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Determinants of Eco-innovation from a European-wide Perspective – an Analysis based on the Community Innovation Survey (CIS).

by

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Determinants of Eco-innovation from a European-wide Perspective – an Analysis based on the Community Innovation Survey (CIS)[1]

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Abstract

Eco-innovations lead to less environmental impacts or to a reduction of energy use and are therefore crucial for climate protection. Recently, the determinants of eco-innovation activities have been widely explored for single countries but there is still a lack of country comparisons mainly because of data restrictions. In 2009, a special module on eco-innovation has been included in the Community Innovation Survey (CIS) allowing a comparison of the determinants of eco-innovation in 19 different European countries. Our analysis especially focuses on Eastern European transformation countries because the determinants of eco-innovation in these countries have not yet been systematically analyzed. Concerning the introduction of eco-innovation, the econometric analysis shows that regulation activities seem to be more important for Eastern European countries. This is especially the case for "traditional fields" such as air, noise, soil, water, recycling or dangerous substances. Except energy saving measures, environmentally related subsidies seem to be quantitatively more important for the Eastern European countries pointing to the lower financial performance of the respective firms. Furthermore, Eastern European countries are more relying on competitors and external R&D as information sources indicating a technology transfer from West to East.

JEL classification: Q55 O33 C25

Keywords: eco-innovation, probit models, country analysis

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[1] The data of the Community Innovation Survey 2008 (CIS 2008) was provided by EUROSTAT. All results and conclusions are mine and not those of EUROSTAT, the European Commission or any of the national authorities whose data have been used.

1. Introduction

Eco-innovations lead to less environmental impacts or to a reduction of energy use and are therefore crucial for climate protection. They help to remedy negative external environmental effects of economic activities. In many cases, these negative external effects have to be internalized by regulation measures so that the corresponding eco-innovation activities are not realized because of market opportunities. On the other side, especially young and dynamic eco-innovation fields such as the development of renewable energies are also economically benign because these eco-innovations may lead to cost-savings. Recently, the determinants of eco-innovation activities have been widely explored for single countries but there is still a lack of country comparisons (Johnstone 2007, Frondel et al. 2007 or Horbach et al. 2013 as exceptions) mainly because of data restrictions. But, on the other side, such a country comparison is useful as it enables analyzing the importance of different development levels, sector structures, regulation measures or innovation systems for the realization of eco-innovations.

For the first time, the special module on eco-innovation of the Community Innovation Survey (CIS) 2008 allows such an analysis for 19 European countries including Eastern Europe. A major focus of the paper lies in the analysis of specificities in the determinants of eco-innovation of Eastern European countries. Compared to the "rich" Western European countries, these countries are characterized by a lower development level connected with less R&D inputs, other environmental impact priorities, a lower environmental awareness of the population or a higher energy intensity of the economy. As far as possible, these country-specific determinants of eco-innovation are analyzed for different eco-innovation fields taking a group of richer countries as reference. The analysis helps to improve the innovation system and to identify regulation deficits in these countries with the aim to improve their eco-innovation performance.

The paper is organized as follows: Section 2 analyzes the theoretical background of the determinants of eco-innovation with a special focus on country-specific differences. In Section 3, the data basis and descriptive results for the specialization of the 19 countries on different eco-innovation fields is presented. The econometric results for the determinants of eco-innovation for country groups and nine eco-innovation fields are reported in Section 4. Section 5 summarizes and concludes.

2. Determinants of eco-innovation – country differences

Within a EU funded research project called „Measuring Eco-Innovation“ (MEI) eco-innovation has been defined as follows (Kemp und Pearson 2008: 7):

“Eco-innovation is the production, application or exploitation of a good, service, production process, organizational structure, or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction of environmental risk, pollution and the negative impacts of resource use (including energy use) compared to relevant alternatives”.

This definition is based on the outcomes of innovation activities. If innovations lead to positive environmental effects, they are defined as eco-innovations. The MEI definition also defines innovations as “green” if the underlying innovation activities were not intended to improve the environment. Therefore, “…it does not matter if environmental improvements have been the primary goal of a new product or process, or came about as a by-product or simply by chance. Eco-innovations can thus be the result of other economic rationales such as increasing market share or reducing costs” (Horbach et al. 2012: 113).

Table 1: Determinants of Eco-Innovation

Supply side	• Technological capabilities • Appropriation problem and market characteristics
Demand side	• (Expected) market demand (demand pull hypothesis) • Social awareness of the need for clean production; environmental consciousness and preference for environmentally friendly products
Institutional and political influences	• Environmental policy (incentive based instruments or regulatory approaches) • Institutional structure: e. g. political opportunities of environmentally oriented groups, organization of information flow, existence of innovation networks

Source: Horbach (2008).

In the following, the different elements of the existing eco-innovation theory (see e. g. Jaffe and Palmer 1997, Hemmelskamp 1999, Cleff and Rennings 1999, Rennings 2000, Jaffe et al. 2002, Brunnermeier and Cohen 2003, Mazzanti and Zoboli 2006, del Rio Gonzalez 2009, Horbach 2008, Kesidou and Demirel 2012, Horbach et al. 2012) are discussed to derive coun-

try-specific determinants of eco-innovation. The general innovation theory accentuates the relevance of technology push and market or demand pull factors for the explanation of innovation activities (Hemmelskamp 1999, see Table 1 for an overview). These factors are of course also relevant for eco-innovations. But as most environmental problems represent negative external effects, there may be no clear economic incentives to develop new environmentally benign products and processes. Therefore, (environmental) policy measures and institutional factors may play an important role for the realization of eco-innovations. Despite the growing harmonization of environmental policies within the EU, countries may set different priorities according to sector structures, energy intensities or environmental impacts. Table 2 shows considerable differences between countries concerning these indicators. As regards energy intensity, the Eastern European countries show very high values (especially Bulgaria 718) pointing to a high need or even potential of renewable energies in the future. All in all, the picture of the share of renewable energies from 2008 to 2011 shows an interesting pattern. Sweden, Portugal, Finland but also Romania (31%) and Latvia (45%) are already characterized by high shares of renewables in electricity consumption not least because of geographical pre-conditions. Sweden and Romania are specialized in hydroelectric power stations. In Sweden, 49% of electricity supply is generated by water power plants (Deutsch-Schwedische Handelskammer 2010, Brunklaus et al. 2013, Deutsch-Rumänische AHK 2012). Countries such as Germany, Italy but also Estonia, Lithuania or Czech Republic show a dynamic development of the share of renewables whereas Hungary, France, Bulgaria, Luxembourg and Slovakia can be characterized as stagnating countries (see Table 2).

Technological capabilities play an important role for the realization of (eco)-innovation. Unfortunately, there is no data for eco-innovation related R&D but the figures on general R&D reveal considerable country differences. Except the Czech Republic (1.3%), the R&D share (in % of GDP) in the Eastern European countries is clearly below the EU-average (1.9%) pointing to a high dependence on foreign knowledge sources (see Table 2).

Eco-innovations may also be dependent on the environmental consciousness of the consumers and firms that may be interpreted as an environmentally oriented demand pull effect. Opinion polls conducted by the European Commission (2013) show a lower environmental awareness in Eastern European countries compared to the European average. In the EU 27.8% (in 2012) of the questioned persons stated that a product's impact on the environment in purchasing decisions is very or rather important for them whereas these figures amounted only to 62% in the Czech Republic and 71% in Bulgaria (European Commission 2013, see Table 2).

Table 2: Country-comparison by different indicators

Countries	GDP per capita in PPS	Industry share in % of all branches	R&D in % of GDP	Share of renewables in electricity consumption in %		Energy intensity[1]	Environmental awareness[2]
	2008	2008	2008	2008	2011	2008	2012
Bulgaria	44	22.0	0.47	9.7	12.9	718.2	71
Cyprus	100	9.5	0.43	0.3	3.4	186.1	88
Czech Republic	81	29.6	1.30	5.2	10.6	370.8	62
Germany	116	25.7	2.69	13.6	21.3	142.4	84
Estonia	69	20.3	1.28	2.1	12.3	463.7	68
Finland	119	24.8	3.7	27.3	29.2	209.3	76
France	107	13.7	2.12	14.4	16.5	151.1	87
Hungary	64	25.1	1.0	5.3	6.4	287.8	79
Ireland	132	23.6	1.45	11.1	17.6	89.4	83
Italy	104	20.7	1.21	16.6	23.5	123.1	85
Lithuania	64	21.5	0.8	4.8	9.0	366.3	69
Luxembourg	264	9.4	1.66	3.6	4.1	138.3	89
Latvia	59	14.1	0.62	38.7	44.7	299.3	70
Malta	81	17.0	0.55	0.0	0.1	176.3	86
Netherlands	134	19.8	1.77	7.1	9.8	149.5	81
Portugal	78	17.3	1.50	34.6	46.5	157.4	80
Romania	47	25.8	0.58	28.1	31.1	412.2	77
Sweden	124	21.6	3.7	53.5	59.6	156.4	81
Slovakia	73	29.0	0.47	18.0	19.8	377.8	70
Total (EU 27)	100	19.8	1.91	16.6	21.7	141.6	83

[1] Gross inland consumption of energy divided by GDP (kg of oil equivalent per 1 000 EUR)
2 Importance of a product´s impact on the environment in purchasing decisions, share of "very or rather important" in %

Source: EUROSTAT (2013), European Commission (2013).

Furthermore, cost-savings as motivation, especially those caused by the reduction of material and energy use may also be more important for eco-innovations because, in many cases, they are connected with less environmental impacts. E. g., less material consumption signifies a reduction of waste, energy savings are normally accompanied by reductions of CO_2-emissions (Horbach et al. 2013). This motivation to introduce eco-innovations may be especially important for countries characterized by a high share of manufacturing sectors such as the Czech Republic, Germany, Hungary, Romania or Slovakia (see Table 2).

There are also regional and location conditions favoring eco-innovations (Cainelli et al. 2011, Horbach 2014a). Many eco-innovations fields are relatively new (e. g. renewable energies, electro mobility) so that they are more dependent on external sources of information and on basic research activities compared to more established innovation fields. Therefore, the existence of universities and other research institutions seems to be especially relevant for eco-innovation. These institutions contribute to the regional availability of high-skilled employees having a "fresh" education in new research fields such as new energy technologies. A recent econometric analysis for France and Germany has shown that a different institutionalization of research activities may have a strong influence on eco-innovation. Due to different priorities of the private-public cooperation system, universities play a more important role for eco-innovation in France compared to Germany (Horbach et al. 2013).

As information flows seem to be especially important for young technologies, local cooperation networks may also especially promote eco-innovation (see also de Marchi 2012). On the other side, sunk costs and path dependencies are not so important for new eco-innovation fields so that the production of eco-innovative products may also offer chances for countries characterized by an under-developed or old industry structure.

3. Data basis and descriptive results for 19 EU countries

The analysis uses data of the Community Innovation Survey (CIS) of the European Commission conducted in 2009 (CIS 2008). For the CIS 2008 a separate module on eco-innovations was introduced. This special module largely follows the definition developed in the MEI project mentioned in Section 2. The CIS-questionnaire defines an eco-innovation as follows:

"An environmental innovation is a new or significantly improved product (good or service), process, organizational method or marketing method that creates environmental benefits compared to alternatives. The environmental benefits can be the primary objective of the innovation or the result of other innovation objectives. The environmental benefits of an innovation can occur during the production of a good or service, or during the after-sale use of a good or service by the end user."

The following contains a list of environmental benefits that an eco-innovation could have produced either within the firm or from the after-sale use of a product by the user. In addition, the survey asked firms whether any of these eco-innovations have been introduced in response

to existing or expected environmental regulations, the availability of financial support by governments, demand from customers, or voluntary codes or industry agreements.

The micro-level firm data of the voluntary special module on eco-innovation is available in the Safe centre on the premises of EUROSTAT in Luxembourg and covers 19 countries and 121395 observations.

Table 3: Specialization of 19 countries on different innovation fields

Countries	Environmental benefits within the enterprise						Env. benefits from after sales use of a good or service by the end user		
	Material	Energy	CO_2	Dang. substances	Air, noise, soil, water	Recyc.	Energy	Air, noise, soil, water	Recyc.
Bulgaria	11.6	13.6	6.0	10.0	10.6	8.7	8.8	8.1	6.2
Cyprus	6.8	8.7	5.4	5.7	8.3	8.6	3.4	3.9	3.7
Czech Rep.	20.4	24.3	14.5	16.9	22.4	31.4	21.4	21.0	20.4
Germany	36.6	42.4	33.3	24.4	37.6	36.7	35.2	27.7	23.2
Estonia	15.2	16.4	6.2	10.3	15.2	14.5	10.8	8.6	7.5
Finland	23.0	23.6	19.2	17.2	16.8	23.3	23.2	14.8	15.43
France	17.9	18.5	13.4	16.1	15.3	23.8	15.2	10.7	11.6
Hungary	37.3	42.7	19.9	34.1	34.5	30.3	21.2	20.0	13.4
Ireland	18.9	22.5	22.0	19.4	17.6	34.23	20.6	14.9	22.6
Italy	10.3	14.5	13.0	16.0	23.7	25.1	23.9	23.9	22.5
Lithuania	12.6	14.3	9.9	12.9	11.8	10.0	9.7	9.4	7.5
Luxembourg	26.5	31.6	32.7	30.6	27.8	48.0	31.6	20.7	29.9
Latvia	9.7	10.2	7.8	9.4	12.3	6.5	8.5	9.9	4.9
Malta	7.8	9.6	5.1	7.3	5.1	12.1	9.2	3.5	7.4
Netherlands	13.8	19.7	16.6	22.4	20.9	22.9	21.9	18.9	15.2
Portugal	27.9	30.0	22.0	30.9	35.5	46.9	28.0	28.8	31.4
Romania	16.9	18.3	12.8	12.0	18.6	18.9	16.7	17.0	11.8
Sweden	31.0	36.6	30.4	30.5	29.6	27.6	33.5	26.8	21.9
Slovakia	11.1	12.9	7.3	10.9	13.8	14.8	11.2	10.7	10.5
Total	17.8	20.7	15.3	17.8	20.8	24.7	19.8	17.5	16.3

Source: CIS 2008, own calculations.

A descriptive analysis of this data with respect to different environmental innovation fields shows that in nearly all countries, the reduction of energy use is an important innovation field. This is especially relevant for Germany, Hungary and Sweden (see Table 3). Furthermore, the recycling sector seems to be important for the Czech Republic, Germany, Hungary, Ireland, Luxembourg, and Portugal. On average, the Eastern European countries, except Hungary, are less eco-innovative compared to the other countries what we would have expected against the background of low R&D spending in these countries. Except Bulgaria, the recycling sector

plays an important role. That is also plausible because the recycling sector predominantly requires low-skilled workers connected with low wages (Horbach 2014b).

A breakdown by different trigger factors shows that regulation activities seem to be much more important for Eastern European countries (EEC´s) for the introduction of eco-innovation (Hungary 61%, Czech Republic 61%, Lithuania 70%, Romania 66%). This is in line with the observation that the environmental awareness of the population is lower in these countries (see Section 2) and that, except Hungary, the Eastern European countries are also more dependent on subsidies confirming the significant influence of the State for the realization of eco-innovation in these countries. But, on the other side, the market demand already plays an important role triggering eco-innovation, especially in Hungary.

Interestingly, Environmental Management Systems (EMS) are already very important in the Eastern European countries.

Table 4: Determinants of eco-innovations and EMS

Countries	Eco-innovations from 2006 to 2008 in response to:					EMS
	Existing regulations or taxes	Expected regulations	Subsidies	Market demand	Voluntary codes	
Bulgaria	36.3	22.8	10.2	16.9	21.8	8.2
Cyprus	29.0	23.5	13.0	16.7	51.2	24.2
Czech Rep.	61.0	43.6	15.6	24.1	42.1	27.2
Germany	34.7	30.4	10.6	32.3	30.3	21.8
Estonia	56.8	45.4	11.8	39.5	59.1	34.1
Finland	30.1	33.1	10.5	55.3	49.1	-
France	41.0	27.5	12.8	32.4	42.5	16.7
Hungary	60.9	54.5	6.5	48.8	49.7	26.1
Ireland	37.5	28.9	13.7	37.8	41.2	-
Italy	42.3	30.3	24.9	28.1	31.9	-
Lithuania	70.1	53.1	23.0	47.3	39.8	20.0
Lux.	22.6	23.9	8.6	26.9	67.4	-
Latvia	51.4	27.6	14.6	19.5	64.3	24.2
Malta	38.7	38.7	16.2	25.0	27.5	9.3
Netherlands	26.4	23.5	16.1	33.0	31.2	22.2
Portugal	42.5	25.8	8.9	31.3	56.7	29.5
Romania	66.4	36.5	17.8	32.8	32.7	-
Sweden	21.8	28.9	9.0	37.4	35.8	70.2
Slovakia	30.6	52.0	12.8	25.4	37.1	21.5
Total	42.4	31.7	14.4	32.2	39.6	-

Source: CIS 2008, own calculations.

4. Econometric results

To analyze the determinants of eco-innovation for different environmental technology fields and countries, binary probit models are applied. For each environmental field, a firm has to decide whether to introduce an innovation related to this field (Y = 1), or not (Y = 0). Following our theoretical analysis different factors such as regulation or cost savings summarized by a vector **x** influence this decision. Therefore, we need an estimation of the probability

Prob (Y = 1| **x**) = F (**x**, β).

Because of the binary nature of our dependent variable, we use the probit model assuming normal distribution. The β parameters reflect the impact of changes in x on the probability (Greene, 2008: 772). We calculate marginal effects that allow comparison of the different eco-innovation areas.

Our dependent variables are derived as follows (see the appendix for an exact definition of all variables). For each environmental innovation field (see Table 5) the firms had to respond to the following question:

"During the three years 2006 to 2008, did your enterprise introduce a product (good or service), process, organizational or marketing innovation with any of the following environmental benefits" (EUROSTAT 2009: 10). The answers were coded as yes/no options so that the resulting variables are dummies.

To capture the determinants of the different eco-innovation fields the following groups of correlated variables are considered:

- Regulation measures, subsidies,
- Market factors: Market demand, cost savings,
- Innovation inputs,
- Innovation objectives,
- Information sources,
- Organizational innovations,
- Control variables (size, sector and country dummies).

Regulation activities, environmentally related subsidies (*envsubsidies*) and general *subsidies* capture the influence of state activities on different eco-innovation fields. The variable *voluntary* denotes the relevance of voluntary codes or agreements for environmental good practice. Market oriented factors are the current or expected market *demand* from customers, *export*

activities and *cost savings* as motivation for the introduction of eco-innovations indicating the competition pressure the firm has to face. The innovation inputs are captured by *internal* and *external R&D* activities, the acquisition of advanced machinery, equipment and computer hardware or software (*equip*), the purchase or licensing of patents and non-patented inventions (*extknowledge*), internal or external *training* for the personnel, activities for the market introduction of new or significantly improved products and processes (*marketintro*) and other activities such as feasibility studies or industrial engineering (*otherinput*). The *variable cooperation* captures cooperation arrangements on innovation.

The econometric analysis also considers the innovation objectives denoting an increase of the range of goods and services (*productrange*), a replacement of outdated products or processes (*replace*), an entry into new markets (*newmarkets*), an increase of the market share (*marketshare*), an improvement of the quality of goods and services (*quality*), an improvement of the *flexibility* or an increase of the *capacity* for producing of goods or services, and improvement of *health* or safety or a reduction of *labor costs* per unit of output.

The importance of the following different information sources for the realization of the firm´s innovation activities are considered: Sources within the firm or firm group (*internal*), *suppliers* of equipment, materials, components or software, *customers*, *competitors* or other firms in the same sector, *consultants* or commercial laboratories or private R&D institutes, *universities* or other higher education institutions, government or public research (*pubresearch*), *conferences*, trade fairs or exhibitions, scientific *journals* and other publications and professional and industry *associations*.

Furthermore, the influence of organizational measures such as new business practices (e. g. supply chain management or lean production) (*business org*.), new methods of organising work responsibilities and decision making (e. g. team work, education or training systems) (*labour org*.) and new methods of organising external relations (e. g. outsourcing or subcontracting (*orgexr*) are tested. Country and sector dummies were also included.

In a first step, probit models including all 18 countries[2] were estimated (see Table 5). The analysis confirms an important result from the recent literature (e. g. Horbach et al. 2012):

[2] Ireland could not be included because of lacking data.

Table 5: Determinants of eco-innovation by different environmental areas – Results for all countries

Determinants	Environmental benefits within the enterprise						Env. benefits from after sales use of a good or service by the end user		
	Material	Energy	CO_2	Dang. sub-stances	Air, noise, soil, water	Recyc.	Energy	Air, noise, soil, water	Recyc.
Regulation	2.5**	5.2**	11.3**	17.0**	22.8**	13.3**	3.1**	15.8**	10.8**
Envsubsidies	2.5**	8.6**	12.7**	3.6**	9.0**	3.9**	12.2**	10.9**	5.8**
Demand	8.5**	6.4**	10.9**	14.8**	8.7**	5.7**	17.3**	17.6**	14.2**
Voluntary	5.8**	9.4**	11.0**	11.5**	12.7**	15.5**	5.8**	9.6**	13.4**
Cost savings	7.4**	6.5**	3.8**	1.8*	2.9**	-	3.6**	2.9**	-
Size	0.0**	0.0**	0.0**	0.0**	0.0**	0.0**	0.0**	0.0**	0.0**
Subsidies	-	-	-	-	2.3**	-1.7*	-	-	-3.1**
Export	-	1.6*	-	-1.7+	1.6*	-	-4.1**	-3.0**	-3.5**
Innovation inputs									
Internal R&D	4.7**	3.5**	-	1.7*	1.7*	-	1.6*	1.8*	-
External R&D	1.4+	2.9**	-	-	-	-	-	-	-
Equip	1.8*	2.7**	-	-	1.9*	1.9**	-	-	-
Extknowledge	1.8*	-	2.6**	-	-	1.7*	1.9*	2.8**	2.8**
Training	1.7*	-	-	-	1.5*	1.8**	-	-	-
Marketintro	3.6**	1.4+	1.8*	2.4**	-	-	4.6**	4.3**	4.4**
Otherinput	1.7*	1.9**	2.0**	1.8*	-	1.4*	1.3+	-	-
Cooperation	-1.6*	-	-	-	-		-	-	-2.5**
Objectives									
Productrange	-	-2.5**	-2.5**	-	-1.8*	-	-	-2.3**	-
Replace	3.1**	-	-	3.2**	-	-	1.3+	-	-
NewMarkets	-1.6*	-1.4+	-1.5+	-	-	-	1.7*	2.8**	1.7*
MarketShare	-	-	-	-	-1.9*	-	-	-	-
Quality	-	-	-	-2.1**	-	-	1.3+	-	-
Flexibility	-	-	1.9*	-	-	-	-	-	-
Capacity	1.5+	3.9**	1.7*	-1.9*	3.7**	1.9*	1.3+	-	-
Health	2.1**	2.5**	9.1**	10.9**	12.7**	7.0**	-	11.8**	7.7**
Laborcosts	8.2**	6.5**	1.6+	-	-1.7+	-	-	-	-
Info Sources									
Internal	1.3+	-	-	-2.1**	-1.5+	-1.4*	-2.3**	-2.1**	-2.6**
Suppliers	-1.4+	-	-	-	-1.5+	-	-	-1.8*	-
Customers	-	-	-	1.8*	-	-	-	-	-
Competitors	-	-	-	-	-3.0**	-	-	-	-1.9+
Consultants	-2.8*	-4.2**	-3.4**	-	-	-	-4.1**	-	-
Universities	-	-	-	-	-	-	-	-	-
Pubresearch	-	-	3.4+	-	-	-	-	-	-4.7*
Conferences	-2.0+	-3.1**	-2.4*	-	-	-	-2.4*	-	-
Journals	-	2.8*	-	3.9**	-	-2.6*	-	-	-
Associations	-	-	-	-	-	-	-	3.4*	3.5*
Org. innovation									
Business org.	3.4**	2.2**	-	2.1**	-	4.5**	-	-	-
Labour org.	2.9**	2.6**	3.6**	2.8**	2.2**	4.5**	2.9**	2.3**	3.8**
Orgexr	2.0**	2.4**	2.7**	2.4**	1.5+	2.1**	2.5**	-	4.4**
Number of obs.	26268	26281	26256	26269	26285	26281	26259	26242	26251

Marginal effects are reported (in %). The marginal effects for the continuous independent variables were calculated at their means. Concerning dummy variables the values report the change in probability for a discrete change of the dummy variable from 0 to 1. Only significant marginal effects (at least at 10% level) are considered. +, *, ** denote significance at the 10%, 5% and 1% level, respectively. Sector and country dummies included but not reported. "-" means that the marginal effect is not significant. Only eco-innovators are considered.

Source: CIS 2008, own estimations.

There are highly positive marginal effects for *regulation*s concerning "traditional end-of-pipe" fields such as air, noise, soil, water (22.8%) and also dangerous substances (17.0%) whereas the respective values for material (2.5%) and energy savings (5.2%) are much lower. For the last-mentioned fields *cost savings* are more important as motivation (material (7.4%) and energy (6.5%)). Environmentally related subsidies (*envsubsidies*) are especially important for innovations reducing CO_2. Not surprisingly, market demand plays an important role for eco-product-innovations but also for the reduction of dangerous substances (14.8%). This may be due to a growing environmental awareness of the customers (see also Section 2, Table 2) so that green characteristics of products play a more important role.

Interestingly, the export orientation is not significantly correlated to eco-innovations, the marginal effects for eco-product-innovations are all negative which is in line of results from recent literature (de Marchi and Grandinetti 2012).

Concerning innovation inputs, internal R&D seems to be especially important for material (4.7%) and energy (3.5%) savings. That is plausible because material and energy savings often stem from changes of the individual production process. On the other side, external knowledge is positively correlated to CO_2 related innovations and eco-product-innovations. In fact, CO_2 reduction technologies are relatively young thus requiring much knowledge from basic research activities.

The objectives of eco-innovations were also tested: An increase of the range of goods and services does not seem to be a relevant objective for eco-innovations (negative or insignificant marginal effects). Interestingly, the introduction of material and energy saving innovations is also accompanied by the reduction of labour costs per unit of output pointing to the fact that material, energy and savings of labour costs are a result of the change of the production process. Not surprisingly, *health* and safety objectives also trigger eco-innovations especially in the fields of dangerous substances and air, soil, noise and water related eco-innovations. The analysis of the information sources shows no clear picture for the sample of all countries whereas organizational innovations seem to be very relevant for nearly all types of eco-innovations.

Table 6: Determinants of eco-innovation by different environmental areas – Results for Germany, France, Netherlands, Luxemburg

Determinants	Environmental benefits within the enterprise						Env. benefits from after sales use of a good or service by the end user		
	Material	Energy	CO_2	Dang. sub-stances	Air, noise, soil, water	Recyc.	Energy	Air, noise, soil, water	Recyc.
Regulation	2.5**	8.0**	9.7**	17.9**	23.4**	11.53**	5.5**	16.3**	10.4**
Envsubsidies	-2.7+	10.0**	13.5**	-	7.1**	-	12.5**	8.9**	-
Demand	7.5**	4.9**	10.8**	11.8**	7.7**	6.9**	17.8**	16.7**	13.9**
Voluntary	9.4**	12.2**	13.5**	13.2**	15.3**	14.7**	8.2**	11.8**	14.2**
Cost savings	5.3**	5.7**	3.1**	-	-	-	-	-	-
Size	0.0**	0.0**	0.0**	0.0**	0.0**	0.0**	0.0**	0.0**	0.0**
Subsidies	-	-	-	-2.5+	-	-	-	-	-
Export	-	-	-	-	3.2*	-	-5.3**	-	-3.3**
Innovation inputs									
Internal R&D	4.8**	3.4**	2.4+	-	-	-	2.4+	-	-
External R&D	-	3.7**	-	-	2.4+	-	-	-	-
Equip	-	-	-	-	-	2.9**	-	-	-
Extknowledge	2.3+	-	2.3+	-	-	-	-	-	3.2**
Training	4.0**	-	-	-	-	-	2.9**	2.2+	-
Marketintro	3.6**	-	-	-	-	-	2.4+	2.1+	-
Otherinput	-	-	-	3.0*	-	-	-	-	-
Cooperation	-	-	-	-	-	-	-	-2.9**	-2.5*
Objectives									
Productrange	-	-	-	-	-	-	-	-2.6*	-2.0+
Replace	3.5**	-	-	3.6**	-	-	-	-	-
NewMarkets	-	-	-2.6*	-	-	-	-	3.7**	2.1+
MarketShare	2.4+	-	-	-	-	2.2+	2.8*	-	2.3*
Quality	-	-	-	-2.7*	-	3.2**	-	-	-
Flexibility	-	-	-	-	-	-	-	-	-
Capacity	-	3.0*	-	-	4.8**	2.3+	-	-	-
Health	4.6**	3.1*	8.9**	13.2**	13.7**	7.3**	-	11.4**	7.5**
Laborcosts	8.5**	4.9**	2.9*	-	-	-	2.8*	-	-
Info Sources									
Internal	3.2**	2.4*	-	-	-	-	-	-	-
Suppliers	-	-2.3+	-	-	-2.3+	-	-	-	-
Customers	-	-	-	2.4+	-	-	-	-	-
Competitors	-	-5.0**	-	-	-	-	-	-3.5*	-3.6*
Consultants	-	-	-	-	-	-	-	-	-
Universities	-	-	-	-	-	-	-	-	-
Pubresearch	6.1+	-	-	-	-	-	-	-	-
Conferences	-	-4.4*	-	-	-	3.2+	-	-	-
Journals	-	-	-	4.1+	-	-	-	-	-
Associations	-4.2+	-	-	-	-	-	-	-	-
Org. innovation									
Business org.	4.2**	-	-	2.3+	2.5+	5.2**	-	-	2.9**
Labour org.	3.3**	-	2.3+	2.1+	-	5.6**	3.0*	-	2.2+
Orgexr	-	2.1+	3.9**	-	-	-	-	-	3.0**
Number of obs.	10539	10539	10539	10539	10539	10539	10523	10523	10523

Marginal effects are reported (in %). The marginal effects for the continuous independent variables were calculated at their means. Concerning dummy variables the values report the change in probability for a discrete change of the dummy variable from 0 to 1. Only significant marginal effects (at least at 10% level) are considered. +, *, ** denote significance at the 10%, 5% and 1% level, respectively. Sector and country dummies included but not reported. "-" means that the marginal effect is not significant.

Source: CIS 2008, own estimations.

In a further step, the specificities of the Eastern European countries are analyzed. To this end, additional probit models were estimated for a group of "rich" countries (Germany, France, Netherlands, Luxemburg) (Table 6) and for the available Eastern European countries (Table 7). The econometric results show that for "traditional fields" such as air, noise, soil, water (25.3% versus 23.4%), recycling (17.2% versus 11.5%), dangerous substances (19.1% versus 17.9%) the marginal effects for the importance of *regulation* measures are slightly higher for the Eastern European countries. This may be explained by lower existing environmental technology standards in these areas in the Eastern countries whereas the "rich" countries have already adapted their abatement technologies in past years. On the other side, for new emerging fields such as material or energy savings within firms regulation measures do not yet play a significant role in Eastern Europe compared to the "rich" countries characterized by important regulation measures in these areas such as the renewable energy law in Germany. This may point to regulation deficits in these countries. For nearly all environmental fields (except recycling) *voluntary* codes or agreements for environmental good practice are less important in Eastern Europe pointing to a still lower environmental awareness confirming the results of opinion polls (see Section 2). Except energy saving measures, environmentally related subsidies (*envsubsidies*) seem to be quantitatively more important for the Eastern European countries pointing to the lower financial performance of Eastern European firms.

In the "young" environmental technology field of energy saving measures the Eastern European countries are more relying on competitors as information sources (6% versus -5%). This argument is also documented by the fact that Eastern European countries are slightly more dependent on external R&D measures (*external R&D* 4.5%, *equip* 5%) indicating a technology transfer from West to East. In the "rich" countries, *internal* information sources are significant whereas this is not the case in the Eastern European countries. The dependence of Eastern European firms on alliances and partnerships is also documented by the significant marginal effects of *orgexr* denoting new methods of organizing external relations. This variable is significant for material (4.6%) and energy (3.1%) savings, CO_2-reductions (4.8%), dangerous substances (5.6%), energy saving products (4.4%) and recycling of products (4.5%). Concerning the innovation objectives the results for the two country groups are very similar.

The country comparison was also enlarged for two further groups of countries, a south country group (Cyprus, Italy, Malta and Portugal) and a north group (Finland and Sweden) (see Appendix 2 and 3 for the econometric results).

Table 7: Determinants of eco-innovation by different environmental areas – Results for Bulgaria, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Romania, Slovakia

Determinants	Environmental benefits within the enterprise						Env. benefits from after sales use of a good or service by the end user		
	Material	Energy	CO_2	Dang. sub-stances	Air, noise, soil, water	Recyc.	Energy	Air, noise, soil, water	Recyc.
Regulation	-	-	15.8**	19.1**	25.3**	17.2**	-	14.5**	11.4**
Envsubsidies	7.5**	8.2**	10.4**	7.2**	11.8**	8.1**	9.0**	10.7**	11.3**
Demand	6.3**	3.3*	7.1**	13.5**	9.3**	4.7**	19.7**	21.5**	15.9**
Voluntary	3.4*	6.9**	8.5**	10.9**	9.8**	15.5**	3.7**	6.7**	10.0**
Cost savings	11.3**	10.0**	3.9**	3.8*	6.1**	-	5.6**	4.9**	-
Size	-	0.0+	0.0**	0.0*	0.0**	0.0**	-	-	-
Subsidies	-3.7*	-	-	-	3.5*	-3.0*	-	-	-5.8**
Export	-	-	-	-	-	-	-5.0**	-4.9**	-3.1*
Innovation inputs									
Internal R&D	5.1**	-	-	2.9*	-	-	-	-	-
External R&D	-	4.5**	-	-	-	4.1**	-	-	-
Equip	3.9*	5.0**	-	-	-	-	-	-	-
Extknowledge	-	-	-	-	-	2.5+	-	3.0+	3.1**
Training	-	-	-	-	-	-	-	-	-
Marketintro	3.5*	2.7+	-	3.8**	-	-	5.3**	7.1**	6.1**
Otherinput	-	-	-	-	-	3.2*	-	2.7+	-
Cooperation	-	2.5+	-	-	-	-	-	-	-2.5**
Objectives									
Productrange	-	-	-	-	-	-	-	-2.5+	-
Replace	3.6**	2.2+	-	3.8**	-	2.4+	-	-	-
NewMarkets	-	-	-	-	-	-	-	4.5**	-
MarketShare	-	-	-	-	-	-	-	-	-
Quality	-	-	-	-2.1**	-	-	-	-	-
Flexibility	-	-		-	-	-	-	-	4.1**
Capacity	-	5.1**		-4.1*	-	2.8+	-	-	-
Health	-	-	9.4**	7.9**	10.6**	6.0**	-	9.4**	3.8**
Laborcosts	9.1**	7.0**	-	-	-4.6**	-	3.8*	-	-
Info Sources									
Internal	-	-2.3+	-	-	-	-	-4.3**	-	-
Suppliers	-	-	-	-	-	-	-	-3.8**	-
Customers	-	-	-	-	-	-	-	-	-
Competitors	-	6.0**	-	-	-4.8**	-	3.8*	-3.8*	-
Consultants	-	-5.2*	-	-	-	-	-5.7**	-	-
Universities	-	-	-	-	-	-	-	-	-
Pubresearch	-	-	7.9*	-	-	-	-	-	-
Conferences	-	-3.4**	-	-	-	-	-2.4*	-	-
Journals	-	-	-3.3+	-	-	-	-	-	-
Associations	-	-	-	-	-	-	5.2+	8.1**	7.1*
Org. innovation									
Business org.	-	-	-	-	-	4.7**	-	-	-
Labour org.	4.9**	3.8**	4.0**	-	-	4.2**	2.6+	-	3.2*
Orgexr	4.6**	3.1**	4.8**	5.6**	-	-	4.4**	-	4.5**
Number of obs.	7258	7258	7258	7258	7258	7258	7258	7258	7258

Marginal effects are reported (in %). The marginal effects for the continuous independent variables were calculated at their means. Concerning dummy variables the values report the change in probability for a discrete change of the dummy variable from 0 to 1. Only significant marginal effects (at least at 10% level) are considered. +, *, ** denote significance at the 10%, 5% and 1% level, respectively. Sector and country dummies included but not reported. "-" means that the marginal effect is not significant.

Source: CIS 2008, own estimations.

The Southern European countries show a slightly higher dependence on environmental subsidies (*envsubsidies*) compared to Germany, France, Netherlands and Luxemburg. Like the Eastern European countries *voluntary* codes for environmental good practice seems to be less important for the Southern countries. Eco-innovativeness within the firm especially for material (*internal R&D* 6.1%) and energy (7.6%) saving innovations within the firm seem to be very important. This is plausible, because Italy, the country with the highest number of firms in the southern group, is one of the technology leaders in the environmental industry (Umweltbundesamt 2014).

Not surprisingly, the results for Finland and Sweden are quite similar to those of Germany, France, Netherlands and Luxemburg due to a similar development level (see Table 2, Section 2) and a longstanding tradition in environmental regulation. Due to limited own innovation activities in material saving technologies, CO_2-reductions, dangerous substances and air, noise, soil and water acquisition the acquisition of external knowledge seem to play a more important role for the Northern countries. The reduction of *labour costs* as innovation objective is highly correlated to material (12%) and energy savings (7.3%) innovations and CO_2-reduction (5.6%), these marginal effects are higher compared to Germany, France, Netherlands and Luxemburg.

4. Summary and conclusions

The paper analyzes the determinants of eco-innovation activities for 19 different countries by nine technology fields. In 2009, a special module on eco-innovation has been included in the Community Innovation Survey (CIS) allowing such an analysis.
A descriptive analysis of this data with respect to different environmental innovation fields show that in nearly all countries the reduction of energy use is an important innovation field. This is especially relevant for Germany, Hungary and Sweden. Furthermore, the recycling sector seems to be important for the Czech Republic, Germany, Hungary, Ireland, Luxembourg, and Portugal. On average, the Eastern European countries, except Hungary, are less eco-innovative compared to the other countries what we would have expected against the background of low R&D spending in these countries.

A breakdown by different trigger factors shows that regulation activities seem to be much more important for Eastern European countries (EEC´s) for the introduction of eco-innovation. This is in line with the observation that the environmental awareness of the popu-

lation is lower in these countries and that, except Hungary, the Eastern European countries are also more dependent on subsidies confirming the more important role of the State for the realization of eco-innovation.

The econometric analysis for all nineteen involved countries confirms an important result from the recent literature: Regulations are very important for "traditional end-of-pipe" fields such as air, noise, soil, water and also dangerous substances whereas their influence on material and energy savings is much lower. For the last-mentioned fields cost savings are more important as motivation. Environmentally related subsidies are especially important for innovations reducing CO_2. Concerning innovation inputs, internal R&D seems to be especially important for material and energy savings. That is plausible because material and energy savings often stem from changes of the individual production process. The objectives of eco-innovations were also tested: Interestingly, the introduction of material and energy saving innovations is also accompanied by the reduction of labour costs per unit of output pointing to the fact that material, energy and savings of labour costs are an overall result of the change of the production process.

In a further step, the specificities of the Eastern European countries are analyzed. To this end, additional probit models were estimated for a group of "rich" countries (Germany, France, Netherlands, Luxemburg) and for the available Eastern European countries. The econometric results show that for "traditional fields" such as air, noise, soil, water, recycling, dangerous substances the marginal effects for the importance of regulation measures are slightly higher for the Eastern European countries. This may be explained by lower existing environmental technology standards in these areas in the Eastern countries whereas the "rich" countries have already adapted their abatement technologies in past years. On the other side, for new emerging fields such as material or energy saving regulation measures within firms do not yet play a significant role in Eastern Europe compared to the "rich" countries characterized by important regulation measures in these areas such as the renewable energy law in Germany pointing to a lack of regulation. For nearly all environmental fields (except recycling) voluntary codes or agreements for environmental good practice are less important in Eastern Europe pointing to a still lower environmental awareness in these countries confirming the results of opinion polls. Except energy saving measures, environmentally related subsidies seem to be quantitatively more important for the Eastern European countries pointing to the lower financial performance of Eastern European firms.

In the "young" environmental technology field of energy saving measures the Eastern European countries are more relying on competitors as information sources. This argument is also documented by the fact that Eastern European countries are slightly more dependent on external R&D measures indicating a technology transfer from West to East. In the "rich" countries, internal information sources are significant whereas this is not the case in the Eastern European countries.

References

Brunklaus, B., Hildenbrand, J., Saransini, S. (2013): ECO-innovative Measures in large Swedish Companies - An inventory based on company reports, VINNOVA 2013:03, Chalmers University of Technology, Gothenburg.

Brunnermeier, S. B., Cohen, M. A. (2003): Determinants of Environmental Innovation in US Manufacturing Industries, Journal of Environmental Economics and Management, Vol. 45, No. 2, 278-293.

Cainelli, G., Mazzanti, M., Zoboli, R. (2011): Environmental innovations, complementarity and local/global cooperation: evidence from North-East Italian industry, International Journal of Technology, Policy and Management Vol. 11, Nos. 3/4, 328-268.

Cleff, T., Rennings, K. (1999): Determinants of Environmental Product and Process Innovation - Evidence from the Mannheim Innovation Panel and a Follow-Up Telephone Survey, European Environment, Vol. 9, No. 5, 191-201.

De Marchi, V., Grandinetti, R. (2012): Who are the green innovators? An empirical analysis of firm's level factors, DRUID 2012 conference paper, Copenhagen.

De Marchi, V. (2012): Environmental innovation and R&D cooperation: Empirical evidence from Spanish manufacturing firms, Research Policy, Vol. 41, 614-623.

Del Rio Gonzalez, P. (2009): The empirical analysis of the determinants for environmental technological change: A research agenda, Ecological Economics, Vol. 68, 861-878.

Deutsch-Rumänische AHK (2012): Erneuerbare Energien in Rumänien: Elektrische Energie, Bukarest. www.ahkrumaenien.ro

Deutsch-Schwedische Handelskammer (2010): Die Klimaschutzziele Schwedens und Deutschlands sind ambitioniert, Stockholm.
http://www.handelskammer.se/de/news/energiepolitische-ziele-deutschland-und-schweden

European Commission (2013): EU skills panorama. http://euskillspanorama.ec.europa.eu/

EUROSTAT (2009): The Community Innovation Survey 2008 (CIS 2008) - The harmonised survey questionnaire, Luxembourg

EUROSTAT (2013): Statistical Data, Luxembourg. http://epp.eurostat.ec.europa.eu

Frondel, M., Horbach, J., Rennings, K. (2007): End-of-Pipe or Cleaner Production? An Empirical Comparison of Environmental Innovation Decisions Across OECD Countries, Business Strategy and the Environment, Vol. 16 No. 8, 571-584.

Greene, W. H. (2008): Econometric Analysis, Sixth Edition. Pearson International, New Jersey.

Hemmelskamp, J. (1999): Umweltpolitik und technischer Fortschritt, Schriftenreihe des Zentrums für Europäische Wirtschaftsforschung, Physica, Heidelberg, New York.
Horbach, J. (2008): Determinants of Environmental Innovation – New Evidence from German Panel Data Sources, Research Policy, Vol. 37, 163-173.
Horbach, J., Rammer, C., Rennings, K. (2012): Determinants of Eco-innovations by Type of Environmental Impact - The Role of Regulatory Push/Pull, Technology Push and Market Pull, Ecological Economics 78 (2012), 112-122.
Horbach, J., Oltra, V., Belin, J. (2013): Determinants and specificities of eco-innovations – An econometric analysis for France and Germany based on the Community Innovation Survey, Industry and Innovation Vol. 20, 6, 523-543.
Horbach, J. (2014a): Do eco-innovations need specific regional characteristics? An econometric analysis for Germany, Review of Regional Research, Vol. 34, Issue 1, 23-38.
Horbach, J. (2014b): Determinants of Labor Shortage - with particular Focus on the German Environmental Sector, Nuremberg.
Jaffe, A., Palmer, K., (1997): Environmental regulation and innovation: a panel study, The Review of Economics and Statistics Vol. X, 610-619.
Jaffe, A. B., Newell, R. G., Stavins, R. N., (2002): Environmental Policy and Technological Change, Environmental and Resource Economics 22, 41-69.
Johnstone, N. (Ed.) (2007): Environmental Policy and Corporate Behaviour, Edwar Elgar, Northhampton.
Kemp, R., P. Pearson (2008): Final report MEI project about measuring eco-innovation, Maastricht, www.merit.unu.edu\MEI.
Kesidou, E., Demirel, P. (2012): On the drivers of eco-innovations: Empirical evidence from the UK, Research Policy, Vol. 41, 862-870.
Mazzanti, M., Zoboli, R. (2006): Examining the factors influencing environmental innovations, FEEM working paper series 20. 2006, Milano.
Rennings, K. (2000): Redefining Innovation – Eco-Innovation Research and the Contribution from Ecological Economics, Ecological Economics, Vol. 32, 319-332.
Umweltbundesamt (2014): Die Umweltwirtschaft in Deutschland, Umwelt, Innovation, Beschäftigung, Februar 2014, Berlin

Appendix 1: Definition of variables and descriptive statistics

Variables	Description	Mean	St. Dev.
Endogenous var.			
	Environmental benefits within the enterprise (1 yes 0 no)		
Material	Reduced material per unit of output	0.18	0.38
Energy	Reduced energy use per unit of output	0.21	0.41
CO2	Reduced CO_2 footprint (total CO_2 production)	0.15	0.36
DangSubstances	Replaced materials with less polluting substitutes	0.18	0.38
AirNoiseSoilWat	Reduced soil, water, noise, or air pollution	0.21	0.41
Recycling	Recycled waste, water or materials	0.25	0.43
	Environmental benefits from after sales use (1 yes 0 no)		
Energyprod	Reduced energy use	0.20	0.40
EmissionsProd	Reduced air, water, soil or noise pollution	0.18	0.38
RecyclingProd	Improved recycling of product after use	0.16	0.37
Determinants			
Regulation	Existing environmental regulations (1 yes 0 no)	0.41	0.49
Envsubsidies	Government grants for eco-innovation (1 yes 0 no)	0.14	0.46
Demand	Current or expected market demand (1 yes 0 no)	0.29	0.46
Voluntary	Voluntary Codes or agreements (1 yes 0 no)	0.37	0.48
Cost savings	Reduce costs per unit of output as motivation (1 high 0 other)	0.10	0.30
Size	Number of employees in 2008	181.9	1575.2
Subsidies	Financial aid from regional, national or EU (1 yes 0 no)	0.09	0.29
Export	Selling goods or services in other (EU)-countries (1 yes 0 no)	0.39	0.49
Innovation inputs			
Internal R&D	Intramural R&D (1 yes 0 no)	0.30	0.46
External R&D	Extramural R&D (1 yes 0 no)	0.15	0.36
Equip	Acquisition of machinery (1 yes 0 no)	0.35	0.48
Extknowledge	Acquisition of external knowledge (1 yes 0 no)	0.11	0.31
Training	Training for innovative activities (1 yes 0 no)	0.24	0.43
Marketintro	Market introduction of innovation (1 yes 0 no)	0.19	0.39
Otherinput	Other activities (e. g. feasibility studies) (1 yes 0 no)	0.19	0.39
Cooperation	Cooperation arrangements on innovation (1 yes 0 no)	0.33	0.47
Objectives			
Productrange	Increased range of goods or services (1 high 0 other)	0.17	0.38
Replace	Replace outdated products or processes (1 high 0 other)	0.12	0.33
NewMarkets	Enter new markets (1 high 0 other)	0.12	0.33
MarketShare	Increase market share (1 high 0 other)	0.15	0.35
Quality	Improve quality of goods or services (1 high 0 other)	0.19	0.39
Flexibility	Improve flexibility for prod. Goods/services (1 high 0 other)	0.11	0.32
Capacity	Increase capacity for prod. goods/services (1 high 0 other)	0.11	0.32
Health	Improve health and safety (1 high 0 other)	0.09	0.29
Laborcosts	Reduce labor costs per unit output (1 high 0 other)	0.10	0.30
Info Sources			
Internal	Sources within the firm (1 high 0 other)	0.17	0.38
Suppliers	Suppliers of equipment, materials (1 high 0 other)	0.08	0.27
Customers	Clients or customers (1 high 0 other)	0.09	0.29
Competitors	Competitors of other firms of same industry (1 high 0 other)	0.04	0.20
Consultants	Consultants, commercial labs (1 high 0 other)	0.03	0.17
Universities	Universities, other higher education institutes (1 high 0 other)	0.02	0.14
Pubresearch	Government or public research institutes (1 high 0 other)	0.02	0.12
Conferences	Conferences, trade fairs, meetings (1 high 0 other)	0.04	0.19

Journals	Scientific journals (1 high 0 other)	0.03	0.16
Associations	Professional and industry associations (1 high 0 other)	0.02	0.14
Org. innovation			
Business org.	New business practices for organizing work (1 yes 0 no)	0.22	0.41
Labour org.	New methods of workplace organization (1 yes 0 no)	0.24	0.42
Orgexr	New methods of organizing external relations (1 yes 0 no)	0.12	0.33
Sector dummies	1 yes, 0 no (for all sector dummies)		
Sec1	Agriculture, forestry and fishery	0.01	0.09
Sec2	Mining	0.01	0.10
Sec3	Food products, beverages and tobacco	0.06	0.24
Sec4	Textiles, leather	0.05	0.22
Sec5	Wood, paper, printing	0.05	0.21
Sec6	Chemical industry, rubber and plastics, glass	0.07	0.26
Sec7	Basic metals and fabricated metals	0.06	0.24
Sec8	(Electrical) machinery and apparatus, motor vehicles	0.08	0.27
Sec9	Furniture and other products	0.05	0.22
Sec10	Electricity, gas, steam	0.01	0.10
Sec11	Water collection and treatment, sewerage, waste	0.02	0.15
Sec12	Construction sector	0.08	0.27
Sec13	Wholesale and retail trade	0.16	0.37
Sec14	Transport and logistics	0.06	0.25
Sec15	Accommodation, restaurants	0.03	0.16
Sec16	Information and communication	0.06	0.23
Sec17	Services: banking sector, assurances, real estate etc.	0.04	0.19
Sec18	Architectural and engineering offices	0.06	0.23
Sec19	Public sector and other services	0.05	0.21
Countries	1 yes, 0 no (for all country dummies)		
Bulgaria	Bulgaria	0.09	0.29
Cyprus	Cyprus	0.01	0.08
Czech Republic	Czech Republic	0.04	0.20
Germany	Germany	0.04	0.19
Estonia	Estonia	0.01	0.11
Finland	Finland	0.02	0.12
France	France	0.12	0.32
Hungary	Hungary	0.03	0.18
Ireland	Ireland	0.01	0.11
Italy	Italy	0.12	0.32
Lithuania	Lithuania	0.01	0.11
Luxembourg	Luxembourg	0.00	0.06
Latvia	Latvia	0.01	0.08
Malta	Malta	0.01	0.09
Netherlands	Netherlands	0.07	0.25
Portugal	Portugal	0.04	0.19
Romania	Romania	0.06	0.23
Sweden	Sweden	0.03	0.16
Slovakia	Slovakia	0.01	0.12

Appendix 2: Determinants of eco-innovation by different environmental areas – Results for Cyprus, Italy, Malta and Portugal

Determinants	Environmental benefits within the enterprise						Env. benefits from after sales use of a good or service by the end user		
	Material	Energy	CO_2	Dang. sub-stances	Air, noise, soil, water	Recyc.	Energy	Air, noise, soil, water	Recyc.
Regulation	4.8**	4.1**	8.3**	13.3**	19.1**	12.8**	-	15.6**	10.3**
Envsubsidies	4.3*	6.4**	14.2**	4.5*	8.3**	-	14.1**	12.3**	6.2**
Demand	12.6**	11.4**	12.4**	21.3**	9.9**	4.2**	13.5**	13.8**	12.5**
Voluntary	2.4+	7.6**	9.2**	8.6**	11.8**	13.9**	5.8**	10.0**	14.8**
Cost savings	6.1**	3.0+	5.5**	5.0**	4.0*	-	4.5**	5.1**	-
Size	-	0.0**	0.0**	-	0.0**	0.0*	0.0**	0.0*	-
Subsidies	-	-	-	-	2.7+	-	-	-	-3.5*
Export	-	2.6+	-	-4.6**	-	3.7**	-	-	-4.4**
Innovation inputs									
Internal R&D	6.1**	7.6**	-	2.8+	3.5*	-	2.4+	-	-
External R&D	-	-	-	-	-3.9*	-3.0+	-	-4.6**	-3.0+
Equip	-	3.2*	-	-	-	3.2*	-	-	-
Extknowledge	-	-	4.1*	-	3.0+	-	3.6*	6.0**	-
Training	-	-	-	-	-	3.5**	-	-	-
Marketintro	-	-	-	5.1**	3.1*	-	4.6**	5.6**	4.7**
Otherinput	2.8+	4.2**	3.6*	-	-	-	-	-	-
Cooperation	-	-	-	-	-3.4*	-	-	-	-
Objectives									
Productrange	-	-3.5*	-4.7**	-	-	-2.6+	-2.5+	-	-
Replace	-	-	-	-	-	-3.0*	-	-	-
NewMarkets	-	-	-3.4*	-3.4*	-	-	-	-	-
MarketShare	-	-	-	-	-4.4**	2.2+	-	-	-
Quality	-	-	-	-	-	3.2**	-	-	-4.0**
Flexibility	-	-	-	-	-	-	-	-	-
Capacity	4.6**	-	-	-	4.3**	-	-	-	5.6**
Health	-	4.3**	10.5**	10.8**	13.9**	7.4**	4.9**	14.4**	11.2**
Laborcosts	5.8**	8.5**	-	-	-	-	-	-	-
Info Sources									
Internal	-	-	-	-4.8**	-4.4**	-2.5+	-4.6**	-7.5**	-5.5**
Suppliers	-2.8+	-	-	-3.0+	-2.3+	-	-	-	-
Customers	-	-	-	2.4+	-	2.7+	-	-	-
Competitors	-	-	-	-	-	-	-	-	-3.6*
Consultants	-5.4*	-4.7*	-5.5*	-	-	7.1**	-6.2**	-	-
Universities	-	-	-	-	-	-	-	-	-
Pubresearch	-8.4*	-	-	-	-	-	-	-	-
Conferences	-	-	-3.6+	-	-	-	-4.5*	-	-
Journals	-	9.3**	5.2*	-	-	-	5.2+	-	-
Associations	-	-	6.7**	-	-	-	-		5.1+
Org. innovation									
Business org.	5.8**	3.2**	-	-	-	-	3.5*	-	-
Labour org.	-	3.5*	4.9**	5.7**	3.9**	3.4*	3.8*	4.3**	6.5**
Orgexr	2.7+	-	-	-	-	2.7+	-	-	5.2**
Number of obs.	6425	6440	6412	6426	6445	6442	6436	6416	6424

Marginal effects are reported (in %). The marginal effects for the continuous independent variables were calculated at their means. Concerning dummy variables the values report the change in probability for a discrete change of the dummy variable from 0 to 1. Only significant marginal effects (at least at 10% level) are considered. +, *, ** denote significance at the 10%, 5% and 1% level, respectively. Sector and country dummies included but not reported. "-" means that the marginal effect is not significant.

Source: CIS 2008, own estimations.

Appendix 3: Determinants of eco-innovation by different environmental areas – Results for Finland and Sweden

Determinants	Environmental benefits within the enterprise						Env. benefits from after sales use of a good or service by the end user		
	Material	Energy	CO_2	Dang. sub-stances	Air, noise, soil, water	Recyc.	Energy	Air, noise, soil, water	Recyc.
Regulation	-	7.1**	9.9**	21.9**	21.6**	10.1**	-	13.6**	12.6**
Envsubsidies	-	11.2**	12.0**	9.6*	12.3**	11.1**	15.9**	18.4**	8.2*
Demand	9.6**	10.0**	16.4**	16.5**	8.7**	6.3*	18.3**	18.3**	11.9**
Voluntary	-	6.9**	10.5**	12.3**	8.2**	20.5**	-	5.3*	11.9**
Cost savings	6.6*	-	-	-	-	-	6.7*	-	-
Size	0.0*	0.0**	0.0**	-	0.0+	0.0*	0.0*	-	0.0+
Subsidies	-	-	-	-8.2*	-	-	-	-	-
Export	-	-	-11.2**	-7.4*	-	-	-	-8.9*	-
Innovation inputs									
Internal R&D	-	-	-	-	-	-	-	7.8*	-
External R&D	-	-	-	-	-	-	-	-	-
Equip	5.3+	-	-	-	-	5.9*	-5.8*	-	5.8*
Extknowledge	4.9+	-	5.0*	4.4+	7.4**	-	-	-	-
Training	-	-	-	-	5.9*	-	-	-	-
Marketintro	7.2**	-	6.8**	-	-	-	9.8**	-	5.3*
Otherinput	-	-	-	-	-	-	-	-	-
Cooperation	-	-	-	-	-	-	-	-	-
Objectives									
Productrange	-4.9+	-5.5*	-5.6*	-	-	-	-4.7+	-	-
Replace	-	-	-	-	-	-	-	-	-
NewMarkets	-	-5.0+	-	-	-5.0+	-	-	-	-
MarketShare	-	-	-	-	-4.4**	-	-4.5+	-	-
Quality	-	-	-	-	-	-	-	-	-
Flexibility	-	-	-	5.5+	8.2**	-	-	-	-
Capacity	-	10.6**	7.7**	-	-	-	-5.9*	-	-
Health	-	-	-	13.7**	11.8**	6.5+	6.3+	9.9**	-
Laborcosts	12.0**	7.3**	5.6*	-	-	-	5.3*	-	-
Info Sources									
Internal	-	-	9.5**	-	-	-	-	-	-
Suppliers	-	-	-	-	-	-8.1+	-	-	-
Customers	-	-	-	-	-	7.1+	-	-6.6+	-
Competitors	-	-	-	-	-	-	-	-	-
Consultants	-	-	-	-	-	-	-	-	-
Universities	-	-	-	-	18.2*	-	-	-	-
Pubresearch	-	-	-	-	-	-	-	-	-
Conferences	-	-	-	-	-	-	-	-	-
Journals	-	19.5*	-	-	-	16.3+	-	-	-
Associations	-	-	-	-	-	-	-		-
Org. innovation									
Business org.	6.6**	8.4**	9.7**	-	-	5.7+	-	-	-
Labour org.	-	-	-	-	-	-	-	8.9**	-
Orgexr	-	5.5+	-	-	-	8.3**	6.5*	-	6.4*
Number of obs.	2046	2044	2045	2044	2043	2042	2042	2043	2044

Marginal effects are reported (in %). The marginal effects for the continuous independent variables were calculated at their means. Concerning dummy variables the values report the change in probability for a discrete change of the dummy variable from 0 to 1. Only significant marginal effects (at least at 10% level) are considered. +, *, ** denote significance at the 10%, 5% and 1% level, respectively. Sector and country dummies included but not reported. "-" means that the marginal effect is not significant.

Source: CIS 2008, own estimations.