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## New Technologies And Sustainability In The Italian Wine Industry

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### Abstract

The new shape of competition is pushing wine firms to invest into new technologies. Given the growing interests in this area, we provide evidence on the determinants of the adoption of the new technologies industry. On the basis of a survey on Italian companies, the main investments in innovations and their key drivers are investigated. We tested whether firm characteristics impact the adoption as well as absorptive capacity, networking and shared knowledge among firms and research institutions and demand factors. Drivers are explored throughout an econometric model. Results lead to policy implications that could be useful to develop supportive actions to innovation.

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### 1. Introduction

The importance of the new technologies and innovation into firms could have multiple and positive impacts: cost-reduction, product differentiation, process innovation, and improvements of managerial organization.

The new shape of competition is pushing towards the application of strict rules and techniques for wine standardization, processes optimization, certifications and cost reduction in order to increase the international competitiveness.

Through the past decades, consumers' awareness towards food safety issues, environment and ethical implications of productions has increased, making consumers' behaviour a more complex subject to study. Lately, the impact of crisis on purchasing power has been rising as well as the globalization, which is pushing towards an

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increasing internationalization of Italian wine products. Seemingly, the competitive arena, regulation and policy incentives are pushing industry to increase R&D investments. Nonetheless, the adoption of new technologies could be also driven also by internal factors to the industry.

A large body of the innovation literature has already investigated the adoption of new technologies and the drivers of innovation in many sectors, thus, theory is consolidated and key drivers have been extensively explored. However, to the knowledge of the authors, not much has been done with respect to specific food sectors.

Under the light of growing needs and academic interests on the topic, this paper provides new evidence on the determinants of the adoption of the newer technologies with specific reference to the wine industry in Italy.

On the basis of a large survey on Italian wine companies carried out in 2013 we investigate the main areas of investment in innovations and the key drivers of their adoption. In this paper we offer a comprehensive analysis of the drivers of innovation activity and adoption of new technologies in the Italian wine industry, which include the assessment of demand factors, supply factors, technological and organizational capabilities, significance of regulation and standards.

Based on the body of literature, the paper explores specifically the following hypotheses:

- Firm characteristics such as economic size and number of employees impacts the likelihood of adopting new technologies because of scale economies;
- Employees skills impacts absorptive capacity, thus, the possibility of implementing the new technologies more easily;
- Networking and shared knowledge among firms, across the supply chain, and with universities and research centres increases the proximity with innovation oriented knowledge, thus, newer technologies;
- Demand factors impact innovation behaviour, especially export orientation.

The hypotheses have been tested throughout an econometric model. Results concerns the key drivers of the newer technologies adoption leading to a number of policy implication that could eventually be useful to develop specific actions to support innovation in such a peculiar and diversified sector.

## 2. Literature Review

Innovation in the wine industry and its correlation with the development and the competitiveness of firms and regions has been gaining growing interest amongst scholars. Most researches provide insight into the territorialised nature of the diffusion of innovation within the wine industry, considered not only as physical conditions but also as the social and institutional context which encourages collaboration among the actors (Velluzzi, 2010; Giuliani, 2007; Alonso, 2010).

Social conventions, territorially rooted, are the main factor affecting the decision making related to innovation for small family firms as described by Gilinsky et al. (2008) in a study about the Tuscan and Californian family wineries which analyzes incentives and barriers to innovate under the influence of location and the managers' perception of the context. On the other hand, the presence of large firms within a cluster characterized by collaboration among actors, influences positively the diffusion of innovation, as demonstrated by Taplin and Breckenridge (2008) considering wineries in North Carolina.

The demand of innovation depends upon co-location linkages inside a wine cluster between customers, suppliers, grapes growers, industry associations, centres for research and all other actors involved in wine industry. Policies should stimulate the process for innovation by shaping the parameters within which opportunities are opened or constrained, but in some cases, as shown by Mytelka (2004) for the wine cluster of Niagara Peninsula in Canada, policies promoted by growers boards and government distribution boards did not always have a positive impact on the innovation process. Weaknesses in the organisational structure and their impact on the diffusion of innovation in the wine industry are also investigated by Aylward (2002) who has considered the case of Australia. His study shows that, although strong efforts in developing R&D have contributed to boost export and to consolidate the international image, there are small firms unable to gain the access to innovation as larger operators have had the opportunity to do because closer to the so-called 'industry's R&D epicentre'. In a different work, Aylward (2007) has evidenced that the significant innovative activity and the development of a research culture within the industry are the result of both strong linkages between firms and the centralized authority by industry peak bodies in deciding

research priorities and resources distribution. The high degree of integrated collaboration among firms, both at vertical and horizontal level, and with institutions supporting R&D and promotion, is thought to lie at the very heart of the export-oriented success for Australian wine industry, which has enjoyed an high level in innovation uptake (Anderson, 2010). The correlation between innovation and export activity in Australian wine clusters has been demonstrated by Aylward (2004), through empirical cases, evidencing that, as the cluster develops in terms of integration among firms, advisory and regulatory bodies, education and research system, the export performance will be enhanced.

The positive role played by the institutional framework in influencing innovation in New World wine countries producers has been deeply analyzed by Cusmano et al. (2010), Aylward (2004) and Aylward and Turpin (2003). They underline the benefit for producers of a nationally centralized institutional framework, which has adopted top-down strategies for the growth of the industry and its international success. The effects of different governance are considered by McDermott (2007) who has compared the development of the two Argentina wine-producing regions of Mendoza and San Juan, while a study carried on in the Serra Gaucha in Rio Grande do Sul, Brazil, has examined the different trajectories followed by two wine firms, located in the same region, in the innovation process related to routines and capabilities (Cherubini and Alves, 2011).

Essential components of the institutional framework as sources of technological change and innovation are the regional research system (Morrison and Rabellotti, 2007) and the high education system. In particular, the linkages between firms and universities have played a significant role in improving the competitiveness of New World producers in the international market (Aylward, 2003; Morrison and Rabellotti, 2007; Cusmano et al., 2009; Cusmano et al., 2010; Giuliani et al., 2011) and contribute to make firms more technology-push oriented and to adopt complex product innovation (Dell'era and Bellini, 2009). Some authors focused on the beneficial effects of university-firms linkages at the level of specific regional cluster, as in the case cases proposed by Tiffin and Kunc (2011), who have studied the wine industry of Ontario, by Giuliani and Arza (2009), who have considered two wine-producing areas, in Chile and Italy, and by Giuliani et al. (2010) who, in a study on three particular wine producing contexts, Piedmont (Italy), Chile and South Africa, have provided evidence that in both old and new producing countries, links between researchers and industry are the key to competitiveness in the wine industry. However, although the regional university is a critical actor in the development of an innovation system, different patterns could be identified as displayed by Kunc and Tiffin (2008) for Chile and Argentina. While Chilean wine industry has benefited of exogenous sources (investments of foreign firms, flying consultants and overseas suppliers) with a restricted activity for local universities at a first stage, Argentina has followed an endogenous path controlled by the central government and research institutions. On the other hand, Farinelli (2013) emphasizes the opening of both South American countries to the international flows of know-how, investments and human resources in a very short time, in the late 1980s for Chile and in the mid-1990s for Argentina, laying the groundwork for the development of local knowledge and technology able to meet international quality standards and consumers' tastes. The relevant role played by public and private investments in knowledge capital and their correlation with key outcome variables for Chilean wine industry is highlighted by Dutz et al. (2014) who have considered the hiring of foreign consultants, the participation to international fairs and the engaging in international cooperation for training and learning.

Extra-regional collaborations of innovative firms have caught the interest for scholars (Doloreux, 2004; Hassink, 2005; Simmie, 2005; Torre, 2009) and, among them, Aylward (2003) suggests the "innovation territories" approach, which takes into consideration various economic spaces, including regions and countries, for the spreading of innovations at different levels. Giuliani and Bell (2005) and Giuliani (2007) underline the importance of the influence of each firms' absorptive capacities not only on the performance of the intra-cluster knowledge system but also on extra-cluster knowledge, particularly by firms with a greater cognitive capacity. Similarly, findings by Morrison and Rabellotti (2009) demonstrate that large Italian wineries characterized by great absorptive capacity have higher propensity to cooperate with operators of different regions.

Outside the cluster, or the region, a multiplicity of knowledge sources come from the market, namely inputs from consumers, distribution firms, retailers, restaurants, caught through the firm area managers or the sales department (Doloreux et al., 2013) and focusing on the improvements of products and processes (Centonze, 2010; Cusmano, 2010; Taplin, 2010). In the wine industry observing the market and understanding the emerging trends, often drive innovation towards the way of communicating the product, by means of the packaging or the label (Balestrini et al.,

2006), or towards the Meaning-Drive Innovations which comply with understated and unspoken needs of the market, by creating new social meaning and contexts of consumption of the product (Verganti, 2008).

### 3. Empirical analysis

In order to estimate the key drivers of new technologies, we constructed a sample of 2,000 wineries and designed a questionnaire for a CATI<sup>†</sup> survey addressed to company managers.<sup>‡</sup> The sample wineries were randomly selected and their number was determined by region, proportional to the number of local companies. Stratification based on company size was applied in order to have a more representative sample.

The questionnaire included questions to gather information on the companies and analyse the drivers of eco-innovation in line with the literature, and identify proxies for regulatory aspects, demand factors, and firm and technology factors including networking and market orientation. The survey was available on a web-based platform. Companies were contacted by telephone to invite participation. This was followed by an email to those managers that agreed to participate, providing our phone contact details and the link to the questionnaire. The average time to complete the questionnaire was 14 minutes and the response rate was 16.8%,<sup>§</sup> providing 334 completed questionnaires.

Most of the firms are small and medium enterprises (SMEs) with about 20% graduate employees. Most also are part of a cooperative or a limited company, although more than 30% are sole proprietorships. 72% of the companies are family businesses and about 80% of companies are farm based, implying they produce grapes, while 20% purchase grapes from vine farms. Cross statistics highlight that 96% of the farm based companies is family owned, implying that non-family businesses are less likely to participate to the agricultural production within the value-chain. Just 4% of the sampled companies have external management, and just 11% takes care of the entire distribution process. Companies frequently collaborate with other wineries and suppliers, but collaborations with universities and research centres is more rare. About 20% of the wineries are organic and ecological certifications, such as ISO 14000 and Carbon Footprint, are less popular. About 20% of companies conduct research activities such as winemaking experiments in order to improve their products.

We test the research hypothesis by employing a logit regression. The logit regressions estimate the correlation among the theoretical drivers on the probability of the firm adopting new technologies (reported in Table 1).

The generalised model used here is the following:

$$Prob(Y_i = j) = \sum_{\mu} c_{\mu} + \sum_k \beta_k R_{ik} + \sum_{\tau} \beta_{\tau} D_{i\tau} + \sum_{\gamma} \beta_{\gamma} T_{i\gamma} + \varepsilon_i \quad (1)$$

where J represents the adoption of one or more innovative technologies, thus equal to zero if no innovation has been introduced and 1 if the company adopted new technologies. With respect to the independent variables:

- R represents the  $k = 1, 2, 3$  proxies of Regulatory Factors;
- D represents the  $\tau = 1, \dots, 7$  proxies of Demand Factors;
- T represents the  $\gamma = 1, \dots, 11$  proxies of Firm-specific and technology-push factors.

<sup>†</sup> Computer Assisted Telephone Interview

<sup>‡</sup> The universe of Italian companies is of about 380,000 wineries (ISMEA, 2012)

<sup>§</sup> Sampling choices and stratification are oriented to minimizing selection bias. When compared with national data on wineries (Source: ISTAT 2011 - Censimento dell'Industria e dei Servizi), the sample is a good representation of all size classes (expressed as numbers of employees) with less than 4% deviation, with the exceptions of wineries with just 1 employee which are under represented, and companies with 3-9 employees which are over represented.

Table 1. Innovative technologies considered for the empirical analysis.

Technology	Description
Innovative Wine Machinery	High level of automatism. Reduction of energy consumption and optimization of specific phases of the wine making process such as: submerged cover fermentation, heated and refrigerated maceration, white-like red wine making, deferred maceration.
Biotechnologies applied to yeasts	Adding selected yeasts that empathize <i>terroir</i> , so local wine characteristics
Biosensors	Monitoring wine quality parameters on machineries during the wine making
Alternative wine making techniques	E.g. pre-fermentative chill maceration, through different chilling agents to increase the anthocyanin rate

Table 2. Results of the analysis and descriptive statistics (\*\* p&lt;0.01, \* p&lt;0.05, + p&lt;0.1)

Variables		Coeff.	Mean	st. dev	min	max	
		Y = 1 New tech adopted					
Regulatory Aspects	ISO 14000/14004 Certification	1.496+ [0.784]	0.061	0.239	0.000	1.000	
	Carbon Footprint Certification	17.47 [2,181]	0.018	0.134	0.000	1.000	
Demand Factors	Share of Sales to Foreign Markets	0.455** [0.115]	2.224	4.206	0.000	30.000	
Firm & Technology Factors	R&D effort and internal capabilities	Share of Graduate Employees	2.041* [0.881]	0.114	0.215	0.000	1.000
	Networking	Relationships with Universities	0.216 [0.479]	0.336	0.473	0.000	1.000
		Collaboration with Other Wineries and Consortia	0.849* [0.349]	0.267	0.443	0.000	1.000
		Relationships with Suppliers of Grapes, Equipment and Chemical Products	0.836* [0.381]	0.382	0.487	0.000	1.000
		Relationships with Customers	0.816* [0.360]	0.100	0.300	0.000	1.000
Structural Characteristics	Volume of Sales (1-5 scale)	0.843** [0.263]	2.227	1.164	1.000	5.000	
Constant		3.214 [5.169]					
Pseudo R2				0.3497			
Obs				258			

Table 2 reports the results of the econometric analysis, which includes the ordered logit and the corresponding descriptive statistics.

Overall, the results of the regressions show that some regulatory aspects, which correspond to the sustainability aspects whose firm is involved, have a strong impact on the probability of adoption of new technologies, confirming that regulation does not necessarily represent an undesirable cost-increasing factor, but can be a driver of firm innovation (Bernauer et al., 2006), resulting in a win-win strategy with positive economic impacts (Porter and van der Linde, 1995). Voluntary environmental certifications, such as the ISO 14000 group, require industrial process control and impact assessment, increasing awareness of environmental impacts and promoting investments.

The significant effect of demand factors, such as the export orientation, may be explained by the growing competition with new world producers on the destination markets. A firm strategy driven by large importing clients, needs that the innovation behaviour be principally alimented by inputs achieved by the market, for the adoption of standardised and cost-saving technologies aiming at both product and processes innovations as evidenced by literature (Centonze, 2010; Cusmano, 2010; Taplin, 2010).

Several firm specific and technology-push factors have been found to be positively correlated with eco-innovation activity (Triguero et al. 2013; Horbach et al., 2008). In particular, findings are consistent with the previous cited studies which highlight the relevant role played by relationships among all actors inside a region, or a wine cluster (Taplin and Breckenridge, 2008; Giuliani, 2007; Alonso, 2010; Velluzzi, 2010). We found a positive correlation between eco-innovation activity and firms' networking with other wineries and consortia. The exchange of knowledge within such a network could generate a leader-follower mechanism that enhances eco-innovation propensity. However, in contrast with other researches, we have found that cooperation with universities and research centres does not affect innovation activity. On the other hand, the indicator of internal capabilities, expressed as share of graduate employees, is highly significant in any of the regressions. This could mean that in wine companies, the wine maker and the firm's staff are responsible for innovation activity, indicating that internalisation of skills and competences is relevant for innovation, and these skills are obtained internally. So, emerges that notwithstanding the lack or weakness of links between producers and universities, innovation is pursued recruiting graduate employees, under the managers' control. The influence of the managers' perception of the context and the effect of the local factors together with social conventions is typical of small and family firms (Gilinsky et al., 2008). Some specific features of innovation patterns in food companies imply that looking at only internal, closed innovation processes is misleading as an indicator of innovation capacity (Capitanio et al., 2010). What differentiates food companies from other manufacturing companies is their high dependency on natural resources and the need for specific (often tacit and local) know-how in their production processes (Dries et al., 2013). Enzing et al. (2011) indicate that a more open system of innovation is more relevant for food companies which often rely heavily on external resources and have more intense interactions with both upstream and downstream partners than companies in other industries.

Following these arguments, we find that wine companies that are more open to interaction with the external environment are also more likely to innovate (Trigueiro et al., 2013). In fact, cooperation with customers and suppliers is correlated with the adoption of newer technologies and these findings are consistent with researches which have focussed on extra-regional collaborations (Alyward, 2003; Doloreux, 2004; Hassink, 2005; Simmie, 2005; Giuliani and Bell, 2005; Giuliani, 2007; Torre, 2009; Morrison and Rabelloti, 2009).

On the demand-side, food companies, such as wine makers, benefit from interaction with downstream partners such as retailers and distributors, which facilitate successful introduction onto the market of new products (Centonze, 2010; Cusmano, 2010; Taplin, 2010; Doloreux et al., 2013).

Structural characteristics, such as size and corporate organisation, affect significantly new technologies adoption, confirming what already discussed by Aylward (2002).

#### **4. Concluding remarks**

The importance of new technologies for industry has risen exponentially in recent years. This paper provides a comprehensive analysis of the drivers of the adoption of new technologies in the Italian wine industry to add to the knowledge on why and how companies integrate environmental sustainability and innovation activity. The analysis is based on original survey data, which are used to determine the impact of the drivers identified by the economic literature, which tends to be non-industry-specific. In contrast to existing empirical studies, we offer a fine grained analysis of a single sector, the wine sector, to understand the difference between a single focus and a broader analysis of a highly diversified national industry, from regulatory to technological perspectives.



Our results confirm the hypothesis that voluntary environmental certification is related to the innovative profile of firms.

We also found a positive correlation between networking and the propensity to eco-innovate. Vertical and horizontal collaboration within the supply-chain (with suppliers of technologies and oenological products, customers or other wineries) and partnerships with competitors accelerates the adoption of ecological innovations. Such an effect could be related to the specificity of the innovation process, which requires wine companies to rely on good access to external information and new knowledge. The crucial role of knowledge is confirmed by a further finding showing a positive correlation between wineries' R&D effort and their innovative behaviour.

Finally, it should be noticed that, although a cross-sectional perspective of the sector and the choice of proxies might be providing information on trends and correlations rather than unequivocal cause-effect mechanisms, our results highlight firm-level rather than external market factors and have implications for policy makers. However, to obtain more robust evidence of the impacts and a clearer direction of the causality between the drivers of and eco-innovative behaviours, historical information on companies rather than a cross-section might be desirable. Further research could focus on in depth qualitative analysis of the correlations found in this study to provide a clearer understanding of the mechanisms driving them.

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