 and the novel concept "ecopreneur" provided similar results (289).

Recently, the Eco-Innovation Observatory EIO (2013) has argued that strategic partnerships between policy makers, businesses, citizens and researchers are key to developing, implementing and applying eco-innovation. If eco-innovation is based on stakeholders working together, it can play a crucial role in the transition to a green and competitive economy. Within this partnership, universities can play a central role in designing competitive systems that are driven by environmental sustainability.

The objective of this paper is to examine the impact of (a) technology push, market pull, the regulatory framework, firm's capabilities and (b) university collaboration on eco-innovation in European SMEs.

The paper is based on evidence from the first survey of Eco-innovation in Europe- 'The Eurobarometer 315 Survey on Attitudes of European Entrepreneurs towards Eco-Innovation'. According to the survey, on average, 43% of European firms in designated sectors had introduced a new or significantly improved eco-innovation in the two years prior to the survey.

There is considerable variation across European countries. Some peripheral countries, such as Portugal and Greece feature in the top five eco-innovators with regard to products and processes, whilst others, such as Hungary and Lithuania lag well behind the EU average. Using prior research on innovation, we develop a model of the determinants of eco-innovation in SMEs and test our model using data from the Eurobarometer survey.

The paper is structured as follows. Section 2 describes the theoretical framework and presents our hypotheses. This is followed by a discussion of the data and methodology employed in the study. Section 4 presents the main findings. The final section concludes and indicates directions for future research.

2. Theoretical framework

What is an eco-innovation? Environmental innovation is an emerging research topic without a universally agreed nomenclature. Consequently, in the literature researchers tend not to differentiate between "eco-innovation," "environmental innovation" and "green innovation". See González-Moreno et al. (2013) for a review on the definitions of eco-innovation.

According to the EOI (2011), eco-innovation is the introduction of any new or significantly improved product (good or service), process, organizational change or marketing solution that reduces the use of natural resources (including materials, energy, water and land) and decreases the release of harmful substances across the whole life-cycle. In this paper, we will use this definition and consider the positive effect on the environment as the essential condition for an innovation to be considered an eco-innovation.

2.1. Drivers of Eco-innovation

The drivers of eco-innovation reflect the drivers of innovation in general. Innovation theory has emphasised the importance of technology push (supply side) and market pull (demand side) as key drivers of (Dosi, 1982). Using this general framework, the Push/Pull innovation model developed by Rennings (2000) states that the adoption of sustainable technological innovations (eco-innovations) is driven by three factors: technology push, regulatory push and market pull. Similarly, Horbach (2008) also distinguishes three main determinants of environmental innovation: supply side, demand side and institutional and political influences.

Cost-savings through a better use of energy and raw materials is a key factor driving eco-innovations (Rennings, 2000). In our model we propose that both high energy and material prices can be incentives to innovate. Moreover, expectations about future prices and availability of these key resources, is also an incentive to develop innovative less material intensive substitutes. Therefore, we can reasonably argue that there is a "supply side" driver of eco-innovation behaviour in firms. Formally, we propose that:

H1: Supply side factors influence the propensity of the firm to develop eco-innovations.

As already mentioned, the general innovation literature underlines the key role of demand pull factors in innovation. The traditional linear model of innovation has been extended as several studies have highlighted that consumers and users actively participate and shape the innovation process. Hence, demand side factors can also be an important element fostering eco-innovations in SMEs. Although demand factors in eco-innovation have usually been overlooked (Kesidou and Demirel, 2012), recent research shows that demand-related factors play a major role in the development of eco-innovations (Horbach, 2008; Kesidou and Demirel, 2012; Wagner, 2007). In particular, Horbach (2008), using a sample of German industrial companies, showed that expectations about revenues are positively linked to expenditure on innovation. Wagner (2007) highlights the impact of "active" consumer involvement in the introduction of environmental innovations. Kesidou and Demirel (2012) also found that demand variables explained the decision to start eco-innovation, but they did not find significant relationships with the levels of investment committed to this innovation strategy. We argue that consumer demands for green products and expectations to increase or even maintain market share are two of the demand side factors that stimulate the development of eco-innovations in SMEs. Formally, we propose that:

H2: Demand side factors influence the propensity of the firm to develop eco-innovations.

We also argue that available technological capabilities (accumulation of human capital, knowledge stocks) induce further innovations. This is referred to by Baumol (2002) as the process whereby "innovation breeds innovation".

Therefore, a fourth driver, business capabilities can be considered as it may drive eco-innovations. Business capabilities would include technological and managerial capabilities as well as other capabilities such as relational capabilities, access to external information and knowledge, including technology support services.

These capabilities will provide firms with the necessary resources both to recognize the potential of eco-innovation and to develop them. Technological and managerial capabilities usually enhance environmental innovations and the importance of technical knowledge obtained from external sources has also been considered in the economic literature (Triguero et al., 2013).

Our model extends previous literature (Rennings, 2000; Horbach, 2008) adding a fourth element as a driver of eco-innovations: business capabilities. We propose that:

H3: Business capabilities influence the propensity of the firm to develop eco-innovations.

Finally, previous literature has also emphasized the role of regulation as a stimulus to the realization of eco-innovations (Ashford and Hall 2011; Frondel et al., 2008). Environmental policy and regulations are key drivers of eco-innovation as they may force firms to realize economically benign environmental innovations. It is argued that firms are not usually able to recognize the cost saving potentials of environmental innovations (Horbach, 2008). In our model, following Rennings (2000) we have included both actual regulations, including standards on occupational safety and health, and expectations about future regulations imposing new standards.

H4: Regulatory framework influences the propensity of the firm to develop eco-innovations.

2.2. The role of Universities and Research Institutions

A common thread throughout the literature is the wide-spread use of collaboration at all stages of the innovation process in order to accelerate innovative activities (Hall and Bagchi-Sen, 2007; Terziosvki and Morgan, 2006). Furthermore, the circular or interactive model of the innovation process in which multiple relationships must be established between all the departments of the firm, as well as, with external agents, means that cooperative R&D is a necessary condition to survive (Häusler et al., 1994).

Hagedoorn et al. (2000) draw on the Transaction Costs and Strategic Management literatures to explain why firms enter into cooperative arrangements. However, rather than mutually exclusive, they see these approaches as complementary. Transaction costs economics (Williamson, 1985) considers cooperation agreements as a hybrid form of organization between the market and the hierarchy that facilitates carrying out R&D activities. From this theoretical point of view, firms would engage in cooperation with Universities and Research Institutions -U&RI- to minimize the cost of transactions involving intangible assets such as technical knowledge and to reduce and share uncertainty in R&D (Hagedoorn et al., 2000). Moreover, cooperation with U&RI reduces the risk of losing control over the results of R&D projects.

R&D cooperation may enhance the potential for discovery as well as the potential for a loss of control over the intellectual property generated. The outcome of joint research is often known to and claimed by both parties. However, universities have limited incentives to act opportunistically; therefore, they may be preferred as research partners when firms face appropriability concerns (Bercovitz and Feldman, 2007).

From the Strategic Management perspective, firms would cooperate with U&RI to share R&D costs and risks (Hagedoorn, 1993; Tether, 2002). Innovation activities are considered risky and costly. The risk of innovation lies in the expected result not being obtained or in the necessity of more financial and technological funds (Tsang, 1998). Cooperating with universities could reduce this risk.

Firms collaborating with U&RI can also increase efficiency, power and synergies through access to networks (Bayona et al., 2002; Jarillo, 1988). Collaboration with universities provides access to national and international knowledge networks. Firms can gain access to the knowledge networks in which their public partners are included (Jones-Evans et al., 1999; Okubo and Sjöberg, 2000). Another advantage from cooperation with U&RI is that firms can gain access to external complementary resources such as financial, personnel, knowledge, etc. (Teece, 1986; Tsang, 1998).

Therefore, U&RI can be considered key partners for SMEs in eco-innovation projects, as this cooperation would give them access to knowledge networks, increasing the business's capabilities. Firms would engage in cooperation with U&RI to minimize the cost of transactions, reducing costs and risks (supply side) associated with eco-innovation projects.

Collaboration will also improve the image of the firm (demand side), as firms engaged in joint projects with U&RI usually have a better reputation among consumers.

Finally, sometimes, cooperating with U&RI is a necessary condition to have access to project funding. Hence, the impact of cooperating with universities and research institutions is twofold. It has a direct effect on eco-innovation and it also may positively impact on the other factors affecting the generation of these activities.

Thus, Universities can play a central role in creating viable alternative systems that integrate environmental sustainability at their core. It can be a main driver of this type of innovations in SMEs.This is also argued by EIO (2013) that states that if eco-innovation is based on partnerships of different stakeholders working together, it can play a crucial role in the transition to a green and competitive economy. Based on these arguments we propose:

H5a: Cooperation with Universities positively influences the propensity of the firm to develop eco-innovation

H5b: Cooperation with Universities positively moderates the propensity of the firm to develop eco-innovation

3. Data and methods

In order to test our proposed model we use data collected in the Flash Eurobarometer survey – "FL315 Attitudes of European entrepreneurs towards eco-innovation". In this dataset, eco-innovation is defined as "the introduction of any new or significantly improved product (good or service), process, organisational change or marketing solution that reduces the use of natural resources (including materials, energy, water and land) and decreases the release of harmful substances across the whole life-cycle".

In the Flash Eurobarometer survey (No 315), a total of 5,222 managers of SMEs in 27 EU Member States were interviewed by telephone between 24 January and 1 February 2011. A sample of SMEs was randomly selected in each country from specific sectors. (The target group for this Flash Eurobarometer was defined as companies small (10-49 employees) and medium (50-249 employees) and operating in the 27 Member States of the European Union. The sectors targeted were Agriculture, Manufacturing, Water Supply and Waste Management, Construction and Food Services. The lists of companies were derived from the Dun and Bradstreet(D&B) database. Where the D&B database coverage was poor (especially in the New Member States), the sample lists were derived from the relevant national institutes using local data sources. The survey sample was selected randomly).

The following Table 1 shows the sample size in each EU27 country as well as the percentage of firms that have developed a new or significantly improved eco-innovation.

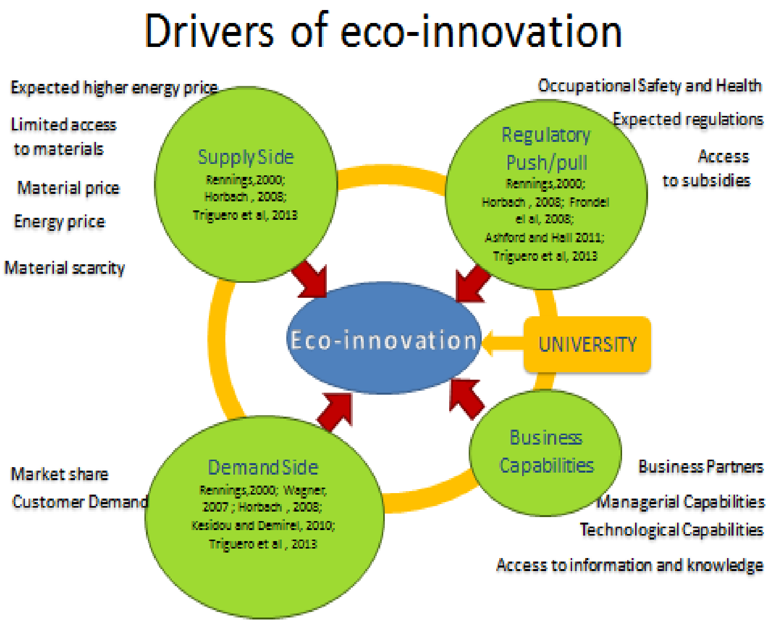

Fig. 1. Drivers of eco-innovation

Table 1. Eco-innovation in EU27

	Total N	*A new or significantly improved eco-innovative product or service*	*A new or significantly improved eco-innovative production process or method*	*A new or significantly improved eco-innovative organisational method*
EU27	5222	24.8	28.8	23.5
Belgium	201	20.0	24.6	20.6
Bulgaria	204	18.4	24.8	23.8
Czech Rep.	200	20.7	22.0	19.1
Denmark	201	19.1	28.4	13.4
Germany	250	24.9	26.0	21.2
Estonia	200	13.9	24.9	19.7
Greece	201	27.9	33.4	25.3
Spain	250	22.1	33.7	31.2
France	250	23.5	23.4	24.1
Ireland	200	24.9	31.5	28.4
Italy	251	30.5	28.8	20.2
Cyprus	50	39.5	22.7	17.0
Latvia	202	25.7	28.9	20.8
Lithuania	202	22.6	20.2	14.8

Luxemburg	51	30.8	34.5	35.4
Hungary	202	12.0	15.4	11.9
Malta	500	29.8	34.9	30.5
Netherlands	200	21.6	31.8	27.6
Austria	200	27.3	27.3	20.2
Poland	200	26.3	42.2	35.4
Portugal	201	28.6	34.4	30.1
Romania	200	27.6	31.6	27.5
Slovenia	200	24.0	26.7	19.0
Slovakia	200	19.9	24.3	22.6
Finland	205	19.2	25.9	7.0
Sweden	200	19.4	29.8	17.5
U.K.	251	24.7	28.3	17.6

Using this data we proceeded to carry out the following statistical analyses in line with the aim of the paper.

Reliability analysis: Firstly, we carried out a reliability analysis of our independent variables to validate the constructs. Cronbach Alfa scores were calculated and exploratory factorial analysis was used to group the survey variables. Subsequently, we included the validated constructs as explanatory variables of innovation performance.

Logistic regression analysis: (Logistic regression does not assume a linear relationship between the dependent and independent variables. The dependent variable must be dichotomous (2 categories). The independent variables need not be interval, nor normally distributed, nor linearly related, nor of equal variance within each group. With the aim of testing our hypotheses we generated two models of logistic regression. Logistic regression is an appropriate method when the dependent variable Y is dichotomous and the aim is to test relationships through a model of conditional probability *Pr(Y=1/X=x)* as a function of *X*. Logistic regression employs binomial probability theory in which there are only two values to predict that probability *(p)* is 1 rather than 0, i.e. the company belongs to one group rather than the other (Eq. 1).

$$p_i = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x_{1,i} + \cdots + \beta_k x_{k,i})}}. \quad (1)$$

where "*p*" is the probability that a case is in a particular category and the "*βs*" are the coefficients of the predictor variables "*x*".

We included several factors as drivers of eco-innovation following our literature review (size, business capabilities, supply side, demand side, policy issues and cooperation with Universities and Research Institutions) as well as country dummies.

Variables

Eco-innovation: A dummy variable is used as a dependent variable in our model. It takes the value 1 when the firm has introduced any kind of eco-innovation (product, process or organizational) that reduces the use of natural resources (including materials, energy, water and land) and decreases the release of harmful substances across the whole life-cycle. The variable takes the value 0 otherwise.

Firm size: A dummy variable that takes the value 1 if the firm has 10 to 49 employees and 0 if it has 50 to 249. All firms in our sample range between 10 to 249 employees.

Business capabilities: A four item Likert-type scale is used. Each item is measured on a 4-point Likert scale from "very important" to "not at all important" as a driver in the development of eco-innovations (Table 3).

Supply side factors: A five item Likert-type scale is used. Each item is measured on a 4-point Likert scale from "very important" to "not at all important" as a driver in the development of eco-innovations (Table 3).

Demand side: A two item Likert-type scale is employed. Each item is measured on a 4-point Likert scale from "very important" to "not at all important" as a driver in the development of eco-innovations (Table 3).

Policy issues: A three item Likert-type scale is used. Each item is measured on a 4-point Likert scale from "very important" to "not at all important" as a driver in the development of eco-innovations (Table 3).

Cooperation with U&RI.: A variable that measures the importance of cooperating with this type of institutions as a driver for eco-innovation. As previous variables, it is a 4-point Likert scale from "very important" to "not at all important".

4. Results and discussions

Table 2 shows the results of the reliability analysis on the research constructs. As mentioned above, each item is measured on a 4-point Likert scale from very important to not at all important as a driver in the development of eco-innovations.

All Cronbach Alphas with the exception of the Demand Side construct can be considered acceptable. We also carried out exploratory factor analysis. All of them yield one single factor solution with an eigenvalue greater than one.

Table 3 shows the results of the logistic regression models. Model 1 shows the direct effects on eco-innovation of key drivers. Model 2 includes the moderating effect of Cooperation with Universities on SMEs' propensity to eco-innovate.

The literature review indicates that the effect of the firm's size on the level of–eco-innovation activity is undetermined from a theoretical perspective (Horbach, 2008) and empirical results are inconclusive (Hoffman et al., 2012). This lack of consensus and inconclusive empirical results may reflect the fact that the relationship between size and eco-innovation is contingent on the technological context in which the firm operates (Revilla and Fernández, 2012). In our research, controlling for country and industry, the negative and significant sign of the relationship between size (small firms) and our dependent variable (coef. -.532 $p<0.01$) shows that the propensity to develop an eco-innovative behavior among entrepreneurs increases with the firm size. Size is usually considered as a proxy for complementary assets and the presence of complementary assets is important for creating incentives and the internal capacity to undertake eco-innovations such as the adoption of pollution prevention techniques (Khanna et al., 2009).

Regarding our hypothesis H1 to H3, all of these are corroborated. We found a positive and significant relationship between supply (coef. .116; $p<0.01$) and demand side factors (coef. .303; $p<0.05$) and business capabilities (coef. .114; $p<0.1$) and the propensity of the firm to develop eco-innovations.

As can be seen, the main findings of our empirical analysis show that policy regulations have no direct and significant effect on eco-innovations. Therefore, we cannot corroborate H4. This finding is similar to Triguero et al. (2013) and in contrary to Horbach's (2008) arguments.

We also found that cooperation with universities is key. We found that cooperation with Universities and Research Institutions (U&RI) has a direct effect on the development of eco-innovations (coef. .075; $p<0.01$). Moreover, it also positively moderates the effect of policy regulations (coef. .063; $p<0.1$) and supply side factors (coef. .063; $p<0.1$) on the propensity of entrepreneurs to develop this type of innovations.

Our findings may suggest that cooperation with universities is reflecting the effect of EU regulation on firms' behavior. EU funding for R&D projects drives basic research at university level and it is through cooperation with universities that SMEs can access leading edge research as universities are considered SMEs' R&D departments.

Table 2. Research variables, constructs and reliability

Construct	***Research variables***	***Cronbach Alpha***
Business Capabilities	Technological and management capabilities within the enterprise Good business partner Good access to external information and knowledge, including technology support services	.701
Supply side	Current high energy price Current high material price Expected future material scarcity Expected future increases in energy price Limited access to materials	.749
Demand side	Increasing market demand for green products Secure or increase existing market share	.683
Policy Issues	Existing regulations, including standards Expected future regulations imposing new standards Access to existing subsidies and fiscal incentives	.768
Cooperation-U&RI	Collaboration with research institutes, agencies and universities	-

Table 3. Logistic Regression

Independent variables	***Model 1***	***Model 2***
Intercept	-1.951***	-2.346***
Firm Size (small firms)	-.532***	-.525***
Main Activity (Food services as reference)		
Agriculture and fishing	.147	.148
Construction	-.077	-.082
Water supply	.219	.199
Manufacture	.089	.079
Country (EU 27) (Romania as reference)		
France	.087	.055
Belgium	.092	.068
The Netherlands	.720***	.699***
Germany	.438**	.405**
Italy	.206	.166
Luxembourg	.236	.264
Denmark	.403*	.360
Ireland	.221	.188
United Kingdom	.181	.178
Greece	.262	.261
Spain	.325	.304
Portugal	.310	.304

Finland	.145	.107
Sweden	.254	.206
Austria	.379*	.356
Cyprus (Republic)	.456	.441
Czech Republic	.300	.260
Estonia	.154	.131
Hungary	.-376	-.404*
Latvia	.050	.032
Lithuania	-.448**	-.473**
Malta	.667*	.665*
Poland	.996***	.972***
Slovakia	.208	.187
Slovenia	.281	.253
Bulgaria	-.178	-.193
Capabilities	.114*	.194*
Supply Side	.116**	.026*
Demand Side	.303***	.378***
Policy regulations	.008	.150*
Cooperation with Universities	.075***	.431***
Capabilities X Coop with Univ		-.052
Supply side X Coop with Univ		.063*
Demand side X Coop with Univ		-.032
Policy regulations X Coop with Univ		.063*
X^2 Model	364.569***	376.437***
-2 Log likelihood	6273.624	6261.756
Nagelkerke	.097	.100
% correctly predicted	61.6%	61.6%
N	4836	4836

****p< 0.01; **p<0.05; *p<0.1*

There is no significant direct effect of policy regulations on SMEs's eco-innovation behavior. However, this effect is significant when firms cooperate with Universities in the development of their R&D projects.

5. Conclusions

Our paper has several implications for managers, as well as for policy makers. For managers, it should be stressed that collaboration with U&RI is essential to drive eco-innovation. This is also important for policy-makers. Our findings suggest that national government should foster cooperation with U&RI following EU example (eg. European Innovation Partnership in EcoAP), as national policies based on subsidies and fiscal incentives seem to be ineffective.

Finally, caution must be exercised in interpreting our results, as the research is based on survey evidence. All the limitations regarding this issue should be acknowledged. Moreover, our database is cross-sectional; hence, causal implications cannot be properly identified.

In order to address these problems and limitations we propose that future research should consider interactions among the terms in our model to test the moderating effect that national culture and cooperation with universities may have on the rest of the theoretical drivers of eco-innovation. Another interesting future line of research is the introduction of additional factors (eg. innovation strategy) that could increase the explanatory power of our model. Moreover, empirical research considering eco-innovative intensity of the firms will also be necessary to increase our understanding of the causal effects of the different factors that affect eco-innovation in SMEs.

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