Eco-innovations in Croatia: exploring entrepreneurs' motivation*

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Abstract

This study explores the motives of innovators in Croatia to develop eco-innovations. We explore both factors which determine initial eco-innovation development, and those which determine the development of eco-innovation with the benefit that either occurs during the production or during the aftersales product use. Variables referring to innovation objectives, market pull/technology push and regulations are included in the models. The empirical analysis relies on the Community Innovation Survey 2008 data for Croatia. The sample consists of 1,621 innovative firms. We estimate binary outcomes models (probit and bivariate probit). The results have shown that eco-innovations are developed in response to regulations, implying that policy makers should be careful in designing instruments and measures. The following innovation activities are significantly related to eco-innovation: increase of market share, improvements in health protection and reduction of labour costs. The results reveal that development of eco-innovation in production and in use is similar in many aspects.

Keywords: eco-innovation, environmental benefits, regulations, Croatia
JEL classification: O31, O33, Q55

1. Introduction

Research on eco-innovation is a relatively new topic which attracts increasingly more interest of researchers in recent years (Díaz-García/González-Moreno/Sáez-Martínez, 2015). The growing interest in eco-innovations is related to the global commitment to sustainable development (Smith/Voß/Grin, 2010; Jänicke, 2012). There has been a substantial discussion on how the goals of sustainable development can be achieved (Rennings/Wiggering, 1997). Innovations, which generally take an indispensable role for economic growth, are recognized as highly relevant for sustainable growth as well. A precondition is, naturally, that innovations have "environmental characteristics". Rennings (2000:322) underlines that the focus of innovation toward sustainable development reflects concerns about direction and content of the overall progress.

The importance of eco-innovations for sustainable development and growth is also emphasized in public policies. In 2008, the European Commission launched

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the Eco-innovation initiative. Furthermore, in 2011, the European Commission launched the Eco-innovation Action Plan (EcoAP), moving towards a comprehensive range of eco-innovative processes, products and services. It was found that the EU environmental policies contribute to the competitiveness of the EU (Costantini/Mazzanti, 2012). This has additionally spurred the research intensity in many European economies. For example, de Marchi (2012) explored the determinants of eco-innovations in Spain, Horbach, Rammer and Rennings (2012) for Germany, Kesidou and Demirel (2012) for the United Kingdom and recently Horbach (2014) for a group of 19 European economies, including some New EU Member States (NMS).

The literature on eco-innovation determinants in transition countries is relatively scarce. Díaz-García, González-Moreno and Sáez-Martínez (2015) argue that there are specific obstacles – competitive advantages based on low labour costs, deficient environmental and industrial policies and the lack of awareness related to potential productivity increases stimulated by eco-innovations – deterring eco-innovation endeavours in transition economies. Horbach (2014) emphasizes the need to analyse the process in Eastern European EU Member States, for which even country-level studies are not readily available. In order to better understand why the transition economies sluggishly introduce eco-innovation as well as to predict possible consequences of joint EU level policy measures, additional research effort is required. EU countries differ with regard to their economic structure (different technologies, energy intensities), but also with regard to sociological structures (different demand for eco-intensive products, regulative framework). Therefore, we can expect that the outcomes of EU harmonisation practices related to the environmental issues will not be the same across the EU countries. Since this is an important push factor for entrepreneurs, the key question is how legislative harmonisation will affect eco-innovation drivers in EU post-transition economies.

In case of Croatia, the data on eco-innovation that would enable research on the impact of joint legislative are not available for the period during which Croatia is officially the EU member state.[1] Previous literature on determinants[2] of eco-innovations in Croatia does not exist. Our aim is to understand what motivates Croatian innovators to develop eco-innovations in the accession period in order to provide a point of comparison for future research of the policy harmonisation

1 Here we refer to Community Innovation Survey (CIS) data that are used in the empirical analysis.

2 We use the terms determinants/factors/drivers and motives interchangeable. We opted for this approach since motives can be related to the internal decision-making process within the firm, while determinants/factors also include external contributions to the decision-making process. Our set of explanatory variables includes both internal and external contributions, but relies on the information obtained by the Survey. Thus, we observe perceptions of external contributions and not the external contributions themselves.

impact of EU membership. In order to understand better the decisions made by Croatian firms, we seek to find the factors which determine firms' decisions to develop eco-innovation, as well as factors which determine the development of eco-innovation with benefits that occur either during production or during the aftersales use.

Paper takes the following structure: the next section briefly summarizes relevant literature on eco-innovations determinants and discusses the relative position of Croatia to other European economies. Section 3 is focused on the data sources and methodology of the empirical estimates, which are presented and discussed in Section 4. Section 5 brings conclusions.

2. Eco-innovation development – literature review

2.1. Definition

Literature offers several definitions of eco-innovation (also called environmental innovation). For example, Kemp (2010) defines eco-innovations as production, assimilation or exploitation of a product, production process, service or management or business method that is novel to an organization and which results in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives. Rennings (2000) suggests that these innovations are measures of relevant actors which develop new ideas, behaviour, products and processes, apply or introduce them, and contribute to a reduction of environmental burdens or to ecologically specified sustainability targets.

According to the Eco-Innovation Observatory (2011), eco-innovations are comprised of any new or significantly improved products (goods or services) or processes, 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 lifecycle. This last definition is closely related to the definition applied in the paper. Specifically, subsequent empirical analysis rests on the CIS definition of eco-innovation, which refers to a new or significantly improved product, process, organizational or marketing method that creates environmental benefit compared to the alternatives. The benefit itself can be the primary objective of the innovation or the result of other innovation objectives and it can occur during the production or during the use by the end user.

According to above-presented definitions, the term, in general, includes all types of innovation (product, process, non-technological innovation) with different levels of novelty. Moreover, extant approach does not distinguish between deliberate and unintentional innovation efforts, nor does it take into account if it is new only to the specific entity (on individual firm, national or wider level). The key issue here is contribution to the environment protection in comparison to

other solutions. However, the scope of potential influences on the environment is unaccounted for.

2.2. Literature review

Innovations in general are recognized as the central pillar of economic growth. Their importance is emphasized already by Schumpeter (1934, 1935, 1947) and has attracted attention of many scholars since (Wennekers/Thurik, 1999; Acemoglu/Gancia/Zilibotti, 2010; Fagerberg/Verspagen, 2007). Eco-innovations have been studied within the fields of environmental and innovation economics (for detailed review of these approaches as well as an evolutionary approach to eco-innovation, see Rennings, 2000). Rennings (2000) summarizes that the focus of environmental economics is on environmental policy and instrument assessment while economics of innovations seeks to understand factors behind innovation development. Our approach to eco-innovations lies within the economics of innovations and we draw on relevant concepts which explain innovation activities within firms.

Eco-innovation emerged in innovation literature as a special case of innovation whose development can be explained by a different set of determinants. This, however, does not mean they are completely separate from traditional approaches to explaining innovation development. Studies on determinants of eco-innovations continue the lasting tradition in empirical studies exploring different characteristics of enterprises engaged in these activities. For instance, the size of the enterprise is frequently considered. Positive relationship between the size and the probability to engage in eco-innovation has been found by Rehfeld, Rennings and Ziegler (2007) and de Marchi (2012). The rational for this is related to the longer presence of the market, market size, better access to finance and larger pool of (possibly better educated) labour force. Similar arguments are also drawn in connection to older firms (Mazzarol/Reboud/Volery, 2010). However, some authors argue that SMEs are more flexible than larger firms, and can, consequently, accommodate the changing conditions on the market relatively more swiftly in order to create innovation (Aragón-Correa/Hurtado-Torres, Sharma/García-Morales, 2008). We can conclude that the extant research findings provide both the evidence on positive as well as negative relationship between firm size and eco-innovations. Due to the fact that there is no univocal decision on the significance of the size, age and the type of an enterprise in the literature, we empirically explore the effect of these variables in the Croatian case.

Traditional discussion on market pull and technology push factors that drive innovation continues in studies on eco-innovation. According to Horbach (2008), eco-innovation theory comprises of technology push, demand side determinants and institutional and political influences (i.e., country-specific environmental policies). In addition to reducing costs and maintaining/increasing competitive-

ness, the demand side could play an important role in developing environmentally-friendly products and services as customers change their buying habits. The studies have shown that these motives are not primary, but still cannot be neglected (Kesidou/Demirel, 2012). Environmental concerns of relevant stakeholders are important for innovative firms, especially if we consider industries that have a large impact on the environment (Horbach, 2008). Cooperation with relevant stakeholders (consumers) can increase demand for certain types of products, leading to increases in market share for engaging firms (Triguero/Moreno-Mondéjar/Davia, 2013). Pujari (2006) emphasizes the importance of close collaboration with suppliers, market focus and cross-functional coordination for new product development projects. Cooperation activities have been deemed important for developing ecological innovations, in particular the cooperation with universities and suppliers (Cainelli/Mazzanti/Montresor, 2012). Klewitz and Hansen (2014) argue that such cooperation (in particular with research institutes) can increase the capacity for developing eco-innovation. This could be related to the public good nature of eco-innovation, where developing certain ideas within universities and research institutes can find its realisation in cooperation with firms. Developing technology is strongly related to the eco-innovations (Cuerva/Triguero-Cano/Córcoles, 2014), since technological solutions enable the development of environmentally-friendly products and services. The above-cited research understands the eco-innovation development as the result of firms' effort to recognize their market potential and seize the opportunity to benefit from them. In our case, the question worth exploring has to do with the extent to which firms in Croatia respond to the market needs and how they aim to accomplish their business objectives by developing eco-innovations. We operationalise this by including the related explanatory variables in the empirical analysis of Croatian innovative firms.

The double externality problem implies a spillover in both the invention and diffusion phase of an innovation due to which eco-innovators have to deal with costs while the possibility to appropriate benefits are limited as they belong to the society (Rennings, 2000; Beise/Rennings, 2005). Therefore, despite the available resources and capabilities, firms can be reluctant to invest in development of eco-innovations unless there is regulatory pressure. As a result, eco-innovation development cannot be explained within the resource-based view (Wernerfelt, 1984) that provides necessary framework often employed in research on innovation (e.g., Danneels, 2002; Terziovski, 2010). Such conditions have created the necessity for policy makers to intervene. We find it crucial to include firms' perceptions on regulations as the driving force for eco-innovation development in the empirical analysis for Croatia.

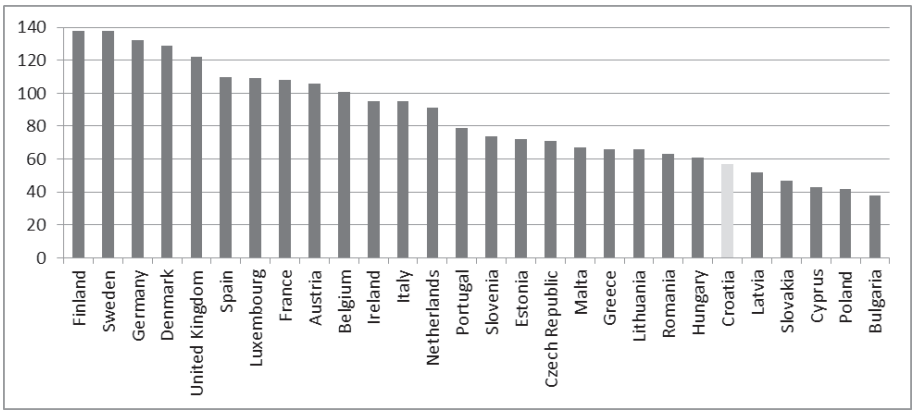
There is evidence that eco-innovations have positive impact on firm performance (Doran/Ryan, 2012) and labour productivity (García-Pozo/Sánchez-Ollero/Marchante-Lara, 2015). Firms are motivated to introduce eco-innovation

in order to achieve environmental protection objectives but also other business objectives (Beise/Rennings, 2005). However, due to possible spillovers and the inability to relate the benefits of environmental innovation strictly to firm profits, the earliest explanation on why firms engage in these activities has been found in government intervention. Similar to any other public good with widespread potential benefits, government intervention is offered as an explanation behind motives for eco-innovation. Porter and van der Linde (1995) argue that enterprises do not foresee potential benefits of eco-innovations by themselves, but such actions should be triggered by appropriate regulations. Large body of literature provides evidence that ecological innovation development is strongly determined by regulations (Horbach/Rammer/Rennings, 2012). However, relevance of regulations for stimulating eco-innovation differs by firm size (Trigueroa/Moreno-Mondéjara/Davia, 2015). Regulations stimulate eco-innovation with both the lowest and the highest environmental impact (Demirel/Kesidou, 2011). Interestingly, regulations are more important for encouraging eco-innovation in less innovative firms (Kesidou/Demirel, 2012). These studies provide additional argument for including variables related to regulation in models on eco-innovation development.

Previously reviewed literature, in particularly empirical studies, is focused on developed market economies. Literature on transition economies, who have experienced significant economic restructuring resulting with important changes in energy consumption patterns (Jorgenson/Alekseyko/Giedraitis, 2014), has not been focused on eco-innovations. Part of the explanation might be related to the argument that environmental protection in Eastern Europe is not integrated into the corporate culture (Harangozó/Kerekes/Zsóka, 2010). Another explanation could be attributed to Durán-Romero and Urraca-Ruiz (2015), who observe different trends in eco-innovation activities in countries at different stages of their development.

Croatia is not a leader in innovation and overall innovation activities are often reduced to catching up with more advanced economies and/or complying with the regulations (see European Innovation Scoreboard, 2015). The first impressions could be obtained from the eco-innovation scoreboard, an indicator which was assessed for Croatia for the first time in the year of its EU accession – 2013. The overall rankings are presented in Figure 1.

Figure 1: Overall eco-innovation scoreboard 2013, EU28=100



Source: Eco-Innovation Observatory.

It can clearly be seen that Croatia is at the bottom of the EU distribution. The factors most contributing to this unfavourable position are related to eco-innovation inputs (measured by government environmental and energy R&D appropriations and outlays, total R&D personnel and researchers and the total value of early stage investments) and socio-economic outputs (measured by exports of products from eco-industries, employment in the eco-industry and circular economy, revenue in the eco-industry and circular economy). It could be argued that this unfavourable ranking is due to the effects of prolonged economic crisis that affected Croatia over a much longer period of time than other neighbouring economies.

Croatian regulation development in the area of environmental protection was shaped by the EU accession process. The process included the development of various strategic documents and institutional advances. The most comprehensive overview of the environmental regulations, institutions and indicators is produced by the Croatian Environment Agency (2015). The report on the current state of environment (the latest issue available only in Croatian) provides multidimensional assessment of different activities with respect to the environment. However, innovation or eco-innovation did not receive much attention. The data analysed in this paper, however, focuses on the pre-accession period. The comparative analysis of the Croatian eco-innovation supporting regulatory system status of development reveals a relatively advanced position related to other countries in South-Eastern Europe during that period (Sevic/Gerasina, 2009). Thus, as the regulatory system was developing in accordance with EU accession requirements, the question remained whether it was able to either support or create additional push for eco-innovations.

2.3. Research questions

We focus on two research questions in this paper. The first one explores the question of what drives innovative enterprises in Croatia to engage in eco-innovation. The second aims to further investigate whether drivers are different if entrepreneurs foresee benefits from the production (such as cost reductions, reduced use of materials and energy, reduced pollution and CO_2 footprint) or benefits from the aftersales use (such as the reduced energy use and pollution as well as recycling after use). We assume that the benefits in the production phase are more related to the technology push theory of the innovation drivers, while the benefits from aftersales are related to the demand driven innovation.

Although regulations are expected to play an important role in eco-innovation development, it is important to examine if firms are likely to respond to other inputs, not just to pressures that come from the legal environment. In order to understand the factors behind eco-innovations, variables broadly referring to market pull and technology push factors that determine innovation activities, as well as those referring to objectives of innovation activities, are included in the analysis. As already cited, it is recognised that eco-innovations contribute to business performance, and that the environmental benefit may be the result of firms' intention to achieve other innovation objectives. We expect that these three groups of variables (innovation objectives, market pull/technology push, and regulation-related factors) will enable us to gain a better insight into eco-innovation development.

3. Data and methodology

Data used in the empirical analysis comes from Community Innovation Survey 2008 (CIS 2008) for Croatia referring to the period from 2006 to 2008. This is the first CIS that provides information on eco-innovations. In Croatia, CIS is carried out by the Croatian Bureau of Statistics and follows the same methodology employed in other European countries. The sampling frame for this survey in Croatia consists of 10,676 enterprises with ten or more employees from which a sample of 4,504 enterprises in total was constructed. The sample includes all medium-sized and large enterprises and a stratified random sample of a small enterprise. It covers industrial[3] and service[4] activities.

3 Following the NACE Rev 2, these activities are included: Mining and quarrying (05 – 09), manufacturing (10 – 33), electricity, gas, steam, and air conditioning supply (35), and water supply; sewerage, waste management and remediation activities (36 – 39).

4 Construction (41 – 43), wholesale trade, except motor vehicles and motorcycles (46), accommodation and food service activities (55 – 56), transportation and storage (49 – 53), financial and insurance activities (64 – 66), real estate activities (68), telecommunications (61), publishing activities (58), information service activities (63), computer programming, consultancy and related activities (62), scientific research and development (72), architectural and engineering activities; technical testing and analysis (71), advertising and marketing research (73).

The response rate was rather high (i.e., 75.6 percent) yielding 3,405 enterprises that responded to the questionnaire. The sample includes large firms (i.e., firms employing more than 250 employees) and SMEs (i.e., firms with 10 to 250 employees), innovators and non-innovators. Considering the subject of our research, we focus on innovative firms, i.e. those that report engagement in innovation development. Hence, the sample in our analysis consists of 1,621 innovative firms.

CIS 2008 includes data on eco-innovations, i.e. product, process, organisational and marketing innovations[5] with environmental benefits from the production of goods and services and from the aftersales use of a good or service by the end user compared to the alternatives in the period from 2006 to 2008. This decomposition of potential benefits in CIS follows findings from the literature (Arundel/Kemp, 2009). Namely, eco-innovation with benefits from production refers to product, process, organisational or marketing innovation having at least one of the following characteristics: reduced material use per unit of output, reduced energy use per unit of output, reduced CO_2 footprint, replacement of materials with less polluting or hazardous substitutes, reduced soil, water, noise or air pollution, and/or recycled waste, water or materials in production. As for the innovation with environmental benefits from the aftersales use, it refers to product, process, organisational or marketing innovation that reduced energy use, and/or reduced air, water, soil or noise pollution, and/or improved the recycling of the product after use.

The CIS 2008 data reflect respondents' perception on environmental benefits (i.e., the entrepreneurs engaging in eco-innovation activities), not the objective measure of their importance for the environment. Therefore, despite the attempts to capture all eco-innovation activities in firms, the contribution of these activities to environment protection from the perspective of society remains rather unclear. Management research relies heavily on managers' perceptions, even though their accuracy could be considered questionable. Perceptions of managers (especially of those from different functions and departments) within the same firm are likely to be very different (Ernst/Teichert, 1997). Also, Mezias and Starbuck (2003: 16) argue that "managers seem to be content to fill in the gaps with folklore that has been socially constructed". These issues are difficult to resolve and they could influence research findings. Despite the issues related to the use of single-informant perceptions in research, the approach enables access to high-quality information provided by the knowledgeable respondents who are likely to reflect the real situation (Glick et al. 1990; Lyon/Lumpkin/Dess, 2000). Keeping in mind the data sources used for the analysis, we can ar-

5 Definitions of product, process, organisational and marketing innovation in CIS are those provided in the Oslo Manual. For a detailed explanation of each innovation type, see the Oslo Manual (2005), Chapter 3.

gue that it is suitable to enable an understanding of firms' determination to introduce innovations with environmental benefits, rather than potential overall benefits on the level of society.

Respondents, in response to question 10 in the CIS 2008 harmonized questionnaire[6], were asked to report if they have developed innovation with any of the environmental benefits either from production or from aftersales use (yes/no answer). If they reported having at least one of the benefits, we consider them to be eco-innovators, i.e., we created a dummy variable which takes the value 1 if a product, process, organisational or marketing innovation with environmental benefits in the production and/or use was developed in a three-year period (0 otherwise). This yields a binary-dependent variable. Accordingly, we estimate the binary outcomes models following the standard probit methodology.

Independent variables in the probit model on determinants of eco-innovation are innovation objectives[7] (increase capacity, improve flexibility, improve health, reduce labour costs, increase market share, enter new markets, improve quality, increase the range of products, and replace the outdated products), R&D activities (R&D internal, R&D external, machinery, knowledge, training, and market), foreign market, cooperation, operating as a part of the enterprise group, total R&D expenditures in 2008, sales per employee in 2006, public funding, size and sector. Definitions of the variables are provided in the Appendix.

The next stage of our research is dedicated to the determinants of innovations with environmental benefits from production and with benefits from the aftersales use. Again, the dependent variable in the model is binary. To explore the determinants of the types of eco-innovation, we employ the bivariate probit. The following variables are included in this model: motives for eco-innovation (existing regulations, expected regulations, grants for eco-innovations, market demand, and voluntary codes), R&D activity (R&D internal, R&D external, machinery, knowledge, training, and market), sources of information (clients, suppliers, competitors, universities, consultants, conferences, publications, and professional associations), cooperation and eco-procedures. We also control for the sector (services) and size (SME).

6 Apart from the section on eco-innovations, CIS 2008 questionnaire includes a section on general information, product and process innovation, abandoned and ongoing innovation activities, expenditures on product and process innovation, sources of information and cooperation for innovation activities, innovation objectives, organisational and marketing innovation and basic economic information. The CIS 2008 questionnaire is available at: http://ec.europa.eu/eurostat/documents/203647/203701/CIS_Survey_form_2008.pdf/.

7 Objectives of product, process, organisational and marketing innovations are included in the analysis as environmental benefit can be present in any of the four innovation types considered. CIS 2008 contains questions about the objectives of innovation separately. As these innovations can have the same objectives, we combine them in one binary variable indicating whether or not it was objective for any of the innovations.

Table 1 shows that almost 50 percent of all innovators in Croatia developed innovation with both environmental benefits, from production and from the aftersales use. Even though Croatia is not among the leading countries when it comes to innovation, a relatively high percent of innovators report development of innovation with environmental benefits. Considering the design of the questionnaire, it is not possible to distinguish whether this refers to several innovations with one of these benefits or one environmental innovation with several environmental benefits.

Innovators are least prone to focus only on environmental benefits that occur after sales (i.e., during the final use of the product). Only 2.9 percent of innovators report innovation with benefits from aftersales use only, while 12.6 percent of innovators developed innovations with environmental benefits in the production processes.

Table 1: Eco-innovation in Croatia from 2006 to 2008 (percent of innovators)

No environmental benefits	34.80
Benefits from production only	12.60
Benefits from aftersales use only	2.90
Benefits both from production and from aftersales use	49.80
Benefits from the production	
■ reduced material use	32.51
■ reduced energy use	36.21
■ reduced CO_2 footprint	21.06
■ materials replaced with less polluting substitutes	34.42
■ reduced soil, water, noise or air pollution	44.05
■ recycled waste	39.98
Benefits after sales/ in use	
■ reduced energy use	34.48
■ reduced air, water, soil or noise pollution	39.98
■ improved recycling of products after use	33.19

Source: authors' calculations based on the CIS 2008 data.

Furthermore, innovators focused the most on innovations that reduce soil, water, noise or air pollution (44.05 percent). This type of environmental benefit is followed by eco-innovations that contribute to recycling waste in the production (39.98 percent). Innovators were least focused on the introduction of innovation that reduced the CO_2 footprint (21.06 percent). As for the benefits that occurred after sales and during the use, innovators in Croatia were focused the most on innovations that reduced air, water, soil or noise pollution (39.98 percent).

Descriptive statistics reveals that the majority of innovative firms innovate in response to the existing or future regulations (Table 2). Such findings are usually interpreted as an argument for the Porter hypothesis. Horbach (2014) finds that for the analysed NMS, regulations seem to be the most important motive for introducing eco-innovation. This also seems to be the case in Croatia, but to a much smaller extent. Horbach (2014) finds that in Lithuania 70 percent, Romania 66, Czech Republic and Hungary 61 percent of ecological innovators are motivated by the existing regulations. This percentage in Croatia is much closer to France (41 percent) or Ireland (37.5 percent).

Voluntary codes and agreement within the sectors also motivate a significant percentage of firms to develop eco-innovations (33.4 percent). As for current and expected market demand, the percentage of firms considering them important is lower (22.2 percent). Government financial incentives are the least important motive for eco-innovations in Croatia. Only ten percent report eco-innovations development in response to grants and subsidies. The explanation might be that government grants were either not available or at least were not recognised by the firms as providing important stimuli for eco-innovation activity at the time.

Table 2: Motives for eco-innovation development – descriptive statistics

Existing environmental regulation or taxes	39.6
Expected environmental regulations or taxes	31.0
Government grants and subsidies	9.9
Current or expected market demand	22.2
Voluntary codes or agreements within the sector	33.4

Source: authors' calculations based on the CIS 2008 data.

Next, we explore the characteristics of eco-innovators in Croatia and compare them with innovators in general. Data presented in Table 3 show that eco-innovators are somewhat more present on the foreign market than innovators. Based on the descriptive statistics, we can conclude that eco-innovations are less present in SMEs and the service sector.

Table 3: Characteristics of innovators and eco-innovators in Croatia (in percent)

		Innovators	Eco-innovators
Sources of information	Clients	62.43	72.19
	Competitors	56.32	65.45
	Conferences	80.26	82.40
	Consultants	54.60	53.18
	Professional associations	58.85	58.80
	Publications	80.20	82.58
	Suppliers	70.45	79.40
	Universities	32.57	40.07
Innovation objectives	Increase capacity	90.99	93.26
	Improve flexibility	85.13	87.92
	Improve health	77.91	82.58
	Reduce labour costs	81.25	86.42
	Increase market share	83.47	85.77
	Enter new markets	71.07	73.78
	Improve quality	93.21	95.22
	Increase the range of products	88.22	89.70
	Replace outdated products	89.20	90.45
R&D activities	R&D external	49.48	45.79
	R&D internal	38.06	44.94
	Knowledge	49.48	46.54
	Machinery	91.24	91.95
	Market	56.88	55.90
	Training	73.29	74.34
	Public funding	1.85	2.25
	Cooperation	32.20	37.36
	Eco-procedures	35.78	46.82
	Group	32.88	35.11
	Foreign market	55.09	58.99
	Services	36.46	29.03
	SME	84.82	81.74

Source: authors' calculations based on the CIS 2008 data.

Sample data also shows that eco-innovators are more likely to report obtaining information from clients, competitors, suppliers and universities. This would imply eco-innovators are more inclined to cooperation. Eco-innovators have more frequently reported cost reduction and health improvement as the main goals of their innovation activity. Focus on health improvement is not surprising, since

for eco-innovations this aspect could provide an important selling point for entrepreneurs' products and services.

Similarly, it is not surprising that eco-innovators more frequently report implementing procedures to identify or reduce the environmental impact. In comparison to innovators in general, eco-innovators are more involved in the internal R&D. They also perform less external R&D, but they report cooperation in developing innovation more frequently. Use of information from external sources in innovation activities is also more frequent among eco-innovators.

Although innovators were the least motivated by public grants to develop eco-innovation, eco-innovators were more frequently the recipients of public funding compared to all innovators.

Following these insights gained from descriptive statistics, the next section is devoted to the empirical analysis and the discussion of the results.

4. Empirical results

We present the results of empirical analysis in two subsections. The first section explores the predictors of developing eco-innovations among innovative firms. The second section explores whether the determinants differ according to the expected benefits from innovation activity perceived by innovative firms. This is followed by the discussion of the results.

We would like to emphasize that several models, which included a wide set of potential variables, were tested and compared in order to define the model that accurately explains eco-innovation. The models presented here are the ones that exhibit the best fit to the data.

4.1. Determinants of eco-innovations

Results of the probit regression show that many of the considered determinants were not found significant (see Table 4). Thus, some of the eco-innovation drivers detected in the literature were not found important in case of Croatia. This refers to the size of the firm as the determinant of eco-innovations. Furthermore, we find no significant relationship between public funding and eco-innovation, contrary to Horbach (2008) findings for Germany. The results implicate that instruments for stimulating eco-innovation such as subsidies and grants were not able to pull entrepreneurs into developing eco-innovation in Croatia in the accession period.

The discussion below is focused only on those variables found to be significant.

Table 4: Determinants of eco-innovations

	Coefficients	Standard errors
Constant	-.069	.346
Increase the range of products	-.087	.131
Replace outdated products	.085	.119
Enter new markets	-.150	.093
Increase the market share	.217*	.115
Improve quality	.132	.149
Improve flexibility	.029	.112
Increase capacity	.021	.128
Improve health	.489***	.098
Reduce labour costs	.230**	.107
Foreign market	.176**	.072
Cooperation	.302***	.084
Group	.163**	.078
R&D internal	.313***	.084
R&D external	-.397***	.087
Machinery	.093	.131
Knowledge	-.064	.086
Training	.095	.091
Market	.015	.087
Total R&D (in log)	.020***	.007
Sales/emp 06 (in log)	-.031	.022
Public funding	.161	.279
Services	-.578***	.072
SME	-.165	.108
Number of observations	1621	
LR chi2 (23)	289.97	
Prob>chi2	.000	
Pseudo R2	0.1384	

Source: authors' estimates.

If we concentrate on the characteristics of the enterprises, three variables were found significant. One of them is presence on foreign market. Extant research findings testify that international firms are more oriented towards environmental issues (Del Río González, 2009). We could argue that experience of operating on foreign markets has raised awareness of different consumer preferences, thus prompting changes in product varieties offered by sampled enterprises. Also, in-

creased competition pressures from the international markets encourage firms to engage in more diversified innovation activities.

Firms that are a part of an enterprise group and those that establish formal cooperation with other subjects are also more likely to be eco-innovators. Cainelli, Mazzanti and Zoboli (2011) have emphasized the role of cooperation in the eco-innovation development process, and the importance of knowledge sharing has also been emphasized by Klewitz and Hansen (2014). Cooperation with subjects with complementary capabilities increases innovation performance in high-tech firms (Romijn/Albu, 2002).

Not all innovation objectives are significantly related to the probability of eco-innovation. Only an increase of market share, an improvement of health and safety, and the reduction of labour costs are significant predictors of activities oriented towards eco-innovations. As Triguero, Moreno-Mondéjar and Davia (2013) suggest, on the basis of their analysis of European SMEs, supply-side factors (such as labour cost reduction) seem more important for environmentally-oriented innovators. Similar has been found for Germany and France, where cost savings are important drivers of eco-innovations (Horbach/Oltra/Belin, 2013).

We find a positive impact of in-house R&D on the probability of eco-innovation. There is also a significant relationship between the external R&D and this type of innovation but the sign of the coefficient indicates a negative impact. However, higher expenditures in total R&D indicate a higher probability of eco-innovations. This might indicate that eco-innovations require more R&D than other types of innovation activities. Although we cannot support this claim with actual data, this issue is worth exploring in future research. For example, if, due to the relative novelty of eco-innovations in transition economies in general, they demand more efforts from entrepreneurs when compared to advanced market economies, this could contribute to the relatively unfavourable positions of the transition economies on the eco-innovation scoreboards.

Horbach (2014) compares Eastern European and "rich" EU Member States determinants of eco-innovations and finds that former transition economies are more dependent on external R&D measures. Our results indicate a positive relationship between internal R&D and eco-innovation and a negative one when it comes to external R&D. This would suggest that, in Croatia, innovators are more likely to engage in eco-innovation if they rely on their own resources.

As for the sectoral differences, firms operating in the service sector are less likely to introduce eco-innovation in comparison with the industry. Although the service sector can contribute to environmental issues, industry is generally perceived as a major polluter and it is under more pressure to reduce negative effects on the environment. Based on this finding, we can argue that industry in

Croatia is more aware of environmental issues and more involved in responding to environment protection by adequate solutions.

4.2. Determinants of innovations with ecological benefits from the production and from the aftersales use

Another issue that we want to explore is whether the determinants of eco-innovations differ according to the main area where the entrepreneur expects to achieve major benefits from such undertakings. In order to explore this issue, we employ the bivariate probit. The rho parameter indicates there is a strong and significant correlation between two equations. Results of the bivariate probit are presented in Table 5.

Development of both types of eco-innovation is influenced by more or less the same motives. Eco-innovation with benefits from production as well as those with benefits from use are significantly determined by existing and expected regulations, current or expected market demand for eco-innovation and voluntary codes and agreements. Available grants and subsidies for eco-innovation are not significant determinant of any of the two types of eco-innovation.

Our results suggest that the decision to innovate in both cases is related to the potential for market expansion (Hemel/Cramel, 2002), regulation pressures and networks impacts.

Table 5: Determinants of innovations with ecological benefits from the production and from the aftersales use, results of the bivariate probit

	Eco-benefits from production	Eco-benefits from aftersales use
Constant	-.815 (.233)***	-1.454 (.216)***
Existing regulations	1.327 (.126)***	.961 (.098)***
Expected regulations	.497 (.145)***	.370 (.108)***
Grants for eco-innovations	.270 (.251)	-.170 (.150)
Market demand	.437 (.154)***	.716 (.120)***
Voluntary codes	.967 (.121)***	.638 (.094)***
Eco-procedures	.152 (.099)	.169 (.086)**
R&D internal	-.068 (.100)	-.081 (.089)
R&D external	-.217 (.108)**	-.159 (.096)*
Machinery	.304 (.146)**	.146 (.136)
Knowledge	-.214 (.103)**	-.037 (.093)
Training	.124 (.106)	.100 (.096)
Market	-.011 (.103)	.033 (0.91)
Clients	.252 (.130)**	.336 (.119)***

	Eco-benefits from production	Eco-benefits from aftersales use
Suppliers	.029 (.135)	.171 (.124)
Competitors	.198 (.122)	.068 (.110)
Universities	.127 (.111)	.025 (.099)
Consultants	-.005 (.107)	.080 (.095)
Conferences	-.025 (.142)	-.086 (.127)
Publications	.156 (.139)	.258 (.126)***
Professional associations	.015 (.110)	-.119 (.098)
Cooperation	.143 (.103)	.046 (.092)
Services	-.477 (.088)***	-.128 (.081)
SME	-.118 (.133)	.163 (.114)
Number of observations	1621	
Wald ch2 (46)	795.42	
Prob>chi2	0.0000	
Rho	.74	
Likelihood-ratio test of rho=0: chi2(1) = 207.84 Prob > chi2 = 0.0000		

Source: authors' estimates.

Eco-innovations with benefits from production are enhanced by the acquisition of machinery, equipment and software as well as information from clients. External R&D and acquisition of external knowledge have a significant, but negative impact on the introduction of innovation with environmental benefits from production.

External R&D negatively affects the probability of innovation with environmental benefits from the aftersales use as well. Information from clients increases the probability of introducing innovation with environmental benefits from the aftersales use. Information from scientific publications and trade publications is also a significant predictor of this type of innovation. Firms that implement procedures to reduce environmental impact are more likely to introduce innovation with environmental benefits that occur during its use. There is no significant relationship between these procedures and innovation with environmental benefits from the production of goods and services.

Information for innovation that comes from universities is not a significant predictor of either eco-innovation from production or the aftersales use. Descriptive statistics indicated that universities are the least used source of information in innovative firms in Croatia. Those that rely on them are not likely to innovate with eco-innovation of any kind. In general, despite the substantial interest and goodwill of academia to work with the business sector in Croatia (Radas/Vehovec, 2006), their collaboration still remains at a low level. The reason behind this can

be found in the low level of innovativeness of the Croatian firms. The important prerequisites for a successful collaboration with academia are the firm's technology orientation and their engagement in R&D activities (Radas, 2005). However, it is not likely that a lack of collaboration between universities and the business sector is sustainable in the long run due to the growing pressure of the globalization processes (Dabić/Švarc, 2011).

4.3. Discussion and implication of the results

Previous two subsections explored two research questions. Related to our first research question, we have clearly established that the exposure to foreign markets and belonging to an enterprise group is a positive predictor for engaging in eco-innovation activities. Since these results are obtained for a (post)transition EU accession country, they might imply that the awareness of the need for eco-innovation is related to the increased exposure to international markets. Thus, from the perspective of managers of innovative firms, the orientation towards foreign markets might increase pressures for developing eco-friendly innovative products that enable firms to increase competitiveness and increase market share. We might speculate that such processes will be evident also in other countries of the region (Western Balkans) on their path towards the European Union.

Some objectives of innovation activities (increase of market share, improved health protection and the reduction of labour costs) were found significantly related to eco-innovation development, while others were not. This finding clearly signals why firms have decided to engage in eco-innovation. It has to be emphasized that the analysis refers to the pre-crisis period in Croatia and yet the labour-cost perspective came into focus. It could be imagined that this factor was even more pronounced in the crisis period. So, one possible extension of the results presented in this paper would lead to the discussion on the differences in making the decision to engage in eco-innovation activities in good versus adverse economic conditions. The results so far provide important insights to managers of firms not engaged in eco-innovation. It could be foreseen that they saw these activities only as cost-increasing and not cost-reducing and thus refrained from making a positive eco-innovation decision. However, since our results point that eco-innovation could be associated with cost reduction, this information might also be important for managers in previously non-innovating firms.

Another important result is related to the positive correlation with internal R&D and the insignificance of public funding for engaging in eco-innovation activities. Taken together, these two factors present a clear message to policy makers in the domain of environmental policy. It could be argued that a regulation push should certainly be accompanied by financial support towards the firms willing to engage in eco-innovations. Keeping again in mind the pre-crisis period the paper is focused on, it could easily be envisaged that the need to rely on the in-

ternal funding in times of crisis might postpone firms' decision to engage in innovation activities. Thus, without active public funding, the goal of creating preconditions for sustainable growth could be postponed. As of July 2013, funding opportunities for eco-innovators in Croatia have increased. They are now eligible to participate in EU funding for eco-innovation provided through programmes and instruments such as the Horizon 2020, LIFE, COSME and ESIF. It would be interesting to explore in the future to which extent EU funding available to firms in Croatia facilitates eco-innovation development.

Related to the second research question, which explores the differences between the foreseen benefits from the production and benefits from the product use/aftersales related to eco-innovations, we have identified that firms are more likely to engage in eco-innovation if they anticipate benefits already in the production phase. Yet, if we consider two types of eco-innovators separately, the motives for their innovation activities are similar – market potential, regulatory pressures and network effects. It could be assumed that by favouring benefits in the production phase, firms indicate that their strategy is more defensive and oriented towards accommodating market requirements rather than actively promoting change. Since Croatia is a small economy and a market follower in most economic sectors, such strategy orientation seems logical. However, whether this is only a correlation or a result of deliberate action cannot be confirmed within the present study; it requires additional research effort probably by conducting in-depth interviews with relevant stakeholders.

The results have shown that regulations are important drivers of eco-innovations in Croatia. During the accession process, which relates to the period analysed in this paper, as Croatia subsequently adopted the new EU legislative, this regulatory pressure probably exerted additional effects on the innovative enterprises. However, there is still the question of whether regulatory pressure led to truly novel solutions and not just incremental changes necessary to comply with the regulations, as it was the case of the Dutch residential building sector (Beerepoota/Beerepoot, 2007).

Important limitation to the discussion on the effects of regulation comes from the data constraints. It would be interesting to provide a comparison for the results obtained in this paper which refer to the accession period and the results after specific EU legislations were adopted. This time dimension would enable a discussion on the adaptation of the firms to new market circumstances and certainly presents one venue for future extensions of the research results presented here. It could be easily foreseen that policy makers would be highly interested in the results of such before–after analysis.

5. Conclusions

Innovations are important for economic growth. Eco-innovations are both in research and policy discussions considered as vital for sustainable growth. Even though the literature on eco-innovation determinants and effects is vast, transition economies have gained little attention. Since these economies are faced with huge restructuring and transformation challenges, the conclusions reached for advanced market economies might not be valid. The aim of this paper is to provide contribution related to revealing the predictors of eco-innovation in a transition economy.

To that end we have explored the Croatian case. Innovative firms in Croatia are not reluctant to consider environmental benefits of their innovation. Data available prevent a complete analysis of the number of eco-innovations and environmental benefits per innovation, however the majority of innovators develop eco-innovations with benefits from both the production and the aftersales use and focus the most on the reduction of soil, water, noise and air pollutions in both aspects.

Exposure to international markets and the cooperation with other subjects are important predictors for eco-innovators. The results reveal that the development of eco-innovation from production and from the aftersales use is similar in many aspects. The differences refer to innovation activities (investment in obtaining external knowledge and machinery predicts the development of eco-innovations from production) and sources of information (scientific journals and technical publications as information sources for innovation determine eco-innovations in the aftersales use). Based on these results, we cannot conclude that either of the eco-innovation types are more related to the technology push or market pull factors.

Eco-innovations with benefits from the production and those with benefits from the aftersales use are interrelated. New solutions indeed can deliver benefits in both aspects simultaneously. We can even speculate that firms truly oriented toward ecology and environmental protection would tend to develop and implement environment-friendly solutions in both areas. When the focus is placed on eco-innovation on the level of firms, as it is the case in this study, development of the two eco-innovation types can be explained by the same or a very similar set of variables. However, we expect that the focus on particular innovation types (or a project level) would enable a more detailed insight into the development of eco-innovation by type.

Results of the analysis show that firms operating in the service sector are less likely to introduce environmental innovation in comparison with the industry. Extant studies focused on specific sectors provide interesting findings, such as Rennings and Rammer's (2011), who find that firms operating in some sectors

can face high costs and losses due to complying with regulatory pressure while at the same time firms in other sectors improve their performance thanks to eco-innovation. For Croatia, a particular focus in future research should be on tourism, since within this economic activity the development of environmentally-friendly services could be an important selling point. Specific research efforts are needed to shed additional light on the subject.

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Appendix

Table A1: Definition of variables

Dependent variables	
Eco-innovation	1 if a firm introduced a product, process, organisational or marketing innovation with environmental benefits in production and/or use, 0 otherwise
Eco-production	1 if a firm introduced a product, process, organisational or marketing innovation with environmental benefits in production, 0 otherwise
Eco-use	1 if a firm introduced a product, process, organisational or marketing innovation with environmental benefits in use, 0 otherwise
Independent variables	
Cooperation	1 if have established a formal cooperation on innovation development (regardless of subject), 0 otherwise
Eco-procedures	1 if have implemented procedures to identify and reduce environmental impact, 0 otherwise
Existing regulations	1 if an eco-innovation was developed in response to existing environmental regulations or taxes on pollution, 0 otherwise
Expected regulations	1 if an eco-innovation was developed in response to expected environmental regulations or taxes on pollution, 0 otherwise
Grants for eco-innovations	1 if an eco-innovation was developed in response to available government grants and subsidies for eco-innovation, 0 otherwise
Market demand for eco-innovations	1 if an eco-innovation was developed in response to current or expected market demand for eco-innovation, 0 otherwise
Voluntary codes	1 if an eco-innovation was developed in response to voluntary codes or agreements within the sector, 0 otherwise
Group	1 if a firm operates as part of the enterprise group, 0 otherwise
Foreign market	1 if products/services are being sold on foreign markets (other EU countries, EFTA and EU candidate countries, and all other countries), 0 otherwise
Clients	1 if a firm reports using information from clients in innovation development, 0 otherwise
Competitors	1 if a firm reports using information from competitors in innovation development, 0 otherwise

Dependent variables	
Conferences	1 if a firm reports using information from conferences in innovation development, 0 otherwise
Consultants	1 if a firm reports using information from consultants, commercial labs or private R&D institutes in innovation development, 0 otherwise
Professional associations	1 if a firm reports using information from professional and industry associations in innovation development, 0 otherwise
Publications	1 if a firm reports using information from scientific journals and technical publications in innovation development, 0 otherwise
Suppliers	1 if a firm reports using information from suppliers in innovation development, 0 otherwise
Universities	1 if a firm reports using information from universities and other higher education institutions in innovation development, 0 otherwise
Increase capacity	1 if the innovation objective was to increase the capacity of production and/or improve the ability to develop a new product or process, 0 otherwise
Improve flexibility	1 if the innovation objective was to improve the flexibility of production, reduce the time to respond to customer or supplier needs and improve the communication within the firm and with external subjects, 0 otherwise
Improve health	1 if the innovation objective was to improve health and safety, 0 otherwise
Reduce labour costs	1 if the innovation objective was to reduce labour costs per unit, 0 otherwise
Increase market share	1 if the innovation objective was to increase market share, 0 otherwise
Enter new markets	1 if the innovation objective was to enter new markets, 0 otherwise
Improve quality	1 if the innovation objective was to improve the quality of products, 0 otherwise
Increase the range of products	1 if the innovation objective was to increase the range of products, 0 otherwise
Replace outdated products	1 if the innovation objective was to replace outdated products or processes, 0 otherwise
Public funding	1 if a firm received local, national or EU finding during 2006–2008, 0 otherwise
R&D external	1 if a firm engaged in external R&D during 2006–2008, 0 otherwise
R&D internal	1 if a firm performed in-house R&D during 2006–2008, 0 otherwise
Knowledge	1 if a firm engaged in the acquisition of external knowledge during 2006–2008, 0 otherwise
Machinery	1 if a firm engaged in the acquisition of machinery, equipment and software during 2006–2008, 0 otherwise

Dependent variables	
Market	1 if a firm engaged in market introduction of innovations during 2006–2008, 0 otherwise
Training	1 if a firm engaged in training for innovation activities during 2006–2008,
Sales/emp 06 (in log)	Log of total sales per employee in 2006
Total R&D (in log)	Log of total R&D expenditures in 2008
Services	1 if a firm operates in the service sector, 0 otherwise
SME	1 if a firm employs less than 250 employees, 0 otherwise