Drivers of Eco-Innovation in the Italian Wine Industry

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Abstract

The importance of eco-innovations for industry has been rising exponentially in recent years. However, even if recent trends show that firms are increasingly committed to eco-innovations, there is little knowledge on why and how companies integrate environmental sustainability into new product development. In this paper we offer a comprehensive analysis of the drivers of eco-innovation in the Italian wine industry on the basis of a large survey on Italian wine producers. We analyse the impact of firms' characteristics and their technological and organizational capabilities on the introduction of eco-innovations. The relevance of the drivers in influencing the probability of introducing eco-innovations is measured with a latent class econometric model. Our evidence shows that business characteristics and firms' scientific search processes and their general innovative behaviour are key drivers of eco-innovation. Therefore, according to our results, firms' commitment to eco-innovate does not differ substantially from other types of innovation activities.

Keywords: *Wine industry, eco-innovation, environmental innovation, green innovation, innovation drivers*
JEL Codes: L2, L6, O3, Q5

1 Introduction

The importance of eco-innovations for industry has been rising exponentially in recent years. Traditionally, eco-innovation was understood mostly as a solution to minimise or fix negative environmental impacts from production and consumption activities. This interpretation derives from consumers' increasing willingness to reduce the ecological footprint of their consumption choices (Harrison et al., 2005), and from public concern about pollution, supporting increasingly restrictive policies punishing environmentally harmful behaviours (Porter and van der Linde, 1995). It is increasingly evident today, however, that the key challenges of the 21st century are not only about reducing pollution, but also about controlling the overconsumption of natural resources. There is evidence that substantial resource-efficiency gains in industrial production can be realised relatively easily and cost effectively (EIO, 2011:7). However, lack of strong coordination between different public policies may lead to an incoherent policy-mix with negative effects on the development and diffusion of environmental-friendly technologies (Costantini and Crespi, 2010) and on the geographical distribution of environmental performance (Costantini et al. 2010).
Over the past decades the global wine production has undergone fundamental changes, characterised by the emergence of New World producers. The new shape of competition is pushing towards the application of strict rules and techniques for wine standardisation, processes optimization, certifications and cost reduction in order to increase the international competitiveness. At the same time, concern about the environmental impact of wine production has increased because of changes in consumers' awareness and in producers' mission, supported by government incentives to the adoption of environmental friendly technologies and processes.

According to this, the environmental economics literature emphasises the key role that environmental regulations play in stimulating eco-innovations. The innovation literature, on the other hand, underlines other important determinants of eco-innovations, mainly the supply-side factors such as firms' organisational capabilities and demand-driven mechanisms, such as customer and societal requirements (Kesidou and Demirel, 2012). Eco-innovation in the wine industry includes a wide set of actions and possible investments, which might mitigate the environmental impact of wine production and reduce the use of resources. Although in the common perception wine firms could be considered eco-friendly when compared to other manufacturing industries, such as plastic and oil processing, some basic information on energy use, water use (average of 25 litres of water per 1 litre of wine) could question that initial prejudice.

In this paper we offer a comprehensive analysis of the drivers of eco-innovation in the Italian wine industry. We analyse the impact of firms' characteristics and their technological and organizational capabilities. On the basis of a large survey on Italian wine producers carried out in 2013 we investigate the main characteristics of eco-innovations in the wine industry and the key drivers of their adoption. The relevance of the drivers in influencing the probability of introducing eco-innovations is measured with a latent class econometric model. We argue that, even in the case of eco-innovation, technology adoption is a complex task that relies on several factors, where business characteristics and other research activities could be at least as relevant as other drivers highlighted in the economic literature such as government environmental regulations, demand factors, market opportunities and resource saving in driving eco-innovation.

2 Theoretical Background

The background to eco-innovations

"Eco-innovation is innovation that reduces the use of natural resources and decreases the release of harmful substances across the whole life-cycle. The understanding of eco-innovation has broadened from a traditional understanding of innovating to reduce environmental impacts towards innovating to minimise the use of natural resources in the design, production, use, re-use and recycling of products and materials." (EIO, 2011:VII).

Despite the interest on eco-innovations is on the rise, research on this field is still limited (De Marchi, 2012). Even if recent trends show that firms are increasingly committed to eco-innovations, there is little knowledge on why and how companies integrate environmental sustainability into new product development (Dangelico and Pujari, 2010). Several recent economic studies aim at determining the factors that drive eco-innovation.

The environmental economics literature has underlined the relevance of **regulatory aspects** in the promotion of eco-innovations. As argued in Brunnermeier and Cohen (2003), given the significant regulatory and non-regulatory pressures on firms to abate pollution and the resultant cost burden, it is natural to wonder whether environmental innovation is a response to these pressures or to other market forces such as international competition and industry or economy-wide characteristics. The question of what role environmental regulation can or should play in this regard has become ever more policy-relevant in recent years. According to the seminal papers of Porter and van der Linde (1995a, 1995b) properly structured environmental regulation may not only benefit and society but also the business sector by making firms realize otherwise neglected investment opportunities. Environmental regulation could force industry to innovate and thus increase resource efficiency and enhance productivity. From this point of view, regulation is not seen as an undesirable cost-increasing factor but as a driver of firms' innovation, leading to a first-mover advantage in markets for eco-innovations (Bernauer et al., 2006) and providing economic opportunities that offset the burdens and costs induced by regulatory compliance (Rennings, 2000). However, this "win-win" hypothesis has been heavily criticized in neoclassical economists, whose supporters argue that regulation might motivate firms to develop eco-innovations, but that these efforts would produce opportunity costs offset only in exceptional cases (Jaffe et al., 1995; Palmer et al., 1995). Moreover, the effectiveness of regulations for firms could potentially differ depending on whether or not they are already ahead of their peers in eco-innovation investments and activities (Kesidou and Demirel, 2012).

The **demand factors** have generally been overlooked, even if recent evidence shows that they play a significant role for the development and adoption of eco-innovations. Several empirical works (Darnall, 2006; Horbach, 2008; Kesidou and Demirel, 2012; Wagner, 2007) demonstrated that demand factors such as the influence of consumers associations and customer requirements for environmentally friendly products affect positively firms' decision to invest in eco-innovation, even though they do not influence the intensity of allocated investments (Demirel and Kesidou, 2011). environmental consciousness of consumers are increasingly popular, and thereby, companies are enforced to enhance their environmental management (Hart, 1997). Therefore, societal and market requirements encourage firms to undertake some minimum investments on eco-innovation activities but these factors do not necessarily encourage them to commit large amounts of resources into eco-innovation. There exists a demand in management fields to anticipate and to plan for environmental concerns and to incorporate this thinking into corporate strategies (Chen, 2007).

Another important set of drivers if found in business **market opportunities**. Eco-innovations offer to companies implementing environmental concern into their strategies the opportunity to consolidate their competitive advantage (De Marchi, 2012). There is empirical evidence that expectations of increases in the turnover of the firm, is an important determinant of eco-innovations, at least in the case of manufacturing firms (Horbach, 2008). Eco-innovations creates new market opportunities for companies, increasing the competitiveness of firms and countries that eco-innovate (Arundel and Kemp, 2009). Porter and van der Linde (1995b) suggested that environmental regulation could also increase turnovers and profits by creating markets for environmentally improved products and technologies, and that compliance costs might be offset by the gains from these innovations.

Business opportunities also derive from **resources efficiency**. Although cleaner production is often associated to reducing environmental impacts, resource efficiency is more specifically associated with reducing resource consumption. The rationale behind this is that inefficient uses in resources can generate pollution, and businesses can increase their productivity through eco-innovation, to make up with the environmental costs (Chen et al., 2006). Accounting for material flows properly and realising potentials to save costs through increasing material productivity will become one key determinant for European companies in the coming decades, in order to maintain competitiveness on global markets (EIO, 2011). Resource efficiency and eco-innovation have both recently climbed the EU policy agenda. The Europe 2020 strategy includes a dedicated flagship initiative on "Resource Efficient Europe" (EC, 2011), which responds directly to the challenge of resource scarcity. Other flagship EC initiatives, mention explicitly that support to the issue of sustainable supply and management of raw materials in the context of industrial processes among the strategic commitments for action (EC 2010a, 2010b). Eco-innovations could bring relevant savings of material costs and for SMEs the potential to improve material productivity is estimated to be even higher than for large enterprises.

Finally, there is limited evidence in the economic literature concerning the role of firms' **organisational and structural characteristics** as drivers of eco-innovation. De Marchi (2012) provides evidence that R&D activities and cooperation trigger environmental innovation, even if they do not complement each other. Moreover, unlike in the case of other types of innovation, R&D intensity is not a significant driver of eco-innovation (De Marchi, 2012; Horbach, 2008). Firm's size seems to be a structural characteristic that boosts green innovations to a greater extent than other innovations. This is also confirmed in Chen (2007) who showed that green core competences of firms have positive effects on their green product innovation performance, green process innovation performance, and green images. However, the relationship between green strategies and firms' performance is non-linear, as the returns in terms of competitive advantage from eco-innovation tend to be much higher for firms with low green innovation performance (Chen and Chang, 2011). As in the case of other innovations, the development of eco-innovations is driven by firms' organisational capabilities (Florida et al., 2001; Kemp et al., 1992; Winn and Roome, 1993). These results are confirmed by Kesidou and Demirel (2012), who highlight the role of environmental management systems (EMS) in eco-innovation. Although external certification alone does not boost eco-innovation because the organisational implementation of EMS is often rather ostentatious, and often dependent on scale factors (Johnstone and Labonne, 2009), organisational capabilities are not only important in firms' decision to undertake eco-innovation activities, but also in increasing the level of resources allocated to eco-innovation activities.

In conclusion, there is large evidence about the impact of individual drivers on firms' commitment to eco-innovate. Yet, we know very little about the response of different types of firms' organisational and structural characteristics to the challenge of eco-innovation. Little is known about firm-level characteristics and their organisational practices in driving the choice and effort put in introducing eco-innovations. In the light of these considerations, in this paper we explore the impact of firm-level characteristics on their eco-innovation activity, expressed in terms of **improvements in resource efficiency and reduction in pollution**. We focus our analysis on several types of drivers:

i) Structural characteristics of firms, such as type of business entity, size expressed in terms of number of employees, managerial practices, staff composition;
ii) Innovation efforts expressed in terms of R&D expenditure, involvement in R&D projects, implementation of scientific search processes; absorptive capacity measured in terms of human capital formation and training;
iii) Company outward orientation, measured both in terms of number of collaborations established with universities, suppliers and other wine firms and in terms of type collaboration agreements (projects grant, exchange of experiences, shared use of equipment, etc.).

We also control for the impact on eco-innovation performance of:

iv) Marketing strategies, such as distribution of wines across different price-points, presence of labels into wine guides, geographical information and type of markets (Ho.Re.Ca., wine shops, distributors);
v) Environmental certifications such as ISO and accreditation of environmental certifications.

3 Empirical analysis

3.1 Introduction

The empirical analysis studies eco-innovation performance and dynamics, focusing on the identification of firm-level drivers of eco-innovation in the Italian wine industry. Choosing one specific manufacturing sector for studying eco-innovative behaviour provides the opportunity to minimise the potential bias in the introduction of eco-innovations which derives from the co-existence of different set of regulations for the promotion and adoption of eco-innovation across different economic sectors, as suggested in Kesidou and Demirel (2012).

The focus on the wine industry also has a number of interesting aspects. First of all, the food and beverage sector is the first manufacturing industry in Europe and is particularly significant in economic terms in Italy. After the automobile industry, this industry is on top of the list for radical eco-innovation (EIO, 2011). Moreover, Frondel et al. (2008) demonstrate that food companies are particularly willing to introduce environmental management systems with respect to other sectors. Secondly, the wine industry is a highly innovative, export-oriented sector, especially within the food sector, no price cap allowing for unlimited product differentiation and innovation. Thirdly, the wine industry is potentially one of the most representative sectors for the implementation of a win-win strategy, which has been found to be a key driver of eco-innovations (Porter and van der Linde, 2005). Given the wide product differentiation and the growing consumers' concerns for environmental and safety aspects, companies are becoming increasingly committed to develop green competences (Chen, 2007). Finally, the wine industry is characterized by the presence of stringent regulation and the grapevine cultivation has pervasive effects on landscape preservation and countryside tourism. Therefore, investments in eco-innovations could have relevant indirect effects on rural economies and their sustainability.

3.2 The Italian wine industry

Italy leads the world market, together with France, for volume of wine production (about 18% of global market). The value of Italian production is estimated at € 8.3bn and consumption at € 4.6bn, two-third of which is sold to hotels and restaurants the total (Rabobank, 2012). A significant share of wine manufactured in Italy is exported. In 2011 volume and value increased respectively of 9.1% and 12.4%, indicating an increase of the average price of wine exported (Rabobank, 2012). A large share of Italian wine companies are family-managed. Family control accounts for 54% of the total net equity. Cooperatives account for a significant part of the total number companies, although their share is gradually decreasing over the years. Foreign investors own some 18% of net equity. The numbers of labels between 1996 and 2012 increased by 76% and the most significant changes have concerned DOC and DOCG wines, indicating the priority of companies to focus on higher quality labels. Large-scale distribution accounts for 43%, although in the case of cooperatives this share rises to 55%. The second most important distribution channel (20%) is the Ho.Re.Ca. and this is mostly due to companies and not to cooperatives. Wine cellars and wine bar represent about 9% of total sales. Other medium-term indicators complete the overall picture: investments level has increased of 12% over the last year, as well as the presence on international markets, with exports rising to 47%. Although 2011 saw a general reduction in level of investments, which were the lowest in the last 6 years, there was a general increase in sales both in Italy (7%) and abroad (about 9%).

3.3 Eco-innovations in the wine industry

The environmental impact of wine production could be reduced by adopting a wide set of technical solutions.[1] Italian wine companies comply with a set of rules,[2] which norm agriculture conditionality, and national laws[3] which discipline waste management and phyto-sanitary use. Companies implementing environmental management systems can choose to certify, as cost saving and diversification tool, through the application of standards with different level of intensity and different actions that can be verified by third party entities. Among the Environmental certifications we find the family of ISO 14000[4], and the carbon footprint.[5]

Mandatory and voluntary rules for environmental management, however, could be accompanied by a set of other actions and investments that companies could implement to increase input efficiency and reduce the production of emissions and waste (outputs) aimed at improving management practices, with the final aim of optimizing outputs and reducing costs.

We account as input indicators of eco-innovation:

- *Improvements in resource efficiency* – improvements in productivity of raw materials, optimization and technologies for the reduction of waste;
- *Reduction of water consumption* – reuse stabilization solution, high-pressure washing, rainwater collection systems, reuse of washing water.
- *Reduction of energy consumption* – solar and eolic energy systems, biomass plants for energy production, underground cellar for reducing air conditioning costs, solar panels system for heating water, electrolytic separation of tartrate;

We account as output indicators of eco-innovation:

- *Waste management* – wireless technology and ozone use for cleaning cloaks, multiple steps sanitation of bottles, recovery of antioxidants from solid wastes, use of recyclable materials and lighter glass bottles;
    - *Wastewater management* - ozone or UV ray use for disinfection and purification of water;
- *Gas emissions* – use of solar irradiation for heating, recovery and purification of CO_2, use of cooling systems, use of hybrid machines.

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[1] See www.agro.geoenvi.org

[2] E.g. the EU Reg. 1698/2005

[3] E.g. the no. 152/2006 and no. 4/2008, as well as the Ministry Decrees no. 12541/2006, no. 13286/2007 and no. 21/2008.

[4] It aims at promoting more effective and efficient environmental management in organizations, and to provide useful and usable tools - ones that are cost effective, system-based, flexible and reflect the best organizations and the best organizational practices available for gathering, interpreting and communicating environmentally relevant information, as well as carbon footprint certifications.

[5] It measures the total amount of carbon dioxide (CO2) and methane (CH4) emissions of a defined activity. The basic concept is that once the emission are known, then strategies can be adopted for its reduction, and their impact can be assessed.

3.4 The survey

In order to estimate the key drivers of eco-innovations we identified a relevant sample of Italian companies and set up a questionnaire for a CATI survey addressed at company managers. The survey has been set up on a web-based platform. A first phone contact has been established in order to ask for their availability to participate in the survey. We then sent an email with the phone contact details and the link to the questionnaire to those managers that agreed to participate. The average time necessary to complete the questionnaire was 14 minutes and the response rate based on the initial survey was 30%. Following the classification of eco-innovation drivers identified in Section 2, the information reported in Table 1 have been asked in the questionnaire.

Table 1. **Description of the eco-innovation drivers**

Type of driver	Specific driver	Description
Structural characteristics	Type of business (TB)	Type of proprietorship, farm based business, legal aspects
	Size (Sz)	Number of employees, volume of production, volume of revenues
	Staff composition (SC)	Number of agronomists, food technologies and administrative staff, non family staff
	Managerial practices (MP)	Presence of productivity incentives and bonus
	Production complexity (PC)	Number of products/line of products
Innovation activity	R&D and technologies (RDT)	Investments in R&D and new technologies, on-going projects
	Scientific search process (SSP)	Small scale product development, market and marketing analyses
	Organizational innovation (OI)	Introduction of new process relative to management, recruiting, customers' and supplier relationships
	Process innovation (PI)	Investments relative to production for speeding up the process, increase the complexity, reducing the use of resources and energy, recovery of sub-products
	Absorptive capacity (AC)	Number of employees with college degree, number of people involved into the R&D process, personnel training
Company outward orientation	Exhibitions (Ex)	Participation in exhibitions and visits to technology exhibitions
	Collaborations (Co)	Collaborations with research institutes, universities, suppliers, other wineries for R&D projects
Marketing Strategies	Distribution (Di)	Hyper-market, supermarket, wine shops, sales on winery directly to customers
	Geography of sales (Geo)	Exports to other countries, national and regional sales
	Price points (Pp)	Price level of wines produced
	Wine guides report (Wg)	Citation into wine guides such as Parker, Wine Spectator and Wine Guru

At present 47 questionnaires have been completed and collected. Descriptive statistics, reported in the Appendix, highlight that the majority of wine companies are small in size and family-owned and usually sole proprietorships. About 15% of employees have a college degree and only the minority of companies implements productivity incentives. The number of labels produced is relatively low and so is the volume of revenues, which is below 3 M€ in 96% of cases. Despite firms' small size a relatively high share of revenues (approx. 7%) is invested in R&D activity. Confirming this, we found that 28% of companies carries out systematically small scale experimental wine production and 21% carries out market analyses. Organizational innovations focus in the area of value-chain management, introducing new approaches to customers and suppliers management. Process innovations focus instead on the improvement of work conditions, on speeding up the production process, on the reduction of energy and water consumption. On average there is only one person per company dedicated to R&D activity. Specialization level of employees is high and approximately 50% of companies invests in continuous staff training programmes.

A relevant share of companies collaborates with external institutions and organizations. Most of the collaborations are established with winemakers and suppliers (about 40%). A relevant share of wine companies cooperates also with universities and research institutes (20%). Direct sales and Ho.Re.Ca. are the main distribution channels. Sales are almost equally distributed among export to other countries, Italian and Regional sales, while most of the wines produced are in the price range €2-15.

None of the companies surveyed had a carbon footprint certification and 11% and 40% respectively has the ISO14001/14004 and Organic certifications.

Descriptive statistics concerning the eco-innovative profile of the sample are reported in Table 2. These results highlight that most of the eco-innovation activity is focused on resource efficiency improvements, more specifically on energy and water consumption rather than output optimization.

Table 2. Descriptive statistics of eco-innovations

Variable	Mean	St. Dev.	Min	Max
INPUT INDICATORS OF ECO-INNOVATION				
- Investments to reduce energy consumption	0.45	0.50	0	1
- Investments to reduce consumption of other materials	0.21	0.41	0	1
- Investments to reduce water use	0.38	0.49	0	1
OUTPUT INDICATORS OF ECO-INNOVATION				
- Investments to reduce waste and emission production	0.26	0.44	0	1
- Investments for the recovery of substances from wastes	0.19	0.40	0	1

3.5 The empirical model

The investigation of the key drivers of eco-innovation in the wine industry is based on a *ordered logit* regression. The regression estimates the impact of firms' characteristics on the probability of adopting a certain type of eco-innovation evaluating the impact of firms' characteristics on the cumulative probability of firms adopting a number of those eco-innovations reported in Table 2. In our model a limited number of adoptions indicates a low effort of the company in eco-innovations, while the adoption of a higher number of types of

eco-innovations indicates a higher effort. Therefore, significant variables will be those characteristics that influence directly eco-innovative attitude.
Given the ordered, categorical nature of the dependent variable, we chose an *ordered logit model* for the econometric procedure. The *logit* specification of the likelihood function has been chosen instead of the normal probability curve of the *ordered probit* because it allows estimating impacts in terms of odds-ratio, which is a more direct interpretation of probability. The empirical model we propose refers to the acronyms of the variables suggested in Table 1, and is reported in equation 1:

$$S_i^* = \beta_1 TB_i + \beta_2 Sz_i + \beta_3 SC_i + \beta_4 MC_i + \beta_5 RDT_i + \beta_5 SSP_i + \beta_6 OI_i + \beta_7 PI_i + \beta_8 AC_i + \beta_9 CO_i + \beta_{10} MS_i + \beta_1 EC_i + \varepsilon_i \quad \text{Eq. 1}$$

Where S^* is a continuous variable accounting for the intensity of adoption of eco-innovations, However, as we cannot observe S^*, we observe instead a categorical representation, *S*, indicating the number of eco-innovation adopted:

$$S = \begin{cases} 0 \; if \; S^* \leq 0 \\ 1 \; if \; 0 < S^* \leq \mu_1 \\ 2 \; if \; \mu_1 < S^* \leq \mu_2 \\ \ldots \\ 5 \; if \; \mu_5 < S^* \end{cases} \quad \text{Eq. 2}$$

Where *i* = 1, …, *N* and refers to each company of the sample. Then the *ordered probit* technique will use the observations on *y*, which are a form of censored data on S^*, to fit the parameter vector. Frequencies of the dependent variable at each level as well as cumulative probability are presented in Table 3. As shown in the Table, as the number of the different types of eco-innovations increases, their probability of adoption decreases. However, few companies adopt only one type of innovation.

Table 3. Descriptive statistics of the dependent variable

	Level	%	Cumulative
Number of eco-innovations	0	36.17	36.17
	1	17.02	53.19
	2	19.15	72.34
	3	19.15	91.49
	4	6.38	97.87
	5	2.13	100

3.6 Results and discussion

The results of the econometric estimation are reported in Table 4. The model shows a discrete fit of the data and the variables selected result significantly different from zero, as indicated by the LR-chi^2 statistic.
In addition to the coefficients, Table 4 reports the odds-ratio values. This measure allows a quantitative interpretation of the marginal probability that an eco-innovation is introduced depending on investments in each of the identified drivers. However, the odds-ratios do not

give information about the direction of the effect. Cut points could be interpreted similarly to the intercept, indicating the value of the predicted variables, *S*, beyond which the outcome S^* shift to the upper level. Therefore, large coefficients, if compared with the magnitude of cutting points could be intended to be responsible of the shift.

Our results show that business characteristics influence the implementation of eco-innovations in several respects. According to the results, farm wineries have a lower probability of introducing eco-innovations than wine manufacturing companies. This is not surprising considering that in this instance we focus on the investigation of eco-innovations that are especially relevant for the manufacturing process. Companies' ownership is also a relevant aspect in the implementation of eco-innovations. Companies that are sole proprietorships are less likely than limited companies and cooperatives to introduce eco-innovations. Unlike in De Marchi (2012), size is not a discriminant factor in eco-innovations. As in other empirical works, we find that neither generalised R&D effort is a significant driver of eco-innovations. On the contrary, in the case of the wine industry we find that scientific search processes expressed in terms of new wine experimentations increases substantially the probability of adoption of eco-innovations. In fact, the magnitude of the coefficient indicates that this variable has a deep impact on eco-innovative behaviour. The odds ratio of about 150 corresponds, in fact, to an increase in probability higher than 90%. The most relevant finding of our exercise is the identification of a positive relationship between companies' generic innovative efforts and eco-innovations. According to our results, those companies that are more committed to process and organizational innovations are also more likely to introduce eco-innovations. In fact, we estimate that the odds ration corresponding to those variables is associated to a probability to adopt eco-innovations of about 60 and 80% respectively.

Absorptive capacity and outward orientation descriptors do not result significant at this stage of the analysis. In particular, companies' collaboration with external partners does no seem to foster significantly the implementation of eco-innovations. Finally, we find that the type of product distribution does not influence eco-innovation activity. However, our results show that companies selling products to Ho.Re.Ca. are less likely to introduce eco-innovations with respect to direct sales, arguably because in the former case rebranding and repackaging practices are more common than in the latter case, therefore the returns from eco-innovations in terms of companies' image with the consumers are much more limited.

Table 4. Results of the regression

Type of driver	Theoretical variable	Variable	Coeff. (log-odds)	Odds Ratio	P-Value	
Structural characteristics	Type of business	Farm-winery	-2.521	0.080	0.070	*
		Sole proprietorship	-2.859	0.057	0.003	**
	Size	No. of employees	-0.030	0.971	0.579	
	Staff composition	Non family management	-3.278	0.038	0.111	
	Complexity	No. of labels	0.150	1.162	0.206	
Innovation activity	R&D and technologies	% R&D on total revenues	0.006	1.006	0.930	
		Number of on-going R&D projects	0.152	1.164	0.809	
		Investments into technologies	-0.020	0.980	0.400	
		No. of new labels/wines last 3 years	-0.476	0.621	0.029	**
	Scientific search	Experiments for creating new wines	5.026	152.353	0.000	***
	Organizational innovation	No. of organizational innovations, last 3 years	0.677	1.967	0.028	**
	Process innovation	No. of process innovation, last 3 years	1.314	3.721	0.037	**
	Absorptive capacity	Employees with college degree	-0.069	0.934	0.854	
		Employees dedicated to R&D	-0.900	0.407	0.155	
Outward orientation		No. of collaborations	-0.118	0.889	0.722	
Marketing strategies		Retail sales %	-0.044	0.957	0.174	
		Ho.Re.Ca. sales %	-0.041	0.960	0.021	**
		Wine shop sales %	-0.022	0.978	0.348	
		National sales %	-0.019	0.981	0.387	
		Export sales %	-0.007	0.993	0.724	
		Average price of wine produced	-0.089	0.915	0.354	
	Cut points	μ_1	-4.060			
		μ_2	-2.378			
		μ_3	-0.064			
		μ_4	3.124			
		μ_5	5.704			
	Log likelihood		-45.078			
	LR $chi^2(22)$		56.470***			
	Pseudo R2		0.385			

4 Concluding remarks

The importance of eco-innovations for industry has been rising exponentially in recent years. In this paper we offered a comprehensive analysis of the drivers of eco-innovation in the Italian wine industry. We analysed the impact of firms' characteristics and their technological and organizational capabilities on the base of a large survey on Italian wine producers. The relevance of the drivers in influencing the probability of introducing eco-innovations is measured with a latent class econometric model.

Our review stresses how both the ecological economics and economics of innovation literature give much emphasis to the investigation of the drivers of eco-innovation, albeit focusing on the effects of the regulatory framework and/or opportunities provided from eco-innovations, expressed in terms of demand and market opportunities or costs saving. There is little evidence concerning the role of firms' organisational and structural characteristics as drivers of eco-innovation. Building on this gap in the economic literature,

in this paper we analyse the impact of a wide range of firms' characteristics on the probability that wine companies introduce eco-innovations. We analyse firms' commitment to eco-innovate considering their cumulative effort in introducing a range of eco-innovations stretching from input indicators such as investments to reduce energy consumption, reduce consumption of other materials and water use, to output indicators such as investments to reduce waste and emission production and the recovery of substances from wastes.
We find that business characteristics influence the implementation of eco-innovations in several respects. Our results show that the nature of the company expressed in terms of ownership and its legal form are key elements for the adoption of eco-innovations. We find no evidence of a positive relationship between company size or R&D intensity and eco-innovation activity. However, we also find that in the case of the wine industry a key driver of eco-innovation is firms' effort in carrying out scientific search processes expressed in terms of new wine experimentations.
Most importantly, our results show that firms' overall attitude towards innovation activity is a key driver of eco-innovation. We provide evidence that eco-innovations and other types of innovation cannot be addressed separately, as firms that have introduced new wines and/or process and organizational innovations are more likely to introduce eco-innovations than firms that do not invest in innovation. This result bring us to the conclusion that eco-innovations and incentives to eco-innovate cannot be considered separately in the implementation of policy schemes.

References

Arundel, A., Kemp, R., (2009), Measuring eco-innovation, UNU-MERIT Working Paper Series No. 2009-017.

Bernauer, T., Engels, S., Kammerer, D., Seijas, J., 2006. Explaining Green Innovation, CIS Working Paper 17.

Brunnermeier, S.B., Cohen, M.A., (2003), Determinants of Environmental Innovation in US Manufacturing Industries, Journal of Environmental Economics and Management, Vol. 45, pp. 278-293.

Chen, Y.-S., 2007. The Driver of Green Innovation and Green Image – Green Core Competence. Journal of Business Ethics 81, 531–543.

Chen, Y.-S., Chang, K.-C., 2011. The nonlinear effect of green innovation on the corporate competitive advantage. Quality & Quantity.

Chen, Y.-S., Lai, S.-B., Wen, C.-T., 2006. The Influence of Green Innovation Performance on Corporate Advantage in Taiwan. Journal of Business Ethics 67, 331–339.

Costantini, V., Crespi, F., 2010. Public policies for a sustainable energy sector: regulation, diversity and fostering of innovation. Journal of Evolutionary Economics.

Costantini, V., Mazzanti, M., Montini, A., 2010. Environmental performance and regonal innovation spillovers.

Dangelico, R.M., Pujari, D., 2010. Mainstreaming Green Product Innovation: Why and How Companies Integrate Environmental Sustainability. Journal of Business Ethics 95, 471–486.

Darnall, N., 2006.Whyfirms mandate ISO 14001 certification. Business &Society 45 (3), 354–381.

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

Demirel, P., Kesidou, E., 2011. Stimulating different types of eco-innovation in the UK: Government policies and firm motivations. Ecological Economics 70, 1546–1557.

EC, 2010a. Communication from the Com- mission: Europe 2020 - A strategy for smart, sustainable and inclusive growth. COM(2010) 2020. Brussels.

EC, 2010b. An Integrated Industrial Policy for the Globalisation Era. Putting Competitiveness and Sustainability at Centre Stage. COM(2010) 614, European Commission, Brussels.

EC, 2011. A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy. COM(2011) 21, European Commission, Brussels.

EIO, 2011. The Eco-Innovation Challenge: Pathways to a resource-efficient Europe. Eco-Innovation Observatory.

Florida, R., Atlas, M., Cline, M., 2001. What makes companies green? Organizational and geographic factors in the adoption of environmental practices. Economic Geography 77 (3), 209–225.

Frondel, M., Horbach, J., Rennings, K., 2008. What triggers environmental management and innovation? Empirical evidence for Germany. Ecological Economics 66, 153–160.

Fryxell, G.E., Szeto, A., 2002. The influence of motivations for seeking ISO 14001 certification: an empirical study of ISO 14001 certified facilities in Hong Kong. Journal of Environmental Management 65 (3), 223–238.

Harrison, R., Newholm, T., Shaw, D., 2005. The Ethical Consumer. Sage Publications Ltd., Thousand Oaks, CA.

Hart, S.L., 1997. Beyond Greening: Strategies for a Sustainable World', Harvard Business Review 75(1), 67–76.

Horbach, J., 2008. Determinants of environmental innovation – new evidence from German panel data sources. Research Policy 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, 112–122.

Jaffe, A.B., Peterson, S., Portney, P., Stavins, R. 1995. Environmental Regulation and the Competitiveness of US Manufacturing: What Does the Evidence Tell Us?, Journal of Economic Literature, Vol. 33, pp. 132-163.

Johnstone, N., Labonne, J., 2009. Why do manufacturing facilities introduce environmental management systems? Improving and/or signaling performance. Ecological Economics 68, 719–730.

Kemp, R., Olsthoorn, X., Oosterhuis, F., Verbruggen, H., 1992. Supply and demand fac- tors of cleaner technologies: some empirical evidence. Environmental Resource Economics 2, 614–634.

Kesidou, E., Demirel, P., 2012. On the drivers of eco-innovations: Empirical evidence from the UK. Research Policy 41, 862–870.

Palmer, K., Oates, W.E., Portney, P.R., 1995. Tightening environmental standards: the benefit–cost or the no-cost paradigm? The Journal of Economic Perspectives 9 (4), 119–132.

Porter, M.E., Van Der Linde, C., 1995a. Green and Competitive: Ending the Stalemate Green and Competitive, Harvard Business Review 73.

Porter, M.E., Van Der Linde, C., 1995b. Toward a New Conception of the Environment-Competitiveness Relationship, Journal of Economic Perspectives 9 (4), 97–118.

Rabobank, 2012. Wine industry survey, Mediobanca Research Department.

Rennings, K., 2000. Redefining innovation — eco-innovation research and the contribution from ecological economics. Ecological Economics 32, 319–332.

Wagner, M., 2007, On the relationship between environmental management, environmental innovation and patenting: Evidence from German manufacturing firms, Research Policy 36, 1587-1602.

Winn, S.F., Roome, N.J., 1993. R&D management responses to the environment: current theory and implications to practice and research. R&D Management 23, 147–160.

Appendix – Descriptive statistics

Type of driver	Specific driver	Variable	Frequency	Mean	St. Dev.	Min	Max
Structural characteristics	Type of business	Farm business vs. industrial business	17%				
		Family owned	81%				
		Sole proprietorship	47%				
		Corporation	32%				
		Partnership	19%				
		Cooperative	2%				
		Consortium	0%				
	Size	<1 M€ revenue	78%				
		1 to 3 M€ revenue	18%				
		3 to 5 M€ revenue	0%				
		5 to 10 M€ revenue	0%				
		10 to 20 M€ revenue	3%				
		> 20 M€ revenue	3%				
		hectolitres of wine produces		11926.76	27987.64	40	150000
		Number of employees		9.55	15.31	0	80
	Staff composition	Number of agronomists and food technologists		1.12	1.76	0	7
		Number of business administration degree employees		1.00	1.39	0	5
		No family management		0.09	0.28	0	1
	Managerial practices	Presence of bonus and/or incentives to management		0.11	0.31	0	1
	Production complexity	Number of wines produced		8.12	4.61	2	26
Innovation activity	R&D and technologies	Incidence of R&D on total revenues (%)		7.09	6.84	0	30
		Number of R&D ongoing projects		1.53	0.72	0	3
		Incidence of new technologies and plants on total revenues (%)		17.45	18.18	0	100
		Number of new wines introduced in last 3 years		2.34	2.15	0	8
	Scientific search	Small scale experimental wine production		0.28	0.45	0	1

	process	Market analysis and marketing research	0.21	0.41	0	1
	Organizational innovation	Introduction of new methods for personnel recruiting	0.26	0.44	0	1
		Introduction of new approaches to manage suppliers	0.43	0.50	0	1
		Introduction of new administrative processes	0.34	0.48	0	1
		Introduction of new systems of resource management	0.15	0.36	0	1
		Introduction of new approaches to manage customers	0.53	0.50	0	1
		Introduction of new approach to manage R&D	0.21	0.41	0	1
		Introduction of new systems of stock management	0.36	0.49	0	1
	Process Innovation	Investments to increase production flexibility	0.28	0.45	0	1
		Investments to reduce energy consumption	0.45	0.50	0	1
		Investments to reduce consumption of other materials	0.21	0.41	0	1
		Investments to reduce waste production	0.26	0.44	0	1
		Investments to reduce water use	0.38	0.49	0	1
		Investments for the recovery of substances from wastes	0.19	0.40	0	1
		Investments to speed up the production process	0.40	0.50	0	1
		Investments to improve working conditions	0.49	0.51	0	1
	Absorptive capacity	Number of employees with college degree	2.30	2.91	0	11
		Number of R&D employees	0.89	1.29	0	6
		Employees continuous training	0.53	0.50	0	1
Company outward orientation	Exhibitions	Participation to product exhibitions and fairs	5.46	6.88	0	30
		Visit to new technology and innovation exhibitions	2.53	4.79	0	30
	Collaborations	Collaboration with other wineries	0.17	0.38	0	1
		Collaboration with customers	0.19	0.40	0	1
		Collaboration with consortiums	0.19	0.40	0	1
		Collaboration with wine makers	0.40	0.50	0	1
		Collaboration with research institutes	0.19	0.40	0	1
		Collaboration with suppliers of technologies	0.43	0.50	0	1

		Collaboration with suppliers	0.06	0.25	0	1
		Collaboration with Universities	0.21	0.41	0	1
Marketing Strategies	Distribution	Ipermarkets and supermarkets (%)	7.38	19.23	0	90
		Ho.Re.Ca. (%)	29.64	29.20	0	90
		Wine shops (%)	21.26	26.16	0	90
		Directly in the winery (%)	36.95	33.08	0	100
	Geography of sales	Other countries	29.48	30.31	0	100
		Italy	27.83	22.10	0	100
		Region	39.40	30.65	0	100
	Price points	Super Value (< €1.99) (%)	2.50	8.36	0	40
		Value (€2 - €5.99) (%)	25.60	32.43	0	100
		Economy (€6 - € 899) (%)	31.79	31.35	0	100
		Popular Premium and Premium (€9 - €14.99) (%)	21.31	28.13	0	100
		Super Premium (€15 - €24.99) (%)	11.38	21.84	0	90
		Ultra Premium e Luxury (> €25) (%)	2.67	7.93	0	40
	Wine guides report	Presence of wines into wine guides	0.57	0.50	0	1
Environmental Certifications	Carbon footprint		0.00	0.00	0	0
	ISO 14001/14004		0.11	0.31	0	1
	Organic		0.40	0.50	0	1