ECOLOGICAL TRANSITION, BIODIVERSITY AND ECOSYSTEM SERVICES: THE CRUCIAL ROLE OF CONSUMERS AND PRODUCERS

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To my mum, dad and sister

CONTENTS

List of tables

List of Figures:

Introduction

Ecological transition is the main solution to climate change and environmental crises. It consists of a transition from an intensive and unsustainable production system to one that is economically, environmentally, and socially sustainable. Its importance has prompted policymakers and international organizations to include it as one of the main goals within national PNRR (Piano Nazionale di Ripresa e Resilienza) and international strategies (European Green Deal). But ecological transition can be reached only through a presence of natural resources variability, indeed, one of the best tools that could reach this goal is the biodiversity. Biodiversity is defined as the variability among living organisms from all sources, including diversity within species, between species, and ecosystems (Convention of Biological Diversity, 1992). A lack of biodiversity would cause the failure to achieve not only ecological transformation but also all 17 sustainable development goals (SDGs) defined by the U.N. in 2015. Rural areas are one of the largest hotspots of biodiversity as they protect biodiversity, prevent soil erosion, mitigate climate change, global warming, and hydrological risks, and promote ecological resilience. One of the main activities of rural areas is agriculture, which has both negative and positive environmental impacts. Sustainable agriculture[1] enables the creation of a sustainable food chain and the production of ecosystem services that society requires. Ecosystem services are defined as direct and indirect contributions of ecosystems to human well-being (TEEB, 2010), which must underpin not only ecological transition but also economic growth to avoid the loss of biodiversity and the related depopulation of rural areas. One of the main problems with ecosystem services is the lack of market valuation; all beneficiaries tend to regard them as gifts from the ecosystem at no cost and for indefinite duration, which is not the case. It is evident by the approximately 1 million species that are now at risk of extinction and the drastic reduction of pollinators (Legambiente, 2021). Further, 60% of the population of fishes, birds, mammals, and reptiles have halved from 1970 to 2014. The actual beneficiaries of ecosystem services are producers, who use these services as productive inputs for all intents and purposes (i.e., benefit from the activity of pollinators), consumers/families (such as the benefit from walking in the mountains), and society (no coastal erosion due to the action of Posidonia). Therefore, to avoid a failure of their evaluation, it is necessary to work on both the supply and demand sides. On the one hand, incentives should be provided to producers to encourage them to produce ecosystem services as a competitive advantage. On the other hand, consumers should be encouraged to purchase sustainable and eco-friendly goods.

This study seeks to address these issues.

The first chapter focuses on abiotic soil ecosystem services, on which few studies have focused. Our goal is to estimate their social value through an experimental choice applied to a sample of 200 people with respect to two niche products grown in Liguria: Rotella apple and Moscatello wine. Before submitting the experimental choice to our sample, we identified five attributes with their respective levels that described our products: use of the soil (two levels), location of the product (two levels), knowledge of the soil (two levels), historical product conservation (three levels), and price (four levels). Once the results of the experimental choice were obtained, we applied a mixed multinomial logit model for the estimation. From the results, we found that consumers attributed a positive social value to abiotic soil ecosystem services; that is, their presence positively impacted their utility. This paper was presented at the international conference related to the EVA course called “Advances in Economic Valuation of Ecosystem Services for Public Policy and Ecosystem Accounting” held on May 25, 2022, as part of the TRANSUMARE festival, held in Genoa, Italy, May 23-28, 2022.

[1] There are different definitions of sustainable agriculture in this work sustainable agriculture is defined as FAO definition: sector in which food is nutritious and accessible for everyone, and where natural resources are managed in a way that maintains ecosystem functions to support current, as well as future human needs.

The second chapter addresses the supply side analysis. First of all, we defined the weaknesses and strengths of the internal and external contexts (SWOT: strengths, Weaknesses, Opportunities and Treats) in which 43 rural areas operate, using focus groups and meetings with various stakeholders (mayors, ANCI, park authorities, and rural firms). These 43 rural areas firms participated in two projects called CAMBIOVIA and BIODIVALP of Liguria Region. This study has two objectives: to rank the sustainability of the enterprises and to target policymakers' strategic interventions necessary for the enhancement of these enterprises. In particular, the firms' sustainability is interpreted from an economic, ecological and market perspective through composite macro-indicators. These sustainability indicators are based on both qualitative and quantitative data and firms are then ranked with respect to each category of macro-indicators through partially ordered sets methods. The methodology applied is entirely innovative and is represented by POSET, a partially ordered set hierarchization tool, which makes it possible to avoid offsets between data and consider their varying natures. In the second case, we used a multi-criteria analysis derived from a questionnaire submitted to 59 stakeholders to enable participatory consensus building, with the addition of a hierarchization approach for partially ordered sets due to the presence of qualitative variables. The results identified the following as the best tools: training, local brands and labels, and territorial networks. While referring to the classification of companies from an ecological, market, and economic point of view, it is seen how they differ for market and ecological sustainability while presenting the same situation, not good, in terms of economic status. This work was presented at the international conference related to the EVA course called "Advances in Economic valuation of Ecosystem Services for Public Policy and Ecosystem Accounting," held on May 25, 2022, as part of the TRANSUMARE festival, held in Genoa, Italy, May 23-28, 2022.

The third chapter analyzes household behavior. This chapter aims to understand whether there is a space to engage consumers in an active demand attitude for ecosystem services that remain embedded in products. This is achieved by profiling consumers based on their consumption behaviors and analyzing their socio-economic-demographic characteristics. Latent class analysis (LCA) was used to study the consumption habits of a sample of 942 consumers. The results presented two groups of consumers. The first group presented less environmentally sustainable consumption habits, while the second group presented greater sustainability in their consumption. Regarding socio-economic-demographic characteristics, it was found that there were more educated consumers with more children and higher incomes in the second group. For group 1, we also observed that consumers' consumption habits were due to their socio-demographic characteristics; in fact, because of their low level of income, they always purchased products from supermarkets. Meanwhile, a high percentage of consumers often bought PDOs (Protected Designation of Origin) and organic products and paid attention to animal and worker welfare as well as the information contained in the labels. With this work we underline the importance of consumers' socio-economic-demographic characteristics for more sustainability behaviors.

CHAPTER 1

SOCIAL VALUE OF GEOLOGICAL CHARACTERISTICS OF THE SOIL

Abstract[2]

Over the last few decades, human activities have caused an over-exploitation of natural resources and a loss of biodiversity. One of the most important natural resources is soil, 33% of which is degraded. The growing concern for the environment has led in recent years to an increase in research on the assessment of ecosystem services. With reference to soil, most studies have evaluated only biotic ecosystem services and the economic value using ecolabels. Our goal is to fill these two gaps by assessing the social and non-useful value attributed by consumers to abiotic soil characteristics (use of soil, location of the product, knowledge of soil, and historical product conservation). To do so, we submitted an experimental choice to a sample of 200 people regarding two niche products cultivated in Liguria: Rotella apples and Moscatello wine. Results showed that most consumers attribute a positive social value of their utility to these abiotic soil characteristics.

Section 1: Introduction

Over the years, human activity has caused significant damage to the environment, such as ecosystem service degradation, natural resource overexploitation, and biodiversity loss (European Commission, 2021). Over the past two decades, the world's awareness of the importance of conserving natural resources for our well-being has increased, prompting policymakers to adopt protocols and strategies aimed at restoring and protecting ecosystem services (such as the Convention on Biological Diversity, Nagoya Protocol, Sustainable Development Goals (SDGs), Paris Agreement, EU Agenda 2030, G20 Summit in Rome, and EU Green Deal). In addition, studies related to the economic valuation of ecosystem services, especially in relation to SDGs, has increased, with the goal of introducing environmental-economic accounting and the valuation of natural capital into policy; from 2014 the European Union has adopted numerous projects such as the Natural Capital Accounting and Valuation of Ecosystem Services (NACAVES), the Knowledge Innovation Project-Integrated System for Natural Capital and Ecosystem Services Accounting (KIP-INCA), the Mapping and Assessment of Ecosystem and their Services (MAES), and Mapping and Assessment for Integrated Ecosystem Accounting (MAIA) that have contributed to the development of SEEA-Ecosystem Accounting (SEEA-EA) of 2021.

Researchers and scholars, moreover, at the academic level, have evaluated several ecosystem services such as marine (including beach, coral reef, seagrass meadow, mangrove, and coastal), forest, freshwater (including lakes, rivers, and watersheds), wetlands, urban, agroforest ecosystem, mountains, drylands, and a few studies related to the soil and quarries (Costanza et al., 2017).

[2] For the ecological part we work in collaboration of two students of EVA (Environmental Valuation and Accounting) course specialized in geological knowledge: Anna Cellino and Lea Terlizzi.

Nevertheless, the data demonstrate that natural resources continue to decline due to the lack of standard monetary valuation and economic measures of ecosystem services that have led to their exclusion from the decision-making process (Cavalletti et al., 2019).

One of the most important natural resources is soil. According to FAO 2015, it is 33% degraded due to human activities. This reflects the few studies related to soil ecosystem services valuation (Jonsson et al., 2016).

Most academic studies related to the valuation of soil ecosystem services have investigated biotic ones (Bartkowski et al., 2020); a further method for soil valuation has been to introduce a signal to consumers for the use of eco-friendly techniques, the ecolabel (Mazzocchi, 2019). This, however, only allows us to detect the usable market value of soil and not its social value.

Our goal is to fill these two soil-related gaps; we seek to assess the social value that consumers place on abiotic soil characteristics to understand the benefits associated with the nature of the soil. To do so, we apply an experimental choice related to two niche products, Rotella apples and Moscatello wine, produced in the Liguria region.

We choose Liguria because it represents a case study extendible to other realities. Despite adverse demographic dynamics, agricultural production has positive results; agricultural goods and services increased in 2019 by 9% compared to previous years; moreover, the sustainable use of the soil has been improved (CREA, 2021). The use of pesticides, chemical products, and fertilizers decreased by 39% compared to 2018, and forest cover increased in 2015 by 6% over 2005. Finally, 33% of its territory is in protected areas, rendering Liguria a high container of biodiversity (CREA, 2021).

This paper is organized as follows: Section 2 introduces the soil ecosystem services valuation review, Section 3 illustrates the application of the experimental method, Section 4 describes our choice of experimental design, in Section 5 the socio-economic characteristics of the sample are reported, Section 6 introduces the basic theory of choice experimental method, Section 7 shows the results and discussion of the estimation, Section 8 illustrates the robustness of results, and conclusions are presented in Section 9.

Section 2: The soil ecosystem services valuation review

One of the most important natural resources for our well-being and for the biodiversity goal is soil. As FAO underlined in 2015, 95% of our food is directly or indirectly produced by the soil. Moreover, the benefits that people obtain from it (ecosystem services),[3] which are described in Table 1.1, are

[3] Ecosystem services currently have different definitions. The milestone is that gave in 2005 by United Nation during the Millennium Ecosystem Assessment (MEA) for which the ecosystem services are the benefits that people obtain from ecosystem. In 2007–2010, during the Economics of Ecosystem and Biodiversity (TEEB) initiative, the European Commission and German Federal Ministry for the Environment defined them as the direct and indirect contributions of the ecosystem to human well-being. In 2017 La Notte et al. gave another definition of ecosystem services: interactions of the ecosystem that produce a change in human well-being. Another issue debated in the literature is the ecosystem services classification system. MEA (2005) introduced four main categories (provisioning services: food, energy, fuel; regulating services: climate regulation and water purification; cultural services: recreational activities, spiritual and cultural needs; and supporting services: ecosystem processes and functions that underpin the other three types of services (primary production, soil formation)). After that, TEEB in 2010 presented a similar classification proposed by MEA, but supporting services was changed to habitat services, and finally CICES (Common International Classification of Ecosystem Services) in 2009 presented another classification as part of the work of the System of Environmental Economic Accounting (SEEA) led by the United Nation Statistical Division, with the aim of overcome the problems of incomparable classification systems in order to create the basis for an ecosystem services accounting system. Today it is at its 5.1 version and continues to change. Its hierarchical structure is similar to the first one because it considers the provisioning and cultural services, merges the TEEB habitat services with regulating ones and, as already appearing in TEEB, it does not

essential for our health and for the maintenance of biodiversity in agricultural production. For example, soil ecosystem services regulate carbon dioxide emissions, climate change, and water cycles, clean our drinking water, and provide medicines, vaccines, and human recreational activities. From the biodiversity side they contribute to the reduction of soil fertilizers, the absorption of carbon in the atmosphere, and water purification (Daily et al., 1997; D'Costa et al., 2006; FAO, 2012, 2015).

Table 1.1: Ecosystem services of the soil

Supporting	Primary production, nutritional cycle, soil formation[4]
Provisioning	Products people obtain from ecosystem: provision of food, fuel, fiber, timber, water, raw materials, source of pharmaceuticals and genetic resources, surface stability, provision of construction materials.
Cultural	Nonmaterial benefits to people from the ecosystem: Cultural heritage, spiritual enrichment, cognitive development, reflection, recreation, and esthetic experiences.
Regulation	Benefits people obtain from the regulation of ecosystem: Climate regulation, water purification and soil contaminant reduction, flood and erosion control, carbon sequestration, water supply, maintenance of air quality.[5]

Source: FAO, 2015

During the last several decades, the awareness of the importance of soil and its sustainable use has increased, pushing governments to adhere to numerous initiatives and strategies at national and international level related to the conservation and preservation of its biodiversity, recapped in the following table:

Table 1.2: soil preservation initiatives

2012	FAO created the Global Soil Partnership
2015	GSP produced the Voluntary Guidelines for Sustainable Management of Soil
2015	U. N. set up the World Soil Day (December 5th of each year) and proclaimed 2015 International Soil Year
2015	U.N. SDGs. Key role of the soil both directly in the 15th goal (Life on land) and indirectly in the 1st (no poverty), 2nd (zero hunger), 3rd (good health and well-being), 6th (clean water and sanitization), 7th (affordable and clean energy), 11th (sustainable cities and communities), and 13th (climate action)

Research on ecosystem services valuation, especially in relation to sustainable economic development, has expanded greatly, contributing to several of the studies basic to issues of assessing natural capital. In relation to the soil, many papers have addressed the valuation of its ecosystem services. For the provisioning function, Decaens et al. (2006), Haley (2006), Porter et al. (2009), and Sandhu et al. (2008) valued the soil's biomass production; Tegtmeier and Duffy (2005) valued the

consider supporting services (which are the ecosystem structure from which the society does not benefit directly but through the flow of final services) in order to avoid double accounting (La Notte et al., 2017; Burkhard and Maes, 2017).

[4] Soil formation means gradual break down of rocks through weathering process (physical, chemical and biological) but, also, the accumulation of material through the action of water, wind and gravity thanks to which the soil forms (FAO, 2015).

[5] Soil has an indirect and direct utility for humans. It is a result of interactions phenomena of human's activities and chemical and physical processes. It hosts organisms from which depend cultural evolution, food chain and biodiversity (Avsis, 2019).

cost of cleaning water, and Dolley and Bolen (2000), Jasinski (2000), and Virta (2004) valued soil's raw materials, while the soil physical environment was evaluated by Dominati et al. (2014a, 2014b). For the regulation function Burke et al. (1989), Dilustro et al. (2005), Juarez et al. (2013), Keesstra et al. (2012), Maljanen et al. (2004), Pepper and Morrissey (1985), Wang and Shao (2013), Sandhu et al. (2008), Tubè et al. (2010), Bond et al. (2011), Colombo et al. (2006), Eastwood et al. (2000), San and Rapera (2010), and Dominati et al. (2014a, 2014b) provide an evaluation of soil biological control, climate and gas regulation, hydrological control, filtering of nutrients and contamination, and recycling of waste and detoxification. Most of these studies focused on the assessment of usable soil value within the market and biotic ecosystem services. Abiotic ecosystem services are included between the 4.2.1.1 and 6.3 code of the CICES table, whose current version is at 5.1. In relation to the soil, studies related to an assessment of its abiotic characteristics do not exist.

Another aspect that has been strongly studied by researchers in relation to the soil has been the introduction of labels. The increase in consumer awareness of the damage to health caused by using unsustainable cultivation techniques has led to the introduction of labels certifying environmentally-friendly products (Mazzocchi et al., 2019). In fact, recent studies have shown that consumers are willing to pay for products that use sustainable production practices (Chen et al., 2018; Pomarici et al., 2018; Lazzarini et al., 2018; Mazzocchi et al., 2019) and ensure high environmental quality (Aderighi et al., 2016). These studies report that consumers are willing to pay an extra 16–24% for seafood labels (Vitale et al., 2020) and for products like coffee, apples, chocolate, seafood, and wine that carry an ecolabel (Lovriero et al., 2002; Sorquist et al., 2013; Roheim et al., 2011; Delmas et al., 2014; Vecchio and Annunziata, 2015), which represents a signal of the quality and sustainability of the soil. Again, the literature has focused on the economic value, referring to the market use of this natural resource.

The last aspect of research on the soil is the relationship between its geological characteristics and the quality of the product. This concept, defined as "terroir" is the only one taking into consideration non-economic aspects of soil, but there is a lack of literature on this idea. The idea is that the geographic origin of a particular product influenced the characteristics of an agricultural product (quality, taste, style). It can be defined as an interactive ecosystem, in a given place, including climate, soil and the product (Seguin, 1988). With terroir the soil is able to convey a "sense of place" in the taste of "local food" by mixing the economic, geographical, and cultural aspects of a certain area (Van Leeuwen et al., 2005; Croce and Perri, 2010; Ghersi, 2018).

To fill this gap in studies on the social value and abiotic ecosystem services of the soil, we applied an experimental choice to a sample of 200 people regarding two niche products produced in Liguria: Rotella apples and Moscatello wine. Our goal is to evaluate the social value that consumers give to soil abiotic ecosystem services (geological features).

In the following section we discuss our choice experiment.

Section 3: Choice experiments

As mentioned in the previous section, our goal is to analyze the value given by consumers to soil geological features contained in products. For our work we use two niche products: Rotella apples and Moscatello wine, which are historical cultivars in the territory of Liguria (Italy), whose cultivation techniques are in line with the 15th U.N. SDG. Our goal is to extract the values of the soil's characteristics (such as the analysis of the land, the use of sustainable cultivation techniques, and the place of production) inside these local products that contribute to biodiversity maintenance; if the

value related to these qualities is recognized by consumers, allowing their sale at a higher price, it can serve as an economic incentive for farmers. In other words, products may be described through the abiotic soil ecosystem services embodied in them, and we seek to determine whether consumers realize that they benefit from these services by acknowledging a positive value.

We apply in empirical terms the choice experimental method, whose use is already familiar in the environmental field in relation to the economic valuation of the attributes of environmental goods (especially non-market ones; Holmes et al., 2017). Its increasing use is also related to the advantages it has, which are:

- the possibility of measuring the consumers' willingness to pay thanks to the presence of the price attribute;
- the non-collinearity, in contrast with contingent valuation, of the characteristics because they are exogenous;
- the assessment of the preferences;
- the ease of the method due to the simplicity of the format and the realistic attributes of the experiment.

In the last two decades researchers have applied this method in different fields, such as wildlife, agri-environment, nature conservation schemes, food and food labelling, water resource management, forest management, green energy, environmental pollution, and waste management. In relation to the agri-environmental schemes, researchers have tried to design an environmental policy that can maximize economic benefits to provide policymakers with the information on public preferences related to farmers' preferences, natural habitats, and the social, environmental, and cultural features of landscapes (Birol et al., 2008). Christe et al. (2006) estimated the benefits that the public derives from the conservation of biodiversity and enhancement of farmland in relation to the design of efficient agri-environment/wildlife management schemes. Hanely et al. (2003) instead reported the benefits of conservation of single species. Li et al. (2004) and Bennett and Willis (2007) investigated public preferences to design an efficient and wildlife scheme. In the food and food labelling field, researchers have sought to understand public preferences for the implementation, adaptation, and formation of food policy (i.e., Genetically Modified Organisms). Burton et al. (2001), Lusk et al. (2003), and Carlsson et al. (2007) tried to understand consumers' attitudes toward GMO food, discovered that their willingness to pay (WTP) is high for no GMOs. Moreover, in relation to food, another important field is food labelling; the goal is to understand consumers' willingness to pay for the signal of origin and for the method of production. Scarpa and Del Giudice (2004) and Scarpa et al. (2005) investigated consumers' preferences in relation to the presence of origin certification and geographic origin, reporting that consumers preferred homemade products and origin certification. For water resource management, researchers have examined policy designs for the sustainable allocation of water resources to inform policymakers of the best policy to maximize social welfare. Birol and Cox (2007) estimated consumers' WTP for the conservation of wetland in England; Hanely et al. (2005, 2006a) and Colombo et al. (2005, 2006, 2007) examined public WTP for improvements in water resource quality, while Paulrud and Laitila (2004) analyzed the recreational activities depending on water. In relation to the forest management field, researchers have investigated public preferences for the application of forest policies that support sustainable management and forest biodiversity conservation, as in Lehtonen et al. (2003). Finally, research on green energy management has analyzed the social costs and benefits of alternative renewable energy resources (i.e., wind farms). Alvarez-Farizo and Hanely (2002) and Bergmann et al. (2006) investigated the social costs of constructing wind farms and of renewable energy resource investment. Nevertheless, while the use

of this method is currently widespread, no previous studies have applied it to study the abiotic characteristics/attributes of the soil.

Section 4: Choice experiment design

Our survey was administered to a sample of 200 people who make a choice related to Rotella apples and Moscatello wine with different soil features. Since that it is a pilot study, our sample is not representative of the population and contains few people. In the choice experiment method, the key phase is the identification of the attributes and levels of the natural resources; as defined in the literature, attributes have certain requirements: relevance to the problem in question, credible/realistic, capable of being understood by the sample population, applicable to policy analysis, and independent of each other and their different levels (orthogonality) (Bergmann et al., 2007; Lombardi et al., 2017; Bennett et al., 2001). As underlined in the literature, the number of attributes cannot be too high due to the increase of complexity, while more levels are conducive to a positive impact on response efficiency (Petr et al., 2021). There are several possibilities for identifying them, like a focus group, as in Bergmann et al. (2007), or drawing them from the literature or from the CICES table. In our case, none of these options were feasible given the absence of research on the soil abiotic component and its absence from the CICES table. To cope with this lack, we divided the information into three fields: sustainable use of soil (first and third attributes), soil geological composition information (second attribute), and the capacity, through cultivation techniques, of creating a relationship between soil, product, and inhabitant (fourth attribute). In the end, we chose five attributes for each product:

- use of the soil (2 levels),
- location of the product (2 levels),
- knowledge of the soil (2 levels),
- historical products conservation (3 levels),
- price (4 levels).

Table 1.3 represents the total attributes and the relative levels of our design related to wine (the attributes and levels for apples are the same except for price, which has the levels: 1.2 €, 1.5 €, 2.5 €, 2.7 €). The full possible combinations are defined using STATA software, which calculates 4560 total combinations; from them we eliminate the implausible and dominant alternatives, that is, the choices with low levels of attributes and high price (and vice versa) are eliminated, which reduced the number of combinations to 2840. Our sample comprised 200 of people chosen from among municipal employees, university students, university professors and researchers, volunteers, and the self-employed; their socio-economic characteristics are presented in Table 1.5. To reduce their cognitive weight, we randomly selected 400 combinations for apples and 400 combinations for wine, whereby each person chooses twice for the apple and twice for the wine. Respondents have four choice-tasks attributed randomly, two for each product, in each of which they must choose from three options: A, B, C (status quo options - no buy; Table 1.4). After that, we built two pilot questionnaires through Google Forms, which are divided into three parts:

1. Introduction: We explain the aim of the survey;
2. Socio-economics: We ask respondents for their socio-economic characteristics: gender, age, education level, work, where they usually buy wine and apples, and whether they generally buy these products.
3. Choice task: Respondents choose from three options A, B, C (status quo options).

The questionnaire was sent by mail due to the COVID pandemic during January and February 2021 and, to simplify, we created a specific mail (questionario.suolo1@gmail.com). After receiving the replies, we built two different datasets, one for Rotella apples and the other for Moscatello wine. In Table 1.4 we present an example choice task related to Rotella apples. It can be seen that there are three different choices: Apple A with particular levels of previously defined attributes, Apple B with different ones, and choice C in which people choose neither Apple A nor Apple B but prefer to buy nothing. The same choices are provided for Moscatello wine.

Table 1.3: Attributes related to wine

Use of soil	
The product derives from an unsustainable use of the soil in which fertilizers are used to obtain the maximum yield of the product in terms of quantity. 	The product derives from a sustainable use of the soil without using artificial chemicals but only natural substances: lime, copper, sulfur, and manure, to respect the environment and consumer health. 
Location of the product	
The origin of the product is known only from the geographical point of view. 	The origin of the product is known only from the geographical point of view and you know the rocks that distinguish the area. 
Knowledge of the soil	
The product is grown on soil that is not checked or analyzed. The presence of any toxic elements is unknown; the product will assimilate substances that may be harmful to health human. 	The product is grown on soil that is checked and analyzed to determine the presence of chemical elements potentially toxic to human health. 

Historical product conservation		
The product is not typical of the place where it is grown. 	The product is typical of the place where it is grown. 	The product is a recovery of a local historical cultivar that maintains a link with the past, keeping alive a tradition that links the soil, product, and inhabitants. 

Price	
Rotella apple	**Moscatello wine**
1.2 €	7 €
1.5 €	10 €
2.5 €	13 €
2.7 €	17 €

Table 1.4: example of choice task for people to apple

Apple A	**Apple B**	
		
The product derives from an unsustainable use of the soil in which fertilizers are used to obtain the maximum yield of the product in terms of quantity. 	The product derives from a sustainable use of the soil without using artificial chemicals but only natural substances: lime, copper, sulfur, and manure, to respect the environment and consumer health. 	
The origin of the product is known only from the geographical point of view. 	The origin of the product is known only from the geographical point of view, and you know the rocks that distinguish the area. 	**Neither A nor B**
The product is grown on soil that is not checked or analyzed. The presence of any toxic elements is unknown; the product will assimilate substances that may be harmful to health human. 	The product is grown on soil that is checked and analyzed to determine the presence of chemical elements potentially toxic to human health. 	
The product is not typical of the place where it is grown. 	The product is a recovery of a local historical cultivar that maintains a link with the past, keeping alive a tradition that links the soil, product, and inhabitants. 	
1.50 €/kg	2.50 €/kg	

Section 5: The socio-economic characteristics of the sample

The second part of the questionnaire elicited information on the respondents' socio-economic aspects (age, education level, gender, profession and shopping habits), described in Table 1.5. We can see that our sample is young (due to the percentage higher than 50% of people with an age below of 40), educated and with a presence of more women.

Table 1.5: the sample's socio-economic data

Title	Result
Sex	Female = 64%; male = 35.5%; not specified = 0.5%
Age	16–18 = 0.50%; 18–25 = 34%; 25–40 = 32%; 40–60 = 27%; 60–75 = 6.50%
Education	Middle school diploma = 2%; high school diploma = 31.5%; three-year degree = 20.5%; master's degree and higher (master's and PhD) = 46%
Profession	Self-employed = 0.5%; employee = 10%; student = 12%; retired = 3%; teacher = 2%; other = 73%

Section 6: Basic Theory of Choice Experiments

The basic theoretical foundation of choice experiments is different from traditional microeconomic theory, which views consumers as maximizing their utility subject to their budget constraints. The two basic building blocks are:

- Lancaster's characteristic theory of value (Lancaster, 1966);
- Random Utility Theory (RUT; McFadden, 1974; Manski, 1977).

Under the first, consumers derive their utility in relation to a specific good, not from its consumption but from its characteristics, called "attributes" (Power et al., 2002). The second building block is Random Utility Theory (RUT), for which the utility of each respondent can be divided into two parts: a deterministic part and a stochastic one. The utility of a representative consumer *n* of choosing an alternative *i* can be expressed as follow:

$$U_{in} = V_{in} + \varepsilon_{in} \quad (1)$$

$i = 1 \ldots\ldots\ldots I$

$n = 1 \ldots\ldots\ldots N$

$$V_{in} = x'_{in}\beta$$

where V_{in} is the deterministic part of the utility defined by x'_{in}, which is composed of the alternatives' observable characteristics (attributes) and the characteristics of respondents, β is the unknown coefficient that we want to estimate, and ε_{in} is the random component. Moreover, it is assumed that the respondent chooses the alternative that maximizes his/her utility; in other words, the probability of the respondent choosing an alternative *i* over a choice-set (C_n) is expressed as:

$$P(i/C_n) = P[(V_{in} + \varepsilon_{in}) > (V_{jn} + \varepsilon_{jn})] \qquad i \neq j \qquad (2)$$

Random Utility Models (RUMs) are used to estimate utility, the simplest of which is the Multinomial Logit Model (MNL), which makes many assumptions distant from reality. The first is the Independence of Irrelevant Alternatives (IIA), which means that the addition or subtraction of an

alternative in relation to a particular choice-set will not affect the probability of the individual choosing any other option (Lombardi et al., 2017; Bergmann et al., 2006). This property derives from the independence and homoscedasticity of error terms, distributed as a Gumbel distribution. This implies equal proportional substitution of the alternatives and lacks consideration of the heterogeneity of consumers; in other words, sample people are treated in the same way even though they have different baseline characteristics (Lombardi et al., 2017). In this case the probability of consumer *n* choosing alternative *i* given the choice-set (C_n) is:

$$P_{in} = \frac{\exp(x'_{in}\beta)}{\sum_{j \in C_n} \exp(x'_{jn}\beta)} \qquad i \neq j \qquad (3)$$

With the relaxation of this property, we can take account of the heterogeneity in preferences among respondents, yielding another RUM. In 2000, McFadden and Train introduced the Mixed Multinomial Logit Model (MMNL), which considers the attributes as random variables and not fixed, allowing them to vary across consumers (Hole, 2013). In this case, the probability of individual *n* choosing alternative *i* is expressed as follow:

$$P_{in} = \int \frac{\exp(x'_{in}\beta)}{\sum_{j \in C_n} \exp(x'_{jn}\beta)} \mathrm{f}(\beta|\theta) d\beta \qquad i \neq j \qquad (4)$$

where $f(\beta|\theta)$ is the density function of the parameter, arising due to the fact that different consumers can have different preferences, and θ is the parameter of the distribution; generally, the usual distribution chosen is normal (Hole, 2013).

Another model that applies consumers' heterogeneity in preferences is the Latent Class Model (LCM), in which the distribution of parameters is not continuous but discrete; in fact, LCM assumes that each respondent belongs to a specific class *q*; the respondents' preferences vary across and not within classes (Junyi Shen, 2009; Pacifico et al., 2013). It is easy to understand that this model is a mix between the multinomial conditional model and MMNL because we have number of parameters that vary between classes but are homogenous within them. In this model, the probability that an individual *n* belonging to class *q* chooses alternative *i* is:

$$P_{in}|q = \frac{\exp(\beta'_q x'_{in})}{\sum \exp(\beta'_q x'_{jn})} \qquad i \neq j \qquad q = 1 \ldots\ldots\ldots\ldots\ldots Q \qquad (5)$$

The goal of our work is to estimate the unknown parameters of the soil's geological attributes and calculate the relative odds ratio, in order to capture how the abiotic characteristics of the soil impact consumers' utility through the Mixed Multinomial Logit and Latent Class models; we do not apply the conditional logit model (MNL) due to its too restrictive assumptions.

Section 7: Results and Discussion

In the following section we provide the results of the estimation of the Mixed Multinomial Logit Model (MMNL) and the Latent Class Model (LCM), made with STATA software. We report the estimation of the coefficient in the following figure, using the coefplot function. Our samples consist in total of 400 observations because the respondents made two different choice occasions for each product (2 for the apple and 2 for the wine); for simplicity, we create two different databases, one for the wine and one for the apple. To check whether respondents' socio-economic features influenced their choice, we introduced them into both estimations but none of them were significant, so we do not report the results. We assume that the consumers' choice is made in the short-term, so the alternative C (of no-buy option) implies a utility equal to 0 and the relative utility of the attributes are 0. Figure 1.1 provides the results for the Moscatello wine MMNL coefficients. The coefficient signs show the influence of the attributes on choice probabilities. All attribute coefficients have the expected signs: the use of the soil (a), the location of the product (b), the knowledge of the soil (c), the historical products conservation (d), and constant (no buy) are significant and positive, indicating a positive impact on respondents' utility. Only the price coefficient is positive (e), contrary to economic theory, and not significant, due to its position near the 0 red line. These results underline that consumer recognized a positive value of the soil's abiotic features on product choice. In the same figure are shown the standard deviations for the two attributes, which are randomly and normally distributed (use of soil and historical products conservation); both of them are significant, which means that the heterogeneity preferences of consumers may be represented by a normal distribution. Table 1.6 provides the same results in term of odds ratio; all attributes except price are significant and positive, meaning that all of them except the price have a positive impact on respondents' probability of choosing Moscatello wine with a unit increase in their value. The use of soil odd ratio is 11.85, so a unit increment of its level yields an increase of 11.85% in the probability of choosing that wine by consumers; that for location of soil is 2.70, knowledge of the soil is 8.50, and historical product conservation is 1.54. Also, in this case we can see that all attributes make a positive contribution to the respondents' utility.

In Figure 1.2 we report the results for the coefficients of the Latent Class Model of Moscatello wine to examine whether there is some difference between consumers; in fact, with this model, the sample is divided into two different groups with the homogenous preferences, and the heterogeneity is between the two classes but not within them. Class 1 includes 57.5% of the sample people and Class 2 42.5%. The results for the first class are very similar to those of the previous MMNL because all attributes are positive and significant for the consumers' utility except price, whose coefficient is positive and not significant. Class 2 has completely different results: the price coefficient is negative, as predicted by economic theory, but not significant; the first attribute (a) is positive and significant, so it makes a positive contribution to the respondents' probability of choosing that wine, the second and fourth have a negative impact on consumers' utility, and the coefficient for knowledge of the soil is positive but not significant. Table 1.7 presents the results for the odds ratios for wine, confirming the patterns shown in Figure 1.2. The odds ratio of Class 1 indicates a positive and significant impact except for price of all attributes on consumers' utility. Class 2 has a different impact on utility: the third attribute and the price have a non-significant impact, while the first, second, and fourth ones have a significantly positive but low impact on consumers' utility. From these results we can understand the presence of the heterogeneity of the preferences of consumers in relation to Moscatello wine.

Figure 1.1: MMNL of Moscatello wine

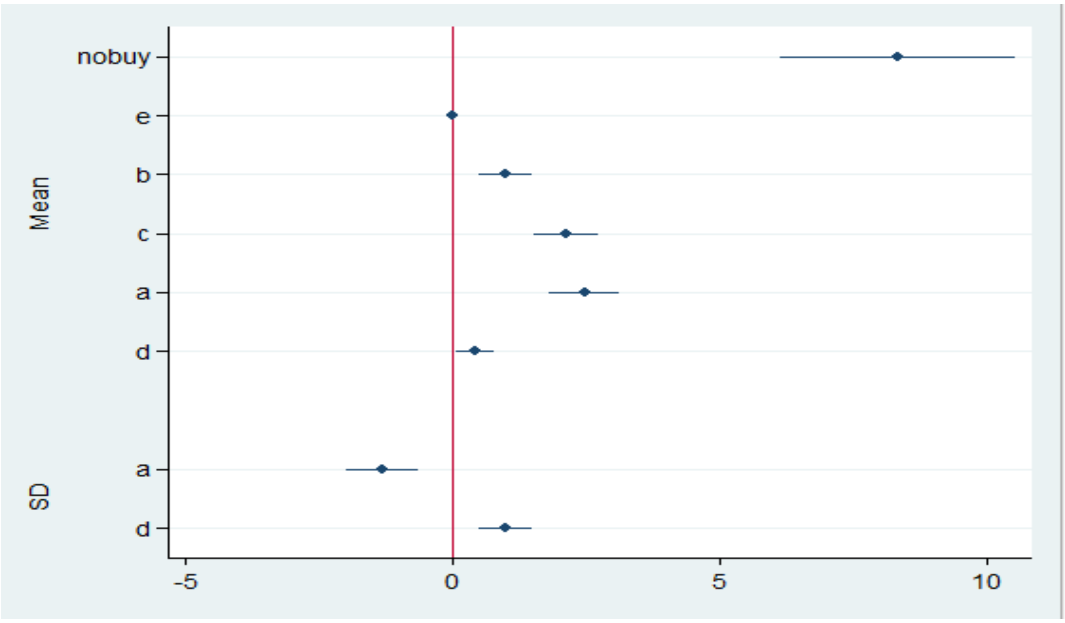


Table 1.6: Odds ratios for the Moscatello wine MMNL

Parameters	**Estimate**	**Std.Error**	**Pr>|t|**
Mean			
No buy	4177.33	4661.26	0.00***
Use of soil	11.85	3.89	0.00***
Location of soil	2.70	6.68	0.00***
Knowledge of soil	8.50	2.59	0.00***
Historical product conservation	1.54	0.28	0.01**
Price	1.01	0.03	0.65
SD			
Use of soil	0.27	0.09	0.00***
Historical product conservation	2.69	0.69	0.00***

***Statistically significant at 1%, ** Statistically significant at 5%, * Statistically significant at 10%

Figure 1.2: Lclogit for Moscatello wine

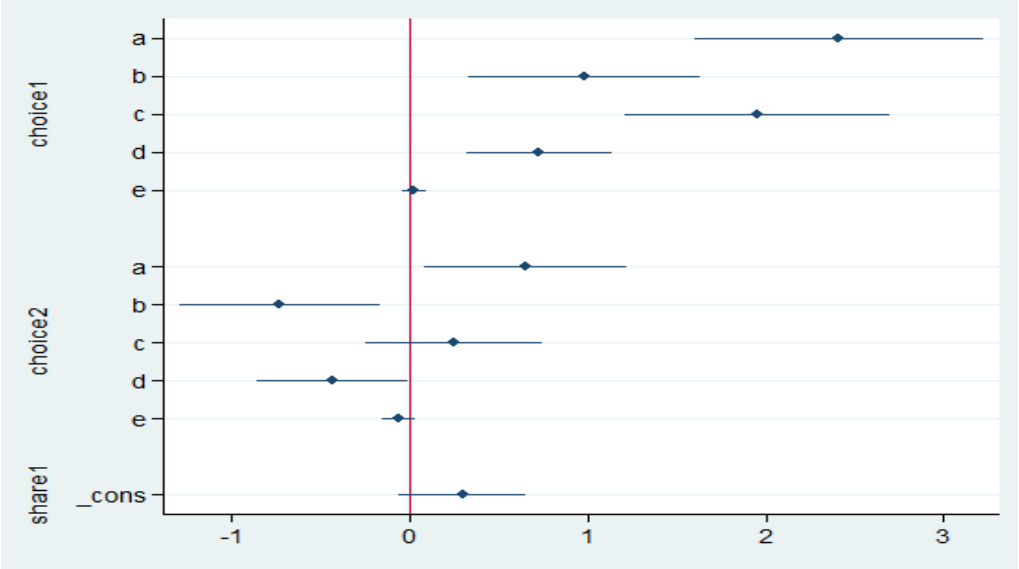


Table 1.7: Odds ratio for the Moscatello wine Lclogit

Parameters	**OR**	**Std.Error**	***p*-value**
Class 1 (57.5%)			
Use of soil	11.13	4.59	0.00***
Location of soil	2.67	0.88	0.00***
Knowledge of soil	7.01	2.65	0.00***
Historical product conservation	2.07	0.43	0.00***
Price	1.02	0.03	0.41
Class 2 (42.5%)			
Use of soil	1.92	0.55	0.02
Location of soil	0.49	0.13	0.01
Knowledge of soil	1.28	0.32	0.32
Historical product conservation	0.64	0.14	0.04
Price	0.94	0.04	0.26
No buy	1.35	0.24	0.09

***Statistically significant at 1%, ** Statistically significant at 5%, * Statistically significant at 10%

For Rotella apples we apply the same models. Figure 1.3 reports the estimation of the MMNL coefficients. In general, the signs of the attributes are in line with our expectations. Price and the location of the soil are not significant, falling on the 0-red line of the plot. The use of the soil, knowledge of the soil, and historical product conservation have a positive and significant impact on consumers' choice probability. This means that consumers recognize the abiotic ecosystem services of soil contained in the products (a = 1.09, d = 0.61, c = 1.93). Also, in this case the heterogeneity of the preferences is distributed normally due to the significance of the standard deviations of the first and the fourth attributes, which are randomly distributed. Table 1.8 presents the estimations of the relative odds ratio. Price and location of the soil do not contribute to respondents' utility, being non-

significant. The odds ratio for the use of the soil is 8.12, meaning that a unit increment of the level of the attribute yields an increase in the consumers' probability of choosing that apple of 8.12%; we can apply the same logic to the other attributes, yielding a value for knowledge of the soil of 6.90 and for historical product conservation of 1.84. Also, in this case we apply the Latent Class Model with two different classes. The first comprises 50.50% of the sample, while the second comprises 49.5%. Figure 1.4 reports the results. In this case, it is clear that the results for the first class are very similar to the results of MMNL with the price coefficient negative and not significant and location of the soil not significant for consumers' utility, while the other factors have a positive significant impact on respondents' utility. In Class 2, the use of the soil, price, and historical product conservation do not significantly affect utility, while the effect of the location of the soil is negative and significant (−0.80), and that of the knowledge of the soil is positive and significant (0.74). In Table 1.9 we provide the results for the odds ratio, giving the same results as in Figure 1.4. Class 1 shows a non-significant effect of price and location of the soil, while the use of the soil has a coefficient of 22.36 and is significant; this means that a unit increment of the attribute level leads to an increase of 22.36% in respondents' probability of choosing the alternative of apple among those in Class 1. Also, the knowledge of the soil and the historical product conservation are positive and significant (8.06, 2.96). In Class 2, use of the soil, historical product conservation, and price do not have significant effects, while the odds ratio for location of the soil and historical product conservation are 0.44 and 0.74, respectively, and significant.

Figure 1. 3: MMNL for Rotella apple

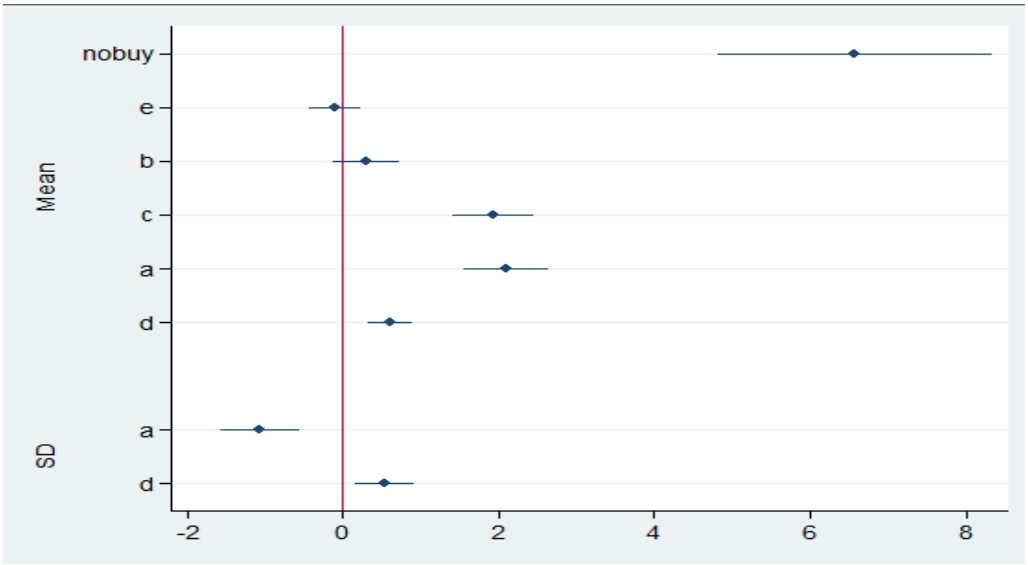


Table 1.8: Odds ratio for the Rotella apple MMNL

Mean			
Parameters	**O.R.**	**Std.Error**	***p*-value**
No buy	719.01	644.06	0.00***
Use of soil	8.12	2.22	0.00***
Location of soil	1.35	0.29	0.16
Knowledge of soil	6.90	1.80	0.00***

Historical product conservation	1.84	0.26	0.00***
Price	0.90	0.15	0.54
SD			
Use of soil	0.34	0.08	0.00***
Historical product conservation	0.17	0.33	0.01**

***Statistically significant at 1%, ** Statistically significant at 5%, * Statistically significant at 10%

Figure 1.4: LCM for Rotella apple

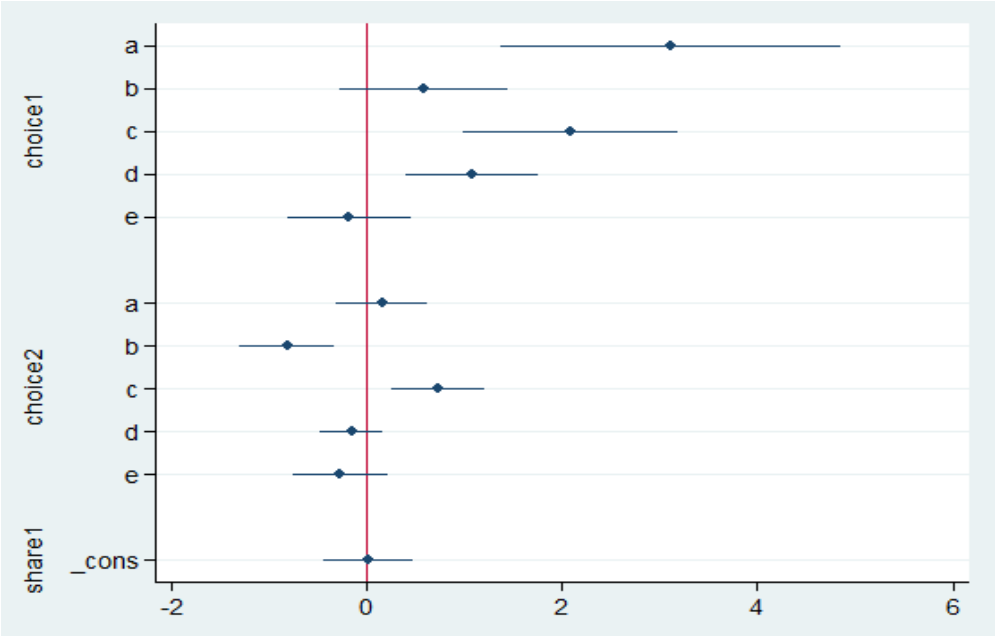


Table 1.9: Odds ratio of Rotella apple LCM

Parameters	**OR**	**Std.Error**	***t*-value**
Class 1 (50.5%)			
Use of soil	22.36	19.80	0.00***
Location of soil	1.79	0.78	0.18
Knowledge of soil	8.06	4.49	0.00***
Historical product conservation	2.96	1.02	0.00***
Price	0.83	0.27	0.58
Class 2 (49.5%)			
Use of soil	1.17	0.27	0.49
Location of soil	0.44	0.11	0.00***
Knowledge of soil	0.74	0.24	0.00***
Historical product conservation	0.85	0.14	0.35
Price	0.76	0.18	0.28
No buy	1.01	0.23	0.94

***Statistically significant at 1%, ** Statistically significant at 5%, * Statistically significant at 10%

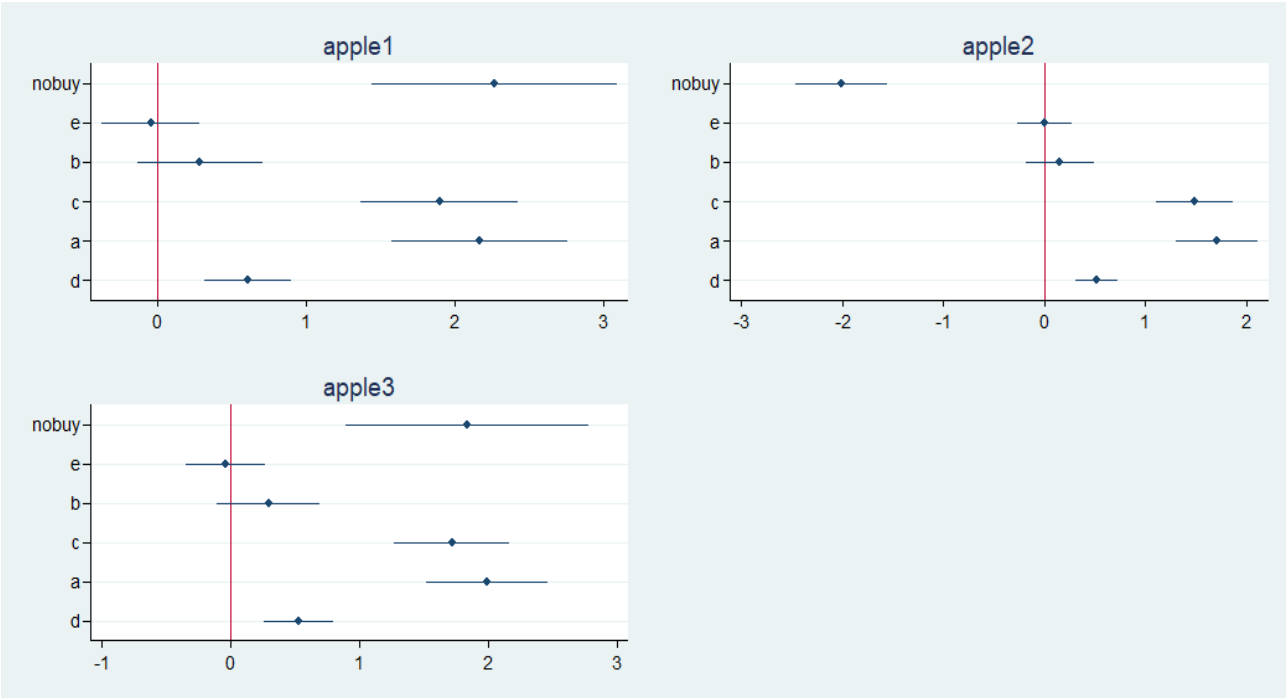
Section 8: Robustness of the results

In the previous section we assumed for simplicity that the alternative C (no buy) has a utility equal to 0 (a standard approach in choice experiments). In other words, there is a no-utility attribute related to no-buy option. However, a choice must have a utility, otherwise nobody would choose it; in fact, as we can see from the previous section, the coefficient value of the constant is different from 0 and in fact rather high. This suggests that the respondents give an intrinsic value to the no-choice option, making our first hypothesis of 0 utility doubtful. In this section we modify this assumption, imagining that the consumers making a no-buy choice plan to buy wine and apples in the future that are different from A or B, but with qualities comparable to and different from the previous attributes. In their opinion, they already buy products with qualities related to these attributes without having those specific labels. Moreover, this choice is not explained by the respondents' socio-economic characteristics because their estimated coefficients are not significantly different from zero. Another implication of utility attribute variation is a time trend. Generally, with utility attributes equal to 0, consumers make a choice in the very short term, but with this change we suppose that consumers have a utility from the no-buy option different from 0, leading them to make a choice in the long term. In this section we re-estimate the Mixed Multinomial Logit Model for Moscatello wine and for Rotella apples in relation to no-buy with the following assumptions:

1) The utility attributes are equal to 1 for the use of soil, location of soil, knowledge of soil, and historical product conservation and equal to the low level of the price; in other words, a person who does not purchase the product plans to later buy a product with the lowest level of all attributes;
2) the utility attributes are equal to 2 for the use of soil, location of soil, knowledge of soil, and historical product conservation and equal to the low level of the price; and
3) the utility attributes are equal to 2 for the first and second and 0 for the other two, while the price is at the low level.

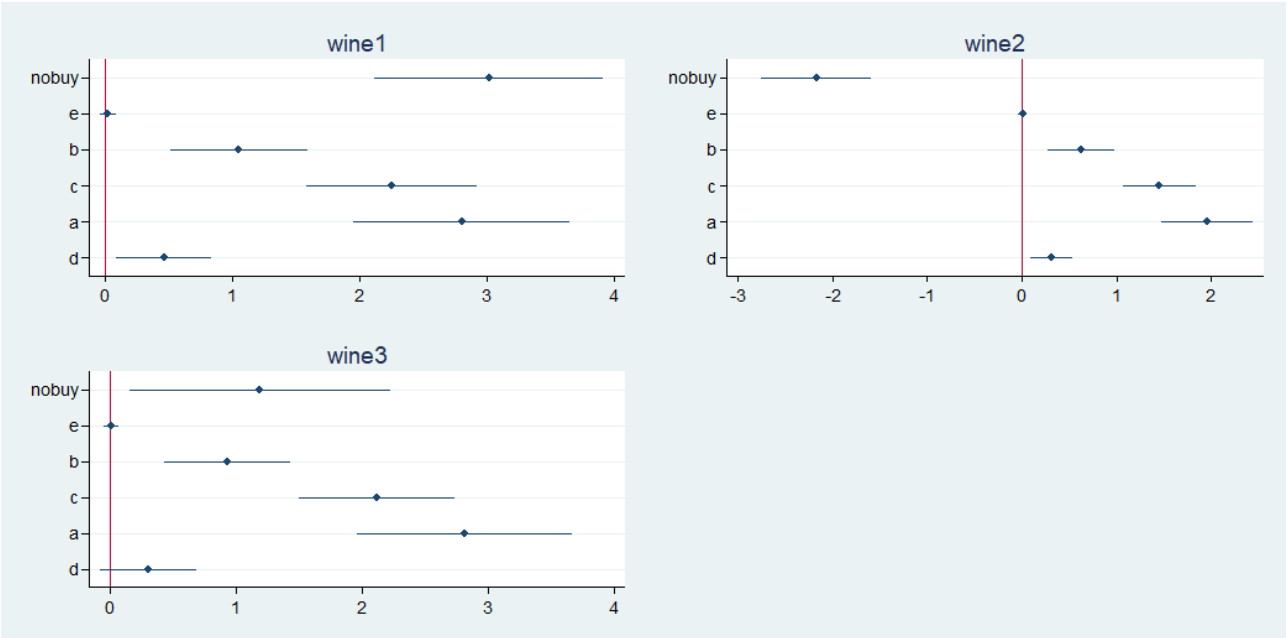
Figure 1.5 reports the results for the MMNL of Rotella apples under the above assumptions. In the figures below we report the estimates of MMNL for Rotella apples by inserting the previous assumptions (with apple1 we indicate the estimate with the assumptions of point 1, apple2 for point 2, and apple3 for point 3). The constant gradually diminishes: For apple 1 it is below 3, starting from a value of the previous section of 6.57; for apple 2 it is negative; and for apple 3 it is below 2. This means that the intrinsic value of the no-buy option decreases.

Figure 1.5: Rotella apple graphs



The results for Moscatello wine are similar; Figure 1.6 shows that the first MMNL estimates a constant with a value lower than in the previous case (8.33); now its value is slightly above 3. The second model has a negative constant, while for the third it is slightly above 1. For Rotella apples the consumers who choose alternative C have a low utility from the no-buy option. These results confirm our expectation that with the variation of the assumptions regarding the utility attributes for the no-buy alternative, consumers recognized an intrinsic value to this choice lower than in the previous case.

Figure 1. 6: Moscatello wine graphs



Section 9: Conclusion

This paper is a pilot study of soil abiotic ecosystem services social value estimation. The total presence of studies related to the market value estimation of soil biotic features pushed us to cover this lack and apply this study. The innovation of our work is related to the topic that no one has previously studied. We used a choice experimental method in relation to two niche products Rotella apple and Moscatello wine submitting a questionnaire to a sample of 200 consumers using two different methods: Mixed Multinomial Logit Model and the Latent Class Model. In general, the results of the estimation of the attributes with the first method underline a positive social value that people give to the soil abiotic features, both for wine and apple, in other words the presence of the higher-level attributes in the products increase consumers' utility. But, with the second method, two different groups are identified for both products: the first one which is similar to the previous one that give a positive social value to the soil abiotic characteristics and the second one that give a negative and non-significant value to them. This may primarily reflect that our questionnaire design was misinterpreted or poorly constructed and should be improve. Another strange result is the non-significance of the price. This can be explained by different reasons, such as the presence of a hypothetical price, the way the questionnaire was constructed, the attributes chosen, and the high-level knowledge of respondents related to these natural resources, which is associated with the higher probability of attendance to the non-cost attributes (Sandorf et al., 2017). These finding are significant for policymakers, in fact, consumers are able to pay a higher price for products that contain a better level of soil's abiotic features; this means that policymakers should try to encourage these feelings through an economic sustain of firms which are in line with sustainable cultivation techniques and, moreover, increase the sensibilization of the soil's importance thanks to local events. Since that it is a pilot study there are limitations derived from the total lack of previous studies related to this topic, that we try to remove in future developments. As we said previously, our questionnaire has to be redefined maybe through: the changing of the attributes, improving the initial presentation, introducing a major explanation of the soil and its related features. Moreover, our sample is not representative of the population, presenting a too low size; this creates bias related to the precision and clarity of results. For this reason, another future improvement is the increase of our sample size.

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CHAPTER 2

MARKET-ORIENTED GOVERNANCE STRATEGIES FOR RECOGNIZED THE SOCIAL VALUE OF RURAL AREAS' FIRMS PRODUCTS. AN ANALYSIS THROUGH POSET AND MULTICRITERIA TOOLS.

Abstract

Agriculture is one of the sectors most affected by extreme climate events but also one of the responsible of climate change due to its emissions. Rural areas firms' have a central role in the process of ecological transition thanks to sustainable agriculture, but their features relegate them to marginal conditions. Current public policies (subsides, regulation and taxes) have incentivized their conditions by not considering the possibility of introducing market policies capable of economically enhancing of their products. In this work we provide to policymakers a classification of market-oriented governance strategies related to the management of rural areas' firms, given by different type of stakeholders. Using a new tool for environmental analysis, POSET, we analyze the supply side of 43 rural areas' firms situated in Liguria Region, in relation to their economic, ecological and market performance. After that, still using POSET and the multicriteria analysis, we involve 59 stakeholders that give their classification in relation to the best market-oriented governance tools that can improve the economic sustainability of these firms. These results provide information to policymakers related to the best market-oriented governance instruments necessary for the economic sustainability of these very important firms for the ecological transition.

Section 1: introduction

Climate change and global warming have a growing attention in policy debate. Social awareness related to their negative impacts and the concerns about human activities emissions pushed countries taking actions to reduce and mitigate their relative damages (Lombardi et al., 2017). E.U. signed Strategies (such as Green Deal, European Biodiversity Strategy, Farm to Fork, Paris Agreement, SDGs) with the aim to achieve the climate neutrality by 2050, reduce the 55% of emission by 2030 (Paris Agreement) and promoted summits (as G20 of 2021). Despite this, global warming continues causing, as one of the most visible consequences, an increment of extreme climate events which have terrible impact in human and economic terms. The economic losses in E.U. are quantified in 12 billion of euros; Italy, which is the country with the highest risk of flood and landslides in Mediterranean area, sustained an economic cost for extreme climate events of € 20.3 billion of euros and a cost in human deaths of 1670 during the last 50 years (European Commission, 2021; Greenpeace, 2021).

To contrast this situation, E.U. called governments to apply adaptation and mitigation policies with the goal to reach the transition versus a sustainable economy (European Commission, 2021). Also U.N. in the 17 Sustainable Development Goals identified two targets refired to them: the 11th, named sustainable cities and communities, that is the mitigation goal and the 13th, called fight against the climate change, which is the adaptation goal (Avsis, 2021). In 2018 nearly all European countries have adopted the National Adaptation Strategy to Climate Change but despite this we are still distance from the 55% reduction's emissions by 2030 and from climate neutrality (Euro-Mediterranean Centre of climate change, 2020).

Starting from that, we analyze the impact in economic term of climate change on rural areas firms' which have a central role in relation to ecological transition whose actual public policies relegate in marginal conditions. If things do not change, the risk is the loosing of a valid contribution for climate neutrality. With this work we give information to policymakers in relation to the best market-oriented governance strategies applicable to these firms in order to improve the competitiveness of their products. Using two different tools, POSET (new for socio-economic field) and multicriteria analysis, we provide a classification of 43 rural areas' firms, situated in Liguria region, related to three different sustainability indicator (ecological, economic and market) and a classification of market-oriented governance tools given by 59 stakeholders.

This work is organized as follow: Section 2 presents the condition of agriculture and mountain farming; Section 3 illustrates the data and firms of our project; in Section 4-5 we introduce the theory related to POSET; Section 6 results and discussion are analyzed; Section 7 introduces the results related to the classification of market-oriented policies and in Section 8 there is the conclusion.

Section 2: Agriculture and mountain farming

Agriculture is one of the sectors most affected by climate change. Extreme climate events influence crop yields and livestock productivity in E.U., provoking a reduction of crops productivity in long term (E.C., 2021). This sector is also one of the main drivers of global warming due to its emission of carbon dioxide, methane (5% of total E.U. GHG emissions) and nitrous oxide especially by intensive agriculture (4.3% of total E.U. GHG emissions) (Lombardi et al., 2017; Mastrojeni, 2021). According to the European Environmental Agency in 2016 agriculture GHG emissions account for 12% while livestock is responsible for 50% of total agriculture emissions (CAP 2023-2027). Food chain produces emissions in its all stages from farmers to waste disposal; it accounts for 31% of the total GHG production in Europe (Lombardi et al., 2017).

But not all agriculture sectors have a negative impact on sustainability transition, in fact, agriculture and mountain farming provide a positive contribution to environment (Euricse, 2013). With their traditional extensive techniques, they contribute to the:

- prevention of biodiversity and soil erosion (Marini et al., 2009),
- mitigation to climate change,
- fight against global warming and hydrological risk,
- promotion of ecological resilience thanks to their heterogeneity.

Moreover, these sectors produce high quality products, absorb carbon dioxide through pastures and forests, produce energy in sustainable way, minimize the impact on environment, satisfy the food security and the animal well-being (Euricse, 2013). But these realities present particular features; most of these firms are small, family-run and are situated in rural areas in which there is a lack of public services provision and poor access to infrastructure and communication; the agriculture or farming is the sole source of income, that depends totally on public subsidies, and their marginal profit is low (Salvioni et al., 2014; Shucksmith et al., 2011). Their ecosystem is fragile and highly vulnerable to climate change, for this reason the application of mitigation and adaption policies is fundamental (Euricse, 2013). Due to the environmental conditions, labor costs are high; many studies demonstrated that firms in mountain and hills have higher costs than ones in lowland (Euricse, 2013). Moreover, another very worried situation is the demographic context, due to the high percentage of ageing people (Shucksmith et al., 2011). These conditions increase the risk of rural areas abandonment with consequent losing of an especially important contribution for ecological transition.

As underlined by International Organizations, rural areas play a key role in archiving Green Deal and E.U.'s Green and ecological transition. Thanks to their protection, use and management of natural resources, they preserve biodiversity and provide the ecosystem services necessary for the society; in other words, they have a significant role in making E.U. first climate neutral continent by 2050 thanks to their sustainable agriculture and production techniques (European Commission, 2020). But, despite that, the majority of rural areas' firms are still in marginal condition with a low economic sustainability and market accessibility; this situation is caused by inefficacy public policies (like subsidies and regulation), applied still today, which not valorized firms' products in economic term and not improving their economic and market competition.

In this context local governance has a central role in avoid rural areas abandonment; a solution could be represented by the introduction of market tools also for the governance of these firms, valorizing the qualities of their products on market. To do this, policymakers should obtain information and data related to these geographical realities through projects. Liguria region, in the north of Italy, is a good example. It promoted two different projects, called CAMBIOVIA and BIODIVALP, whose goals are: the valorization of biodiversity and alpine ecosystems through a participative governance, share of knowledge related to biodiversity, the experimentation of sustainable economic models based on environmental qualities, the economic sustainability of small producers to incentivize them to continue their business avoiding rural areas abandonment. This is a case of participative and integrate governance that comprehend different territories like Liguria, Piemonte and Valle d'Aosta Region, Gran Paradiso National Park, Asters-CEN74 and the Ècrins National Park.

In presence of these types of data, to give synthetic information, are usually used composite indicators ignoring the multidimensional nature and the incomparability of data. For this reason, a new instrument is used: the POSET (Partially Order Set). POSET is an initial stage tool in socio-economic field that overcome the limitation of aggregative approaches.

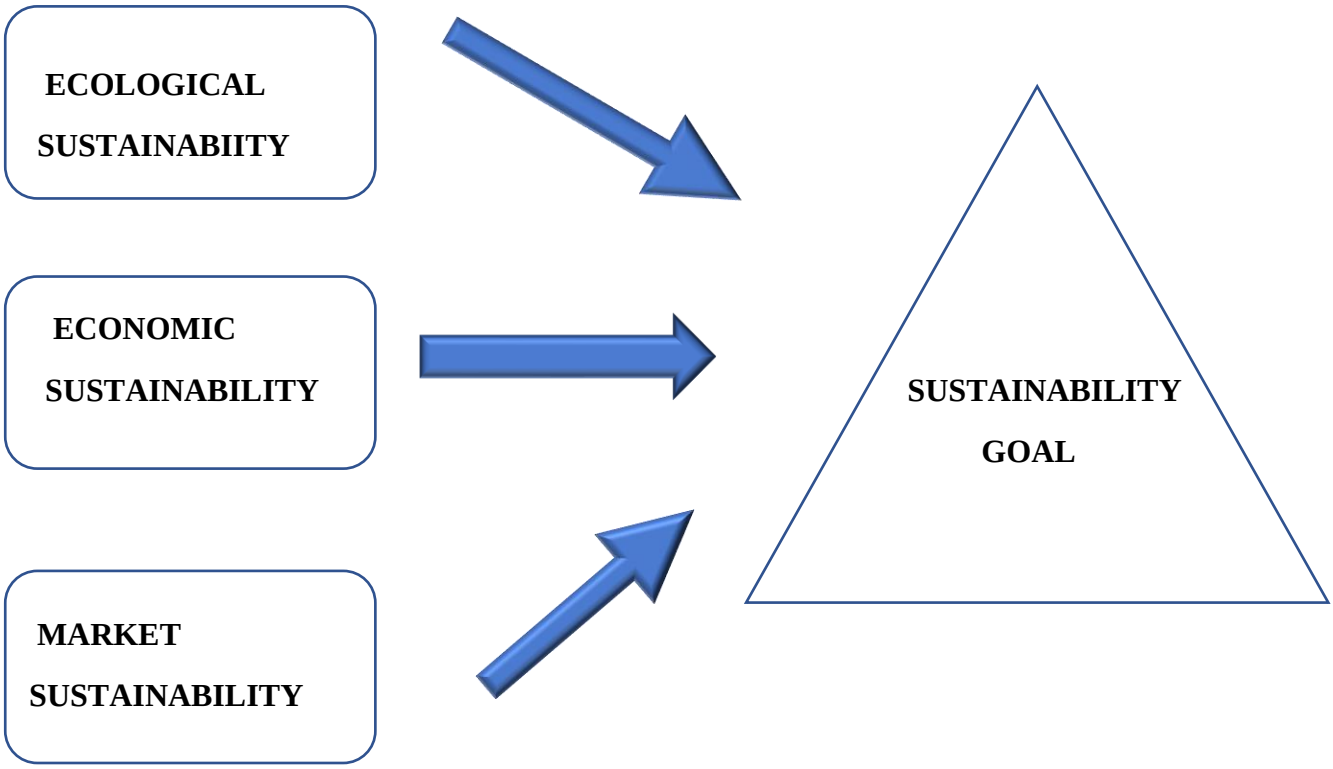
With this method and starting from the previous projects, we provide to policymakers information to define which are the best market strategies for the economic sustainability improvement of rural areas' firms. Their goal is the economic valorization of firms' products to improve their economic and market competition through market policies. To do this, we start from firms' supply analysis, understanding their situation in relation to economic sustainability, ecological sustainability and market sustainability performance through POSET. After that, involving other stakeholders, we obtain a classification of the governance strategies, through a multicriteria analysis, that improve the economic sustainability of these firms and in which governance should invest. This method allows us to identify these strategies with more disclosure.

We divided our work into two different analyses; the first one is related to the supply side description of firms', in term of three different sustainability performance (ecological, economic and market) (Fig. 2.1) thanks to which we can classify for each indicator, 43 rural areas' firms of Liguria Region, using POSET method. These firms are selected from nearly 50 ones that make their activity in rural areas. Considering the relation between firms and territory and the role in biodiversity maintenance of each firm, we selected 43 firms that belong to different sectors: cattle and sheep breeding, dairy farming and beekeeping. From this analysis has been defined a SWOT (strengths, weaknesses, opportunities and threats) which is the base of the second part; involving other stakeholders it has defined the classification of governance strategies through a multicriteria analysis. These firms participated to the two previous mention Liguria Projects. We choose Liguria because it represents a very interesting case study; in fact, in addition to begin an extraordinary container of biodiversity, the regional production of agricultural goods and services grew in value in 2019 by 9% compared to the

previous year and testifies an innovative process in progress that is leading agriculture to become a fundamental part of the economy and society, especially in rural areas (CREA, 2021).

The originality of this project is related to application of POSET for socio-economic field to a sustainability problem; none before us used this method for this field. We give information to policymakers using a non-compensative tool which take in account the multidimensionality of data and their different nature.

Figure 2. 1: Our three indicators of sustainability goal



Section 3: Data analysis

In the following section we describe data used in our project. As we said previously our goal is to define a classification of governance strategies that can improve the economic sustainability of our firms, through market policies. They are 43 firms (agritourism, beekeepers and farms related to cattle, sheep and dairy farming) placed in rural context of the Regional Natural Park of the Antola, Aveto, Beigua and Alpi Liguri, Val Bormida and Val Vara in Liguria Region, that participated to two European projects, CAMBIOVIA and BIODIVALP. To understand the positive and negative factors that contribute to firms' economic sustainability, we apply a supply analysis. First, we submitted to these firms an interview, made by self-reported data, divided into four parts:

1. demographic,
2. ecological,
3. economic (self-reported),

4. development directions and critical issues.

From their answers, we extracted the firms' strengths, weaknesses, opportunities and threats (SWOT). Firms' weaknesses are related to economic sustainability, all firms underlined problems in relation to: management control, product quality and production process, marketing and communication, sales channels distribution and innovation technology. This information permits us to introduce these problems as criteria in a multicriteria tree represented in fig. 2.2 that use we explain in the following sections. Moreover, from the same information, we obtain firms' classification in relation to three different sustainability indicators (ecological, economic and market). Each of these three indicators are summarized by attributes/variables that come from interviews, as we can see in table 2.1. In particular, the ecological sustainability is made by:

1) the time spent in grazing areas,
2) independently produced hay,
3) feed with organic certification,
4) are the grazing areas inside the park?

We decided to use these variables in order to analyze ecological indicator due to the features of these firms. They are small firms and are agriculture and mountain farming, so their ecological contribution must be valued through the activities that they can do which are summarized by the previous ones (as time spent in grazing areas, the type of feed uses for their animals and so on…). Higher are the results of the previous variables higher is the performance in ecological sustainability term; if firms spend more time in grazing areas and if they are inside the park, this means that the feed of animals is natural, uncontaminated and more control. If firms give to their animals feed with organic certification, they do not incentivize intensive production and increase the quality of the product for their animals. The same logic is for the independently produced hay. From the firms' responses we see that the situation of ecological sustainability is good; we know that 23% of firms never spent time in grazing areas, 12% from 1 to 5 months, 47% from 6 to 11 months and 19% always. 28% of firms no produce hay by their own, 26% up to 50%, 42% produce more than 50% of independently hay and 5%. In relation to the feed with organic certification 79% of firms declared its using while the 19% no. Finally, 56% of firms use the grazing areas inside the park while the 44% not.

The economic sustainability is summarized by:

1) investment in the last 5 years,
2) adherence to brands and principals or possession of its own logo and / or presence in a cooperative and / or presence in a consortium,
3) sufficient profit margins,
4) interest in increasing turnover by increasing production and sales and / or interest in selling in high quality markets at higher prices without increasing production in a sustainable way,
5) absence financial resources,
6) absence of entrepreneurial skills (i.e. lack of knowledge required to further develop the business),
7) difficulty in accessing credit,
8) use of RDP (Rural Development Plan).

We decided to use these indicators because they represent the economic sustainability in long and short run for these firms. The first, second and fourth ones imply economic sustainability in long-term, in fact, only if the firms have prospective of economic stability and growth, they are willing to: invest and increase their production, increase the quality of the products, adhere to brands,

cooperative or consortium which are the only possibility for these firms to apply economy of scale. Sufficient profit margins, absence of financial resources and entrepreneurial skills, difficulty in accessing credit represent conditions for short-term economic sustainability; in fact, if there is a lack of financial resources, also due to the difficulty in accessing credit, and insufficient profit margins, firms will have problems in production activity. The absence of entrepreneurial skills implies a lack of future improvement and development of firms also in economic term due to the lack of knowledge required to further develop the business. From economic point of view the situation is not so good. The 40% of firms declared that they do not invest in the last 5 years while the rest 60% make investment; the same percentage is for adherence to brands/logo, consortium/cooperatives, 60% declared that they are not in consortium/cooperatives, brands/logo while the other 40% have at least one of them. 28% of firms declared to not have a sufficient margin profit, 26% perhaps and the 47% have a sufficient margin profit. In relation to the interest in increasing turnover by increasing production and sales and / or interest in selling in high quality markets at higher prices without increasing production in a sustainable way the 14% of firms declared no interest in anything, another 14% are interested in at least one of two cases and the rest 70% in both. 47% of firms declared to not have absence of financial resources the rest 53% have problems in them. The 81% of firms have entrepreneurial skills while the rest 19% not. For the accessing credit the 79% have problem in accessing to it while the rest 19% not. The 79% of firms use Rural Development Plan while the other 5% not.

Finally, the market sustainability is composed by:

1) sales channels divided into: channel A (direct sales), channel B (sale at local fairs and markets and / or sale at local shops and / or sale at municipal fairs and markets and / or sale at provincial fairs and markets), channel C (sale to local restaurants and in the city and / or sale to large-scale distribution;
2) problems related to roads and infrastructure,
3) expensive and too demanding distribution,
4) ownership of site and/or active social pages.

To reach the market sustainability there must be certain conditions: the costs of distribution must be low; there have to be infrastructure and roads to reach different sales channels; use IT channels in order to reach major number of people. Naturally, more sales channels, low problems with infrastructures, low distribution costs and the ownership of sites and social pages imply higher market sustainability. For the sales channel 23% of firms sale at only one channel, 37% at 2 channels and 40% to three. 53% of firms declared to not have problems related to roads and infrastructure and the rest 47% yes; 65% of firms declared that the distribution is too expensive and too demanding while the rest 35% not. Finally, 30% have not a social page or a site, 35% have at least one and 35% have both. From firms answer we are able to extract the strengths, weaknesses, opportunities and threats of firms; in particular, in relation to the strengths we define a multicriteria tree which is the starting point for the identification of the best market oriented governance strategy.

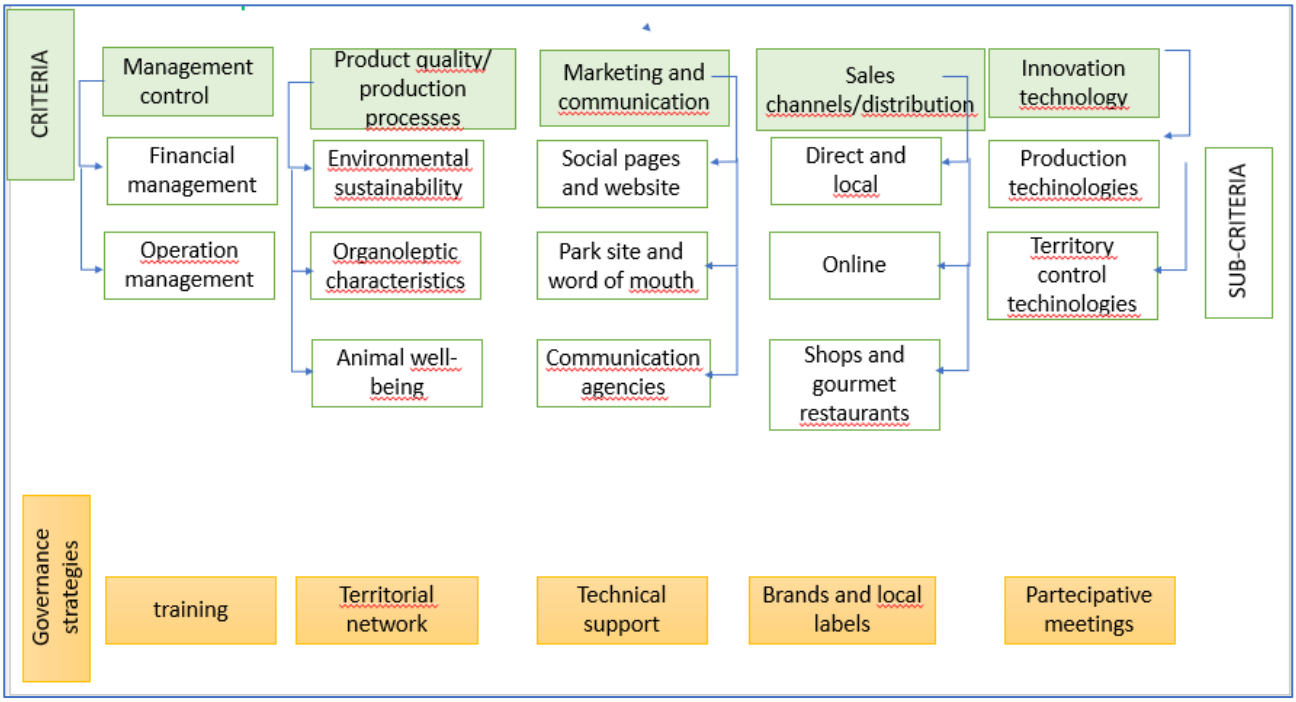
Table 2.1: Summary of the sustainability indicators

ECOLOGICAL SUSTAINABILITY	
the time spent in grazing areas	0-Never 1-from 1 to 5 months 2-from 6 to 11 months 3-always 4-n.d.

independently produced hay	0-no 1-upto 50% 2-more than 50% 3-n.d.
feed with organic certification	0-no 1-yes 2-n.d.
are the grazing areas inside the park?	0-no 1-yes 2-n.d.
ECONOMIC SUSTAINABILITY	
investment in the last 5 years	0-no 1-yes 2-n.d.
adherence to brands and principals or possession of its own logo and / or presence in a cooperative and / or presence in a consortium	0-Nothihg 1-at least one 2-n.d.
sufficient profit margins	0-no 1-perhaps 2-yes 3-n.d.
interest in increasing turnover by increasing production and sales and / or interest in selling in high quality markets at higher prices without increasing production in a sustainable way	0-nothing 1-in at least one of two cases 2-yes in at least one of two cases 3-n.d
absence financial resources	0-no 1-yes 2-n.d.
absence of entrepreneurial skills	0-no 1-yes 2-n.d.
difficulty in accessing credit	0-no 1-yes 2-n.d.
use of PSR	0-no 1-yes 2-n.d.
MARKET SUSTAINABILITY	
sales channels divided into: channel A (direct sales), channel B (sale at local fairs and markets and / or sale at local shops and / or sale at municipal fairs and markets and / or sale at provincial fairs and markets), channel C (sale to local restaurants and in the city and / or sale to large-scale distribution)	0-only one channel 1-two channels 2-three channels 3-n.d.
problems related to roads and infrastructure	0-no 1-yes 2-n.d.
expensive and too demanding distribution	0-no 1-yes

	2-n.d.
ownership of site and/or active social pages	0-nothing 1-one of the two 2-both 3-n.d.

Figure 2.2: Firms' multicriteria tree



Starting from that, the next step is the application of POSET method to obtain the classification of firms in relation to each sustainability performance indicator. The description of POSET method and the results of this classification are in Section 4-5 and 6. While in Section 7 stakeholders give their classification in relation to the best market strategies for these firms.

Section 4: Basic theory of POSET

Social analysis treated a lot of qualitative and ordinal data which described many socio-economic variables. To get information and extract a unidimensional score, useful for policymakers, researchers usually aggregate these types of data into composite indicators, coding qualitative information into numerical scores through a complex algorithm (Fattore et al., 2014). But these indicators are ambiguous and especially inaccurate due to, as Nobel prize Amartya Sen underlined, the nature of socio-economic variables for which are impossible provide a numerical representation of them in a complete and definitive way without imprecision (Comin, 2021). These composite indicators lump together incommensurable features into a single representation; in other words, incomparable components are aggregated producing a single measurement that hides key qualitative differences among dimensions and variables, providing loose of information, obscure of essential information or its misleading and not clarity interpretation (Comin, 2021; Fattore et al., 2014; Fattore et al., 2011; Maggino and Fattore, 2011). To overcome these limitations related to composite indicators, researchers look for a new tool more oriented to complexity and more capable of reproducing the

reality that take in account the different metrics of the data, not making any compensations (Fattore et al., 2014). Among them has been proposed the POSET (Partially Ordered Set) whose application to socio-economic problems is at a beginning stage (Fattore et al., 2011; Fattore et al., 2012). Until now, it has been used in other fields, such as mathematics. Its goal is to build a synthetic indicator on multidimensional system related to partial structures associated to them without introducing any aggregation of the elements (Fattore, 2016). In the following section we introduce some mathematical definitions related to POSET.

Section 5: POSET definitions

Assume that, as in our case, we want to assess the sustainability economic or ecological or market performance of n elements (our 43 firms) which are included in a finite set X ($x_1 \ldots\ldots\ldots x_n$).

Let assume, moreover, that each element is assessed by k variables ($v_1 \ldots\ldots v_k$), generally called attributes, both are continuous and ordinal data, measured by different scales whose sequence of scores can represent achievement profiles. Defining $p=(p_1 \ldots .p_k)$ and $q=(q_1 \ldots .q_k)$ as two different profiles of two initial elements that can be compared with a binary relation in this way:

$q \blacktriangleleft p \Leftrightarrow q_i \blacktriangleleft p_i \quad \forall i = 1, \ldots, k$

This means that first profile (q) is less than the second one (p) if and only if all its components are equal but not higher than those of the second one and in at least one case is strictly inferior. This criterion of order is called product sorting and in the case of its respectful we can say that p dominated q (Comim, 2020; Fattore, 2016). In the case in which q does not respect this definition, this type of ordering cannot be realized, providing a partially order set (POSET) which is the typical natural data structure of ordinal multidimensional system (Alaimo et al., 2020).

From the previous definition we can define POSET in a more formal way:

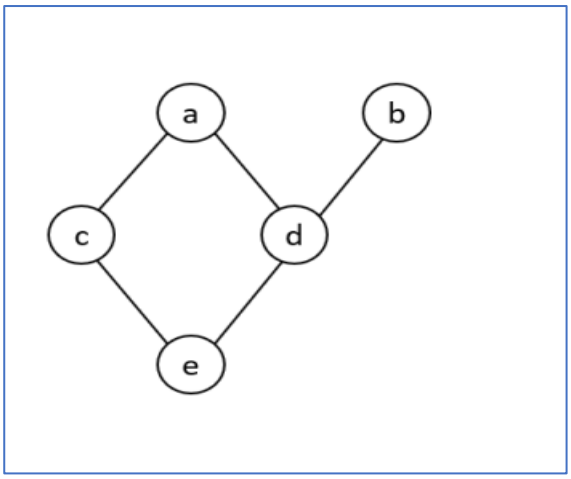
A POSET P=(X,<) is a set X equipped with a partial order relation <, that is a binary relation satisfying the properties of reflexivity, antisymmetry and transitivity (Davey and Priestley, 2002):

1. $x \leq x$ for all x in X (reflexivity);
2. if $x \leq y$ and $y \leq x$ then $x = y$ (antisymmetry);
3. if $x \leq y$ and $y \leq z$, then $x \leq z$ (transitivity).

When $x \leq y$ we can say that x and y are comparable otherwise incomparable ($x \parallel y$); if all profiles in a POSET are comparable we have a chain, in the opposite case we have an antichain (Fattore, 2012). POSET can be represented in graphical way through Hasse diagram (fig. 2.3) which is a graph made by nodes (the profiles) and edges that link them to each other. Fig. 2.3 represents a very simple Hasse diagram of a POSET made by 5 profiles (a, b, c, d, e); the profiles a and b are the maximal because they are not dominated by no other, while the e one is the minimum because it is dominated by all other ones. In case of the presence of other profiles dominated by the others, we have two minimal while in the case of only one profile that dominated all the others there will be a maximum (Fattore, 2016). From Fig. 2.3 we can see that the profile a is linked to the profile c and d through an edge because they are comparable (a>c; a>d) while the c and d ones and a and e not because they are incomparable ($c \parallel d$; $a \parallel e$) (Alaimo, 2020; Fattore, 2016; Rimoldi et al., 2020; Fattore, 2012). Another important aspect is the shape of Hasse diagram that are defined by: the height of the POSET which is represented by the number of elements of the longest chain and by the width equal to the largest antichains. In our example the height is represented by 3 profiles (e, d, b) while the width is equal to 2. Hasse diagram represents a POSET, combining all its comparability and incomparability (Caperna

and Boccuzzo, 2018); the observation of its shape is important in relation to the understanding of the attributes' information power of influence. For instance, the inclusion of a particular attribute or its exclusion can increase/reduce the number of incomparability provoking a crush/enlarge in its shape due to the increase/reduction of POSET width (Comim, 2021). In other word it is possible to understand the change of information in relation to the Hasse diagram shape.

Figure 2. 3: POSET example



Source: Fattore et al., 2016.

The following process is the calculation of a domination rank related to all units contains two further steps. The first one is the application of linear extensions in which the comparability are added to the POSET while the incomparability are disambiguated; in other word with this process, we add the dominances transforming two incomparable profiles into two comparable ones, maintaining all the previous dominances.

Defining linear extension in a more formal way:

given two POSET π_1 e π_2 we can say that π_2 is a linear extension of π_1 if and only if $x \blacktriangleleft_1 y \Rightarrow x \blacktriangleleft_2 y$, thus if π_2 contains at least all the dominances of π_1 (Comin, 2021).

The set of all linear extensions are generally indicated with $\Omega(\pi)$. Moreover, there is an important theorem related to linear extension:

each finite POSET π coincides with the intersection of its extensions (Schröder, 2002).

After calculating the linear extension, the second step is the definition of mutual ranking probability (MRP), a matrix, defined by the equation 1, which contained the fraction of linear extension of π POSET in which x_j dominated x_i. In other word MRP is a scoring function of positive values, which assigned a higher rank to x_j respect to x_i, if in the POSET, x_j dominates x_i (De Loof et al., 2008; De Loof, 2010). To calculate this rank is used the singular value decomposition algorithm.

$$Mij = \frac{|\{\lambda \in \Omega(\pi): xi \prec\lambda xj\}|}{|\Omega(\pi)|} \qquad \text{Eq. (1)}$$

In this way is calculated the dominance rank for all initial variables; it is a weighted average of linear extension without deciding, like happens for composite indicators, an arbitrary and subjective weight on attributes. Its value is included form 0 to 1; higher is the dominance the closer the value is to 1.

But the dominance rank is a forcing of starting POSET due to the adding of comparability from incomparable profiles necessary to obtain linear extension. To have the level of this forcing rank we can calculate the incomparability matrix I defined in this way:

$I_{ij} = \min (M_{ij} , M_{ji})$ Eq (2)

In other words, the incomparability rank is given by the minimum between the dominance rank of x_i and x_j and expresses the degree of comparability of an element with the other; naturally, higher is the incomparability rank the more the dominance rank is a forcing of initial POSET (Fattore et al., 2012; Alaimo et al., 2020; Rimoldi et al., 2020).

In the next section we present the result of the POSET application to our dataset; for each 43 firms we calculate a rank of dominance and incomparability for all three sustainability indicators (ecological, economic and market) obtaining a classification represented in a cartesian diagram. Moreover, we represent in graphical way the dominance between all firms for each indicator through Hasse diagram. Our goal is to obtain a classification of these firms for each indicator to give information to policymakers in relation to the status of these small/family firms placed in rural areas and provide them a synthetic indicator that can take in account different data; in this way governance can have a design of firms' supply side.

Section 6: Discussion and results

In this section we analyze the procedure and the results of POSET application. To better understand the features of our 43 firms, it was necessary an analysis of their supply characteristics in relation to economic, ecological and market sustainability performance, through POSET method. Our procedure can be divided into two different steps: the first one related to Hasse diagram realization and the second one related to dominance and incomparability rank calculation. For the first step, we start from the results of firms' interview that, with their answers, produce profiles in relation to each indicator attributes (table 2.2-2.3-2.4) obtaining the following results:

Table 2.2: Frequencies of ecological indicator

Profiles	0000	0001	0100	0200	0301	1001	1101	1200	1201	2001	2100	2101
Frequencies	2	2	2	3	1	1	2	1	1	2	3	3
Profiles	2111	2200	2210	2211	2321	3000	3001	3010	3011	3201	3210	
Frequencies	1	7	2	1	1	1	2	1	1	1	2	

Table 2.3: Frequencies of market indicator

Profiles	0000	0001	0002	0100	0101	0102	0110	1000	1001	1010	1011	1100	1101
Frequencies	1	2	2	2	1	1	1	4	3	1	1	1	1
Profiles	1102	1110	1112	2000	2001	2002	2011	2012	2101	2102	2111	2112	
Frequencies	2	1	2	2	1	2	2	2	1	2	3	2	

Table 2.4: Frequencies of economic indicator

Profiles	00110000	00021011	00101000	00220001	01011011	01020000	01020100	01021000
Frequencies	1	1	1	1	1	1	1	1
Profiles	01021110	01021111	01110002	01121001	01200000	01220001	01220120	0122100
Frequencies	1	1	1	1	1	1	1	1
Profiles	01231000	10021101	10101000	10110001	10120001	10121001	10200000	1022000
Frequencies	1	1	2	1	1	2	2	1
Profiles	10221001	10221100	11010011	11021100	11021101	11111000	11120001	1122000
Frequencies	1	1	1	1	1	1	1	3
Profiles	11220011	11221001	11221011	20220000				
Frequencies	2	2	1	1				

The above tables indicate the frequencies of profiles in each indicator. The ecological indicator profiles are made by 4 attributes (as we can see from table 2.1); there are two firms with the lowest profiles and another two with the highest. In table 2.3 we see the same situation for market indicator; in this case only one firm presents lowest profile (minimum) while 2 ones present the highest one. For the economic indicator the attributes are higher, so the profiles of each firm are made by 8 variables; but in this case only one firm has the highest profile and only one has lowest one.

After that, through PyHasse software, we realized the Hasse diagram for each indicator. Fig. 2.4 represents the diagram of ecological indicator. We see an elongated figure with 8 different levels, suggesting a low numbers of incomparability between attributes, and 4 widths; moreover, the presence of not so different widths indicates a homogenous distribution of incomparability (Comim, 2021). Fig. 2.5 shows the Hasse diagram of market indicator that has a different structure, in fact, it is more crushed, with 7 levels indicating the presence of more incomparability/low-correlate variables, and with a width of 6. Finally, fig. 2.6 is the Hasse diagram of economic indicator that have another crushed structure due to the presence of higher number of attributes (8 rather than 4 of the previous two indicators) with only 6 levels, meaning the presence of high amount of incomparability, and a width of 8. As we said in the previous section from the shape of Hasse diagram we can understand the influence of the attributes, in fact, in this case we can assume that the attributes of ecological indicator Hasse diagram are more correlated than those of market one. In other word, with this indicator if policymakers decided to improve an attribute, this implies an improvement of another; while if the Hasse diagram structure is crushed an improvement of one attribute could imply a deterioration of another. In relation to other criteria of market and ecological sustainability, firms are differentiated in relation to their performance. The diagram of economic indicator cannot be compared to the two previous ones, due to its higher number of attributes, 8 rather than 4. We decided to eliminate four attributes (as we have the same attributes of other sustainability indicator) with the highest correlation between one another and four attributes with the lowest one in order to obtain two

different figures of Hasse diagram's economic indicator made by 4 attributes comparable with the two other indicators. Fig. 2.7 represents the Hasse diagram of economic indicator after eliminating 4 attributes with the lowest correlation; it seems more like the Hasse diagram's ecological indicator, suggesting low presence of incomparability (due to its lower width) in comparison to the previous one. Fig. 2.8 is the diagram of economic indicator after eliminating the attributes with the highest correlation; its shape is similar to the market indicator with the same levels (6) of the previous graph and a lower width (4), meaning a reduction of incomparability but not so high due to the presence of crushed shape. This means that these attributes, due to their high correlation, do not have a high impact on diagram shape. Summarizing the results derived from this analysis we can understand the importance of attributes for the Hasse diagram shape; more correlated attributes provide a more longed figure while low correlation provides more crushed one. Moreover, from these diagrams we understand that firms' economic indicators are not so differentiated, thus they have the same performance. While the other two indicators have different performance.

Figure 2. 4: Hasse diagram of ecological indicator

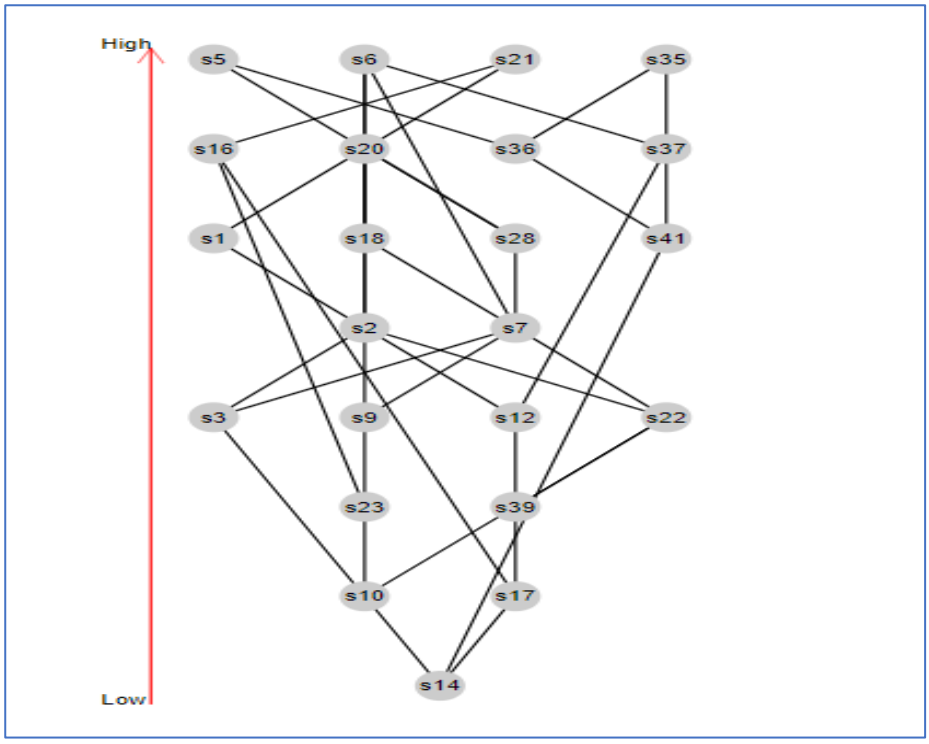


Figure 2.5: Hasse diagram of market indicator

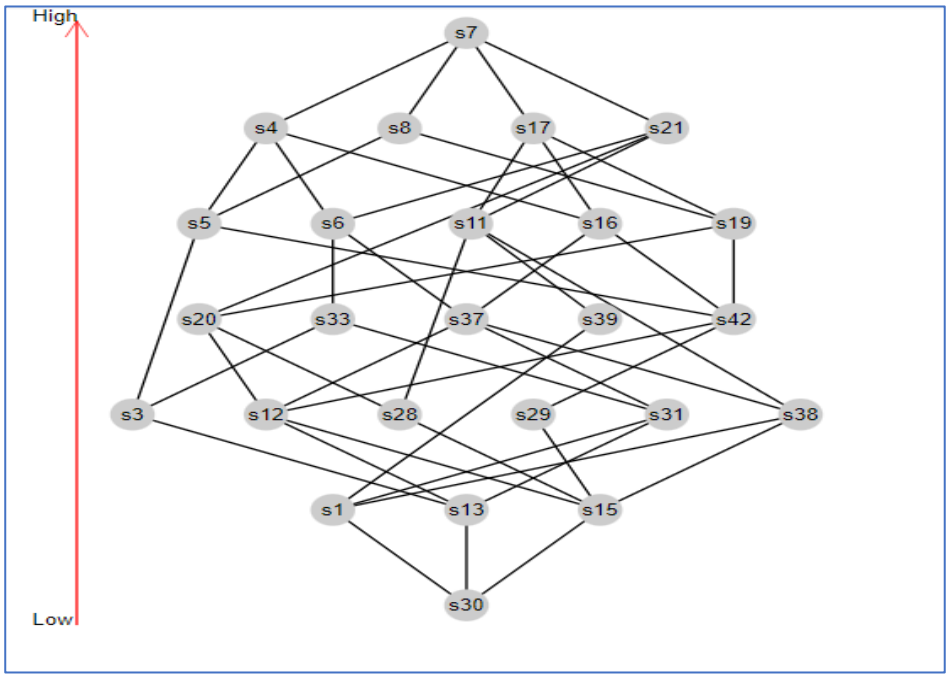


Figure 2. 6: Hasse diagram of economic indicator

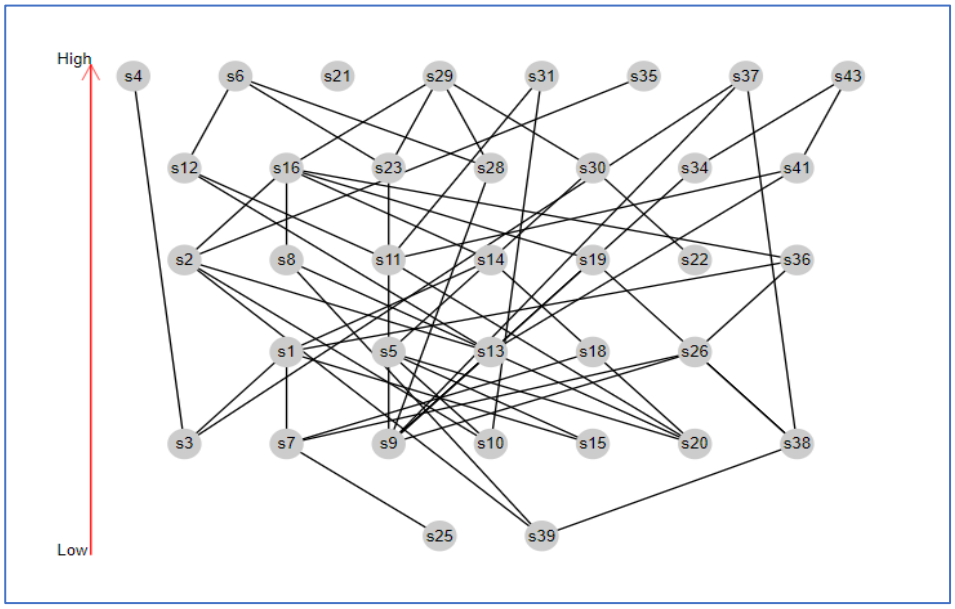


Figure 2.7: economic indicator more comparable

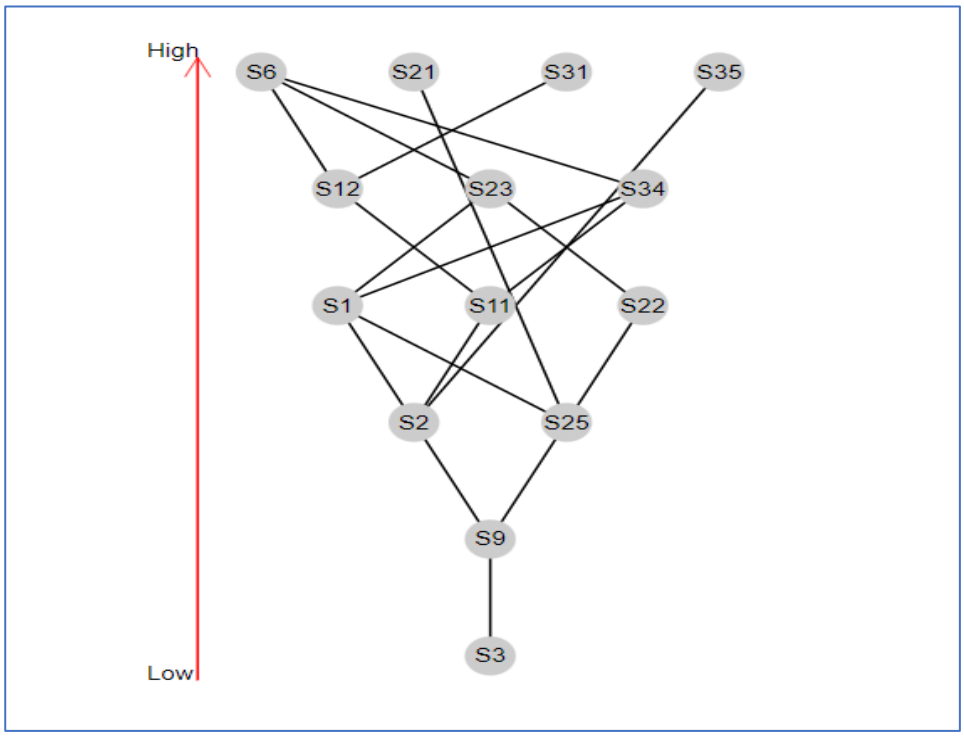
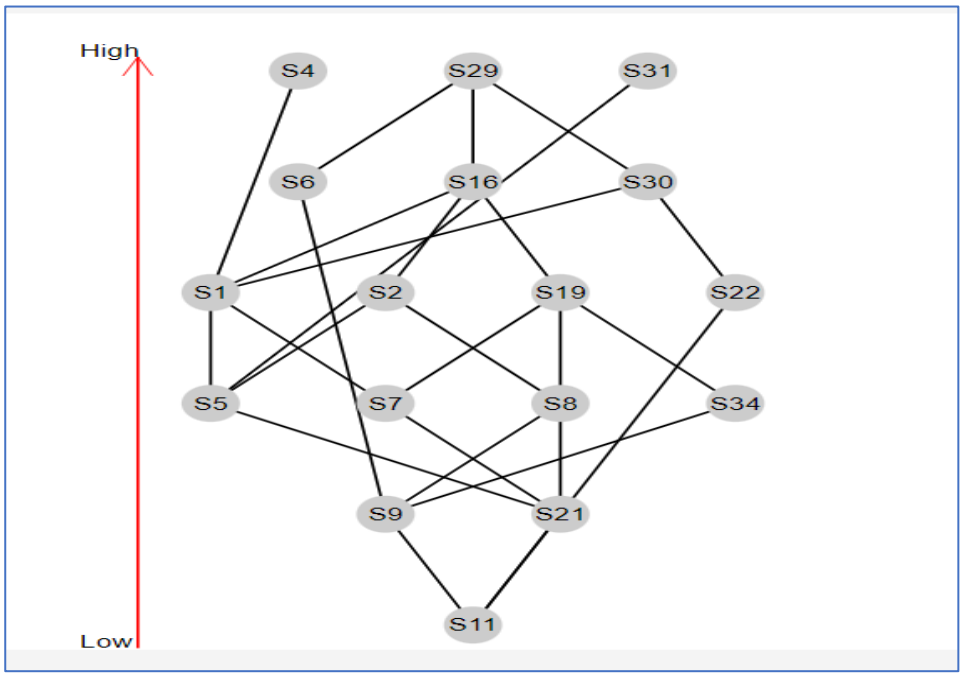


Figure 2.8. economic indicator less comparable



The second part of our analysis can help us to better understand firms' economic, ecological and market performance. Using POSET method we provide firms' economic, ecological and market classification. We calculate for each indicator the dominance and the incomparability (defined in section 5) rank of all firms. As we said in section 5, higher is the dominance rank (value between 0 and 1) better is performance's firms, while higher is the incomparability worst is their performance due to the major forcing of the dominance. First of all, we eliminated firms which have not answer to

all questions; so, we have 41 firms for the ecological indicator, 39 for economic one and 43 for the market performance. In fig. 2.9 there is the graph representation of the firms' performance indicators (ecological, economic and market); in the x-axis there is the value of the dominance while in the y-axis the incomparability one. It can be seen that economic dominance value of the firms has an higher value of incomparability maybe due to the presence of high number of attributes. Moreover, we can see that the economic performance of the firms (orange line) is not so different; we have most of the firms concentrated in the central part of the graph. This also can be report in tab. 2.2; 8 firms have the economic dominance rank equal and greater than 0.70, 22 between 0.40 to 0.69 and 9 below 0.39. For the other two indicators the situation is different; the ecological performance (blue line) presents a major differentiation between firms while in market one (grey line), firms have a major distribution. Tab 2.2 can understand us better: 9 firms have an ecological dominance rank equal and greater than 0.70, 19 between 0.40 to 0.69 and 13 below 0.39; 16 firms have a market dominance rank equal and greater than 0.70, 15 between 0.40 to 0.69 and 12 below 0.39. Combining the POSET dominance rank of the three performance indicators, we have different types of firms:

1. firms with the highest value in all three indicators, meaning a good capacity of economic management, market accessibility and environmental preservation (which are few);
2. firms in marginal conditions (the majority) with low values in all three indicators;
3. firms aware of importance of market accessibility and environmental preservation but with low investment capacity.

Figure 2.9: firms' ecological, economic and market performance

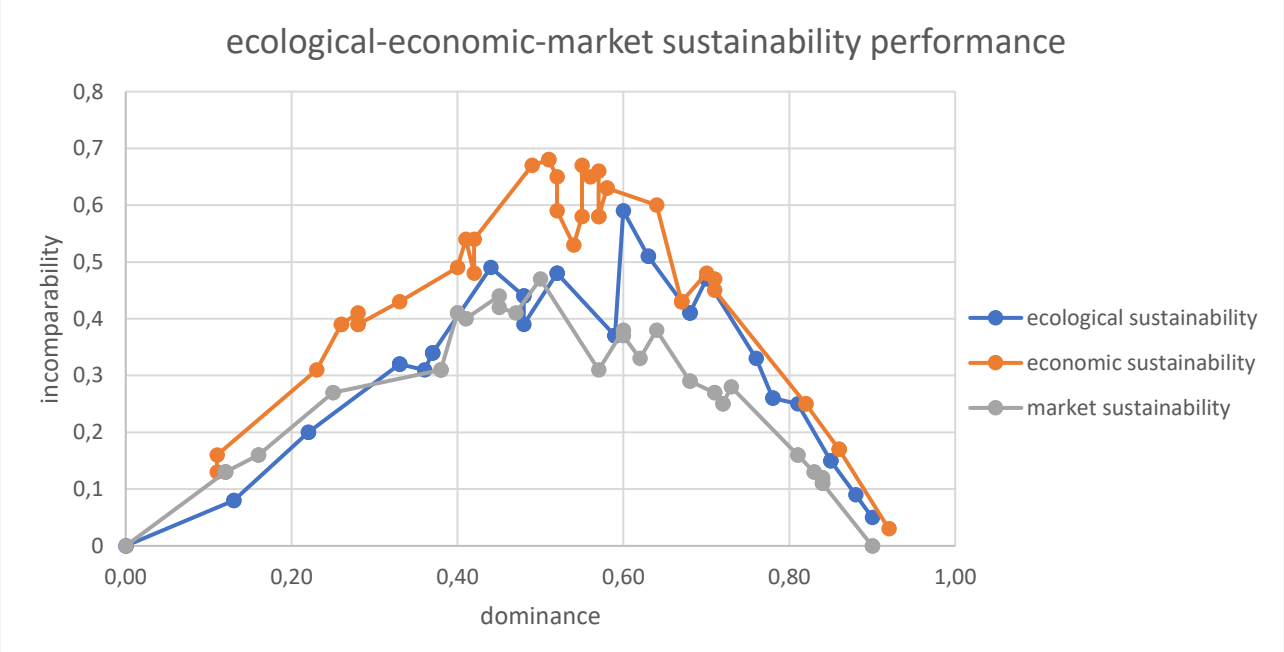


Table 2.2: Dominance results of firms' sustainability indicators

INDICATOR SUSTAINABILITY PERFORMANCE	≥ 0.70	0.40≤X≥ 0.69	≤ 0.39
ECONOMIC PERFORMANCE	8	22	9
ECOLOGICAL PERFORMANCE	9	19	13
MARKET PERFORMANCE	16	15	12

Section 7: governance strategies in rural areas firms

In these following sections we analyze the results of the stakeholders' classification in relation to market-oriented governance strategies. Before analyzing our results, we made a review in relation to the governance forms used in rural areas firms applied by countries. Naturally each country has a different territorial characteristic that imply different policy application (OECD, 2022). An OECD survey of 2018-2019 reported as main governance tool in the OECD rural firms' countries, the use of grant and loans programs and direct subsidies (OECD, 2022). Moreover, other policies include multi-level governance cooperation between different types of region and local actors, such as: horizontal and vertical coordination, rural-urban partnerships, multi-stakeholders engagement and the public-private partnership. Horizontal coordination permits coordination across the same government level, taking account of rural particularities; a good example is the rural proofing in UK in that policymakers makes an ex ante ministerial assessment of rural development and an ex post regional valuation, relates to different ministers' policy decision on rural regions. In this way domestic policies consider the rural firms' needs. The vertical coordination makes linkages between higher and lower levels of government including institutional, financial and informational aspects in order to improve the quality and the coherence of public policy (e.g. FORA that is a co-ordination platforms used in many OECD countries which see the coordination of different level of policymakers) (OECD, 2022). Rural-urban partnership is a form of institutional collaboration in term of economic, infrastructure and governance linkages that realized a share of territory and labor market; a good example is the reciprocity contracts of France. Another bottom-up governance form is the multi-stakeholder engagement in that citizens are engaged in policy design; rural dwellers have a better knowledge of local conditions adopting better policies to the rural context. Finally, the last governance strategy is the public-private partnership (PPP) that is relevant to meet local demand for better and sufficient infrastructure (e.g. Varmland University in Sweden which is the meeting place for researches, companies, financiers and entrepreneurs).

Section 7.1: Classification of governance strategies

As we said in the previous sections, after our interviews to the 43 rural firms', we extracted the determinant factors for their economic sustainability, obtaining the multicriteria tree of fig. 2.2. These results can be divided into: criteria which are the determinant factors on which firms want to improve (green square of fig. 2.2), sub-criteria (white square of fig. 2.2) and governance strategies (yellow square of fig. 2.2). The criteria are represented by the management control, product quality and production processes, marketing and communication, sales channels distribution and innovation technology; while governance strategies are: training (promotion of dedicated training processes), territorial network (promotion of associative forms like consortia for which can be the share of distribution, production and marketing costs and of best practices), technical support, local brands and labels and participated meetings. Starting from that, we elaborate a questionnaire made by pair confrontation of criteria, sub-criteria and in relation to each criterion of governance strategies. After that, we submitted it to our 59 stakeholders asking them which one they prefer, thus, in case of voting which one they would choose. We divided stakeholders into four categories in relation to the place in which they work: associations, public institutions, firms, free land and universities. The 10% of them work in associations, 31% in public institutions, 15% in firms, 25% as free land and the last 19% in university. Once the results are obtained, we elaborate the classification using two different non-compensative methods: POSET and multicriteria analysis. For the first method we calculate a POSET for each respondent and aggregate the preferences for criteria, sub-criteria and governance strategies. To obtain the rank that stakeholders give to governance strategies and criteria, we apply this process:

- calculation of criteria's average height[6] and their relative weight; in other word we divided each average height with their total sum;
- for each governance strategies we multiply their average height with the criteria's relative weight of above;
- calculation the average of each governance tools obtaining the classification of the strategies.

With multicriteria analysis we are able to understand how stakeholder preferences were formed, in other words who voted for what, ensuring greater transparency in relation to resource allocation choice. Specifically, we calculated the matrix of pairwise comparisons indicating the number of times the criterion, governance strategies or sub-criterion in the column is preferred over the one located in the row. The same method was applied to the different categories of stakeholders identified above in order to have more disclosure in relation to preference formation; to do so, we normalized the above matrices for each category to then calculate for each column the respective geometric mean and weight. This result indicates as a percentage average how often a criterion or an instrument wins comparison with the other elements.

In relation to the POSET the criteria classification for the stakeholders is:

1. product quality (4.38);
2. marketing (3.1);
3. management control (2.83);
4. sales channels (2.55);
5. innovation technology (2.14).

While the classification of stakeholders' governance strategies is the follow:

1. territorial network (1.68);
2. training (1.62);
3. brands and labels (1.61);
4. technical support (1.54);
5. participated meetings (1.04).

In relation to the preferences of the five criteria, stakeholders identified product quality (4.38) as the most relevant for firms' economic sustainability followed by marketing (3.10) while the least relevant is technological innovation (2.14). With reference to governance strategies, stakeholders identified territorial networks, training and brands and labels as the tools on which to allocate most resources.

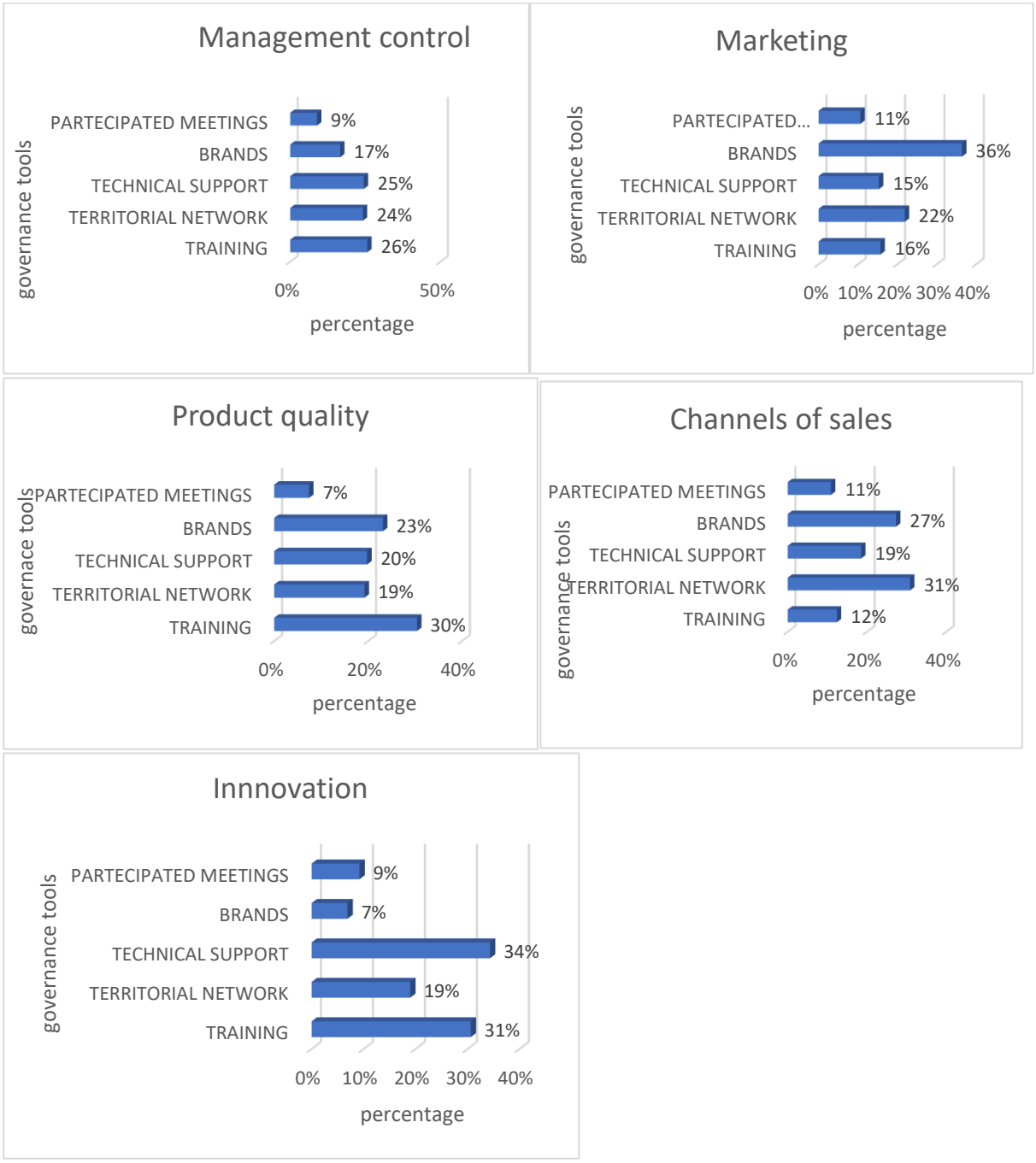
After that we calculate the same results using multicriteria analysis. The classification of the criteria is the follow:

1. product quality (44%);
2. marketing (20%);
3. management control and sales of channel (14%);
4. innovation technology (9%).

[6] Average height is the expected position of that element in a randomly extracted linear extension within the POSET. We know that each POSET is defined by its linear extensions; to obtain the average height it must be extracted randomly the position of a particular element from linear extensions and after that calculate an average (i.e. if I have an element that has been extracted 2 times in second position and two times in third one, the average height is ((2*2)+(3*2))/4).

We see that the 44% of the stakeholders vote the quality of the product as the most important criteria for firms' economic sustainability followed by marketing (the same of the POSET method). Stakeholders have also voted, for each criterion, the governance tools in which policymakers should invest (fig. 2.10). From these results we can see that in relation to the management control criteria training (26%), technical support (25%) and territorial network play a key role obtaining the highest weight; for marketing criteria we have brands (36%), territorial network (22%) and training (16%); for quality of product tools with the highest percentage are training (30%), brands (23%) and technical support (20%). In relation to the channels of sales territorial network (31%), brands (27%) and technical support (19%) present the highest stakeholders' preferences and finally for the last one innovation criteria technical support (34%) and training (31%) represent more than 50% of the preferences. Training, territorial network and brands represent the governance tools with the greatest weight on which policymakers should allocate resources in relation to the preferences expressed by stakeholders.

Figure 2.10: classification of governance tools



Section 7.2: The analysis of stakeholders

In order to have greater transparency of the results obtained with reference to the criteria and governance instruments on which to allocate resources, we proceed to apply the same process explained in the previous section for each category of stakeholders. As reiterated above, the stakeholders were divided into 5 categories: associations, institutions, universities, businesses and professions. In our dataset: 10% are represented by associations, 31% are the public institutions, 15% are firms, 25% are professions and the last 19% are represented by university. Product quality, as can be seen from the graphs below (fig. 2.11), was confirmed as the preferred criterion by all stakeholders except for associations, which indicated marketing (28%) as their preferred criterion. Of course, it

must be considered that associations identify only 10 % of our sample. The second criterion preferred by all, apart from the associations that identified product quality and sales channels as their preferred criteria, is marketing. Management control and sales channels show similar preferences expressed by all stakeholders, with the exception of firms that identified management control (18%) as the second most preferred criterion. Next, the preferred tool, with reference to each criterion, was analyzed by each category of stakeholders.

Figure 2.11: classification of criteria between stakeholders' categories

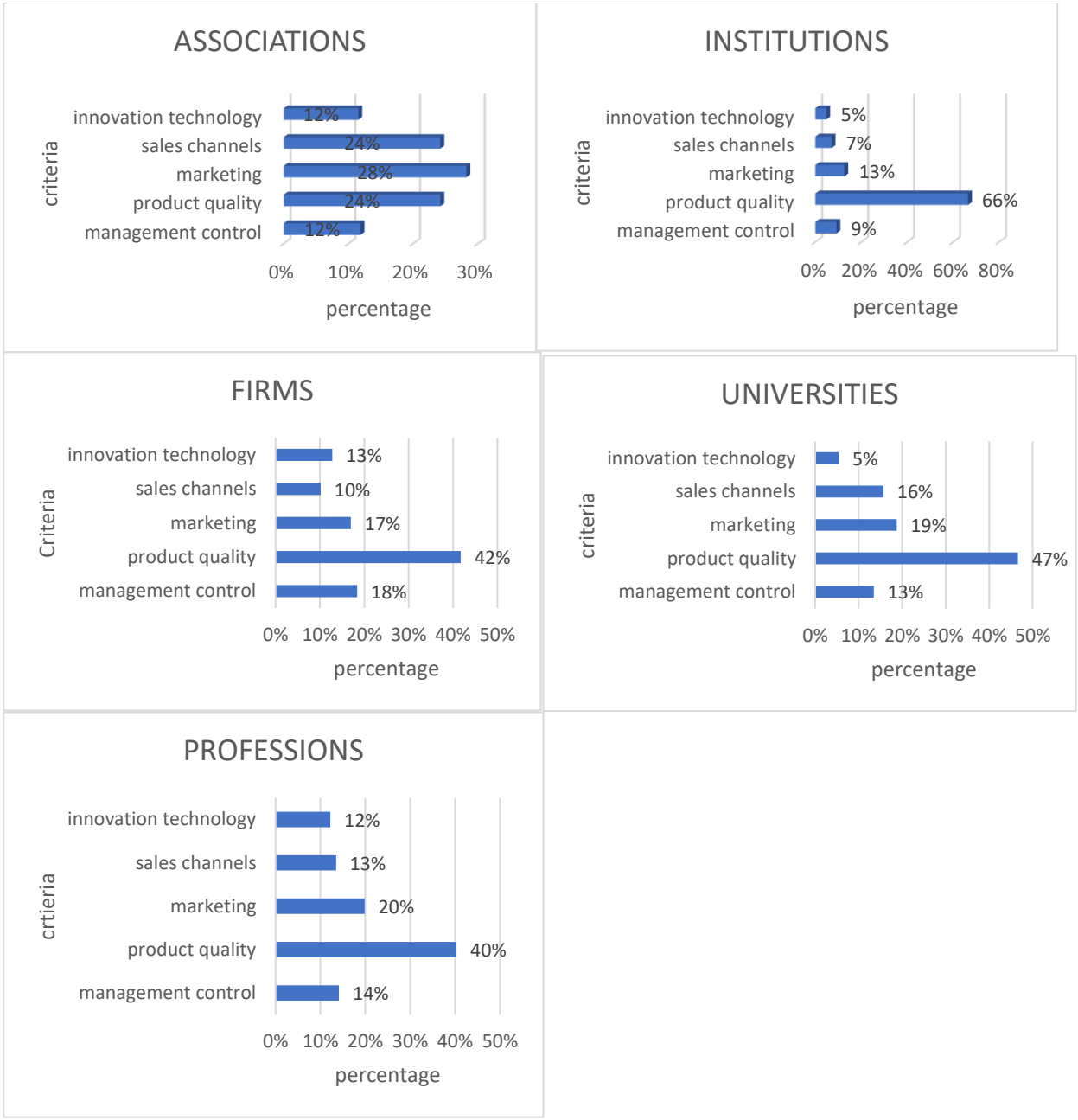
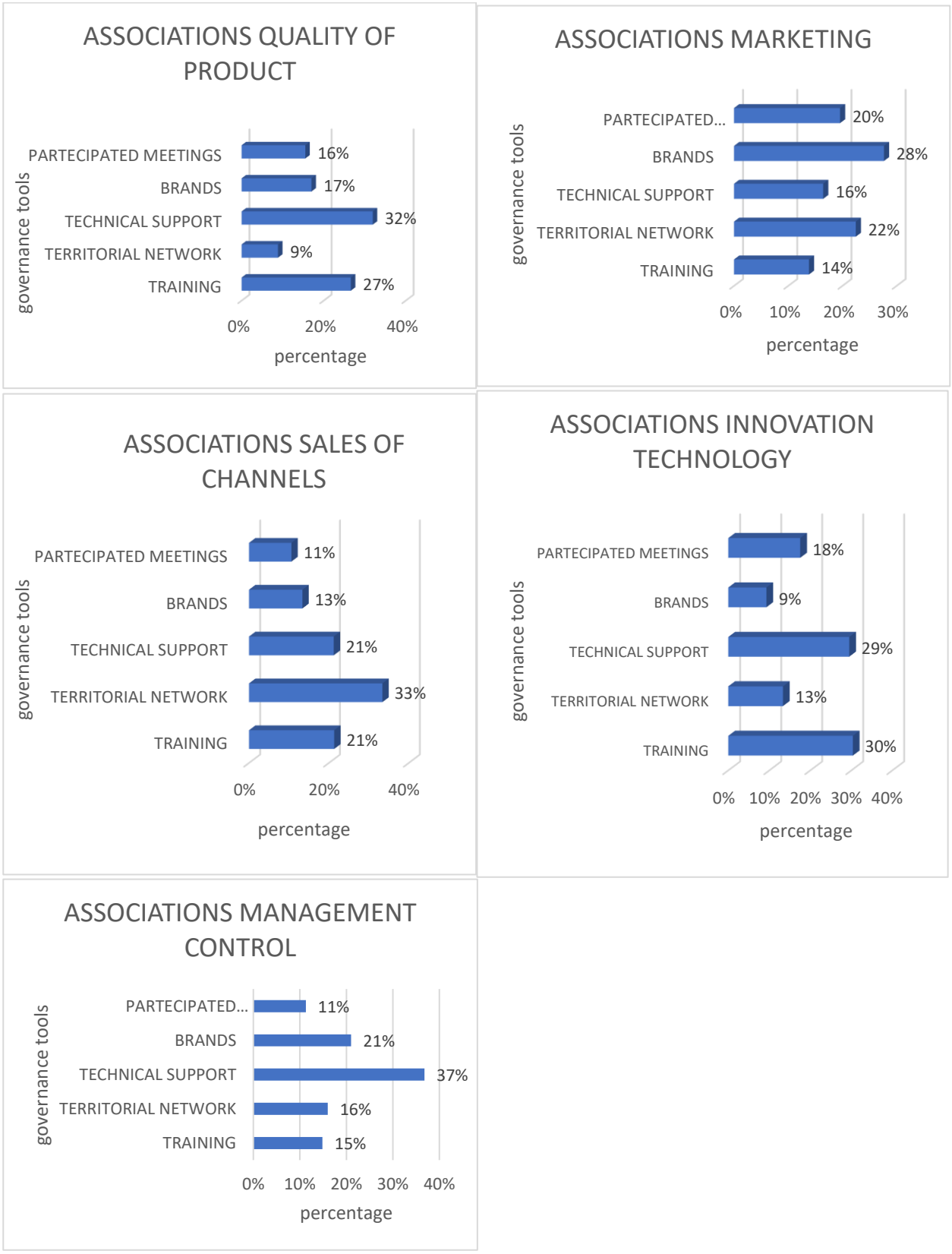


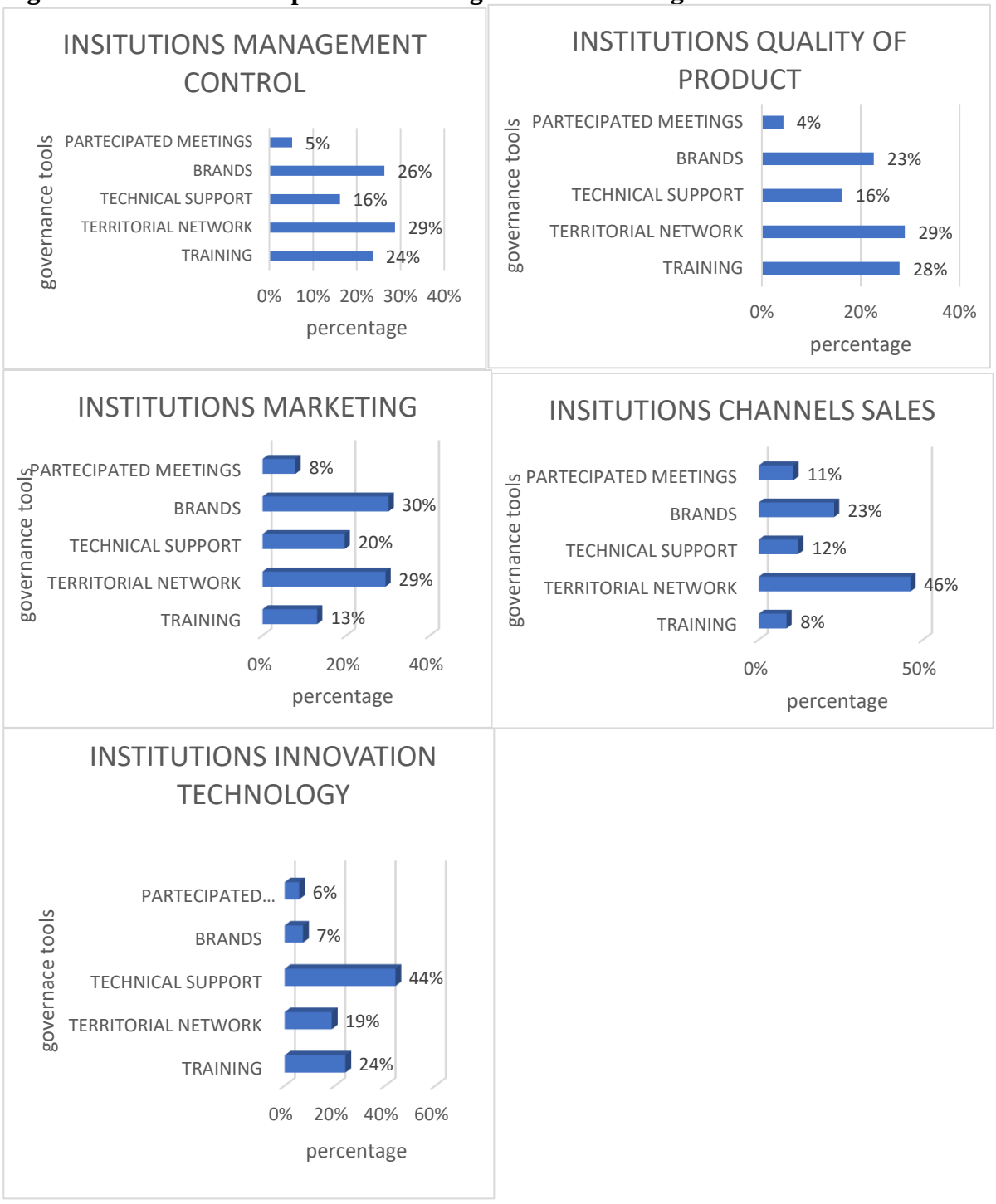
Figure 2.12: Associations preferences for governance strategies



For associations (fig. 2.12), the preferred criteria were marketing (28%), product quality (24%) and distribution channels (24%). In relation to marketing the tool the most weight is brands and labels (28%) followed by territorial network (22%), participatory meetings (20%), technical support (16%) and training (14%). The tool with the highest weight in relation to product quality is technical support

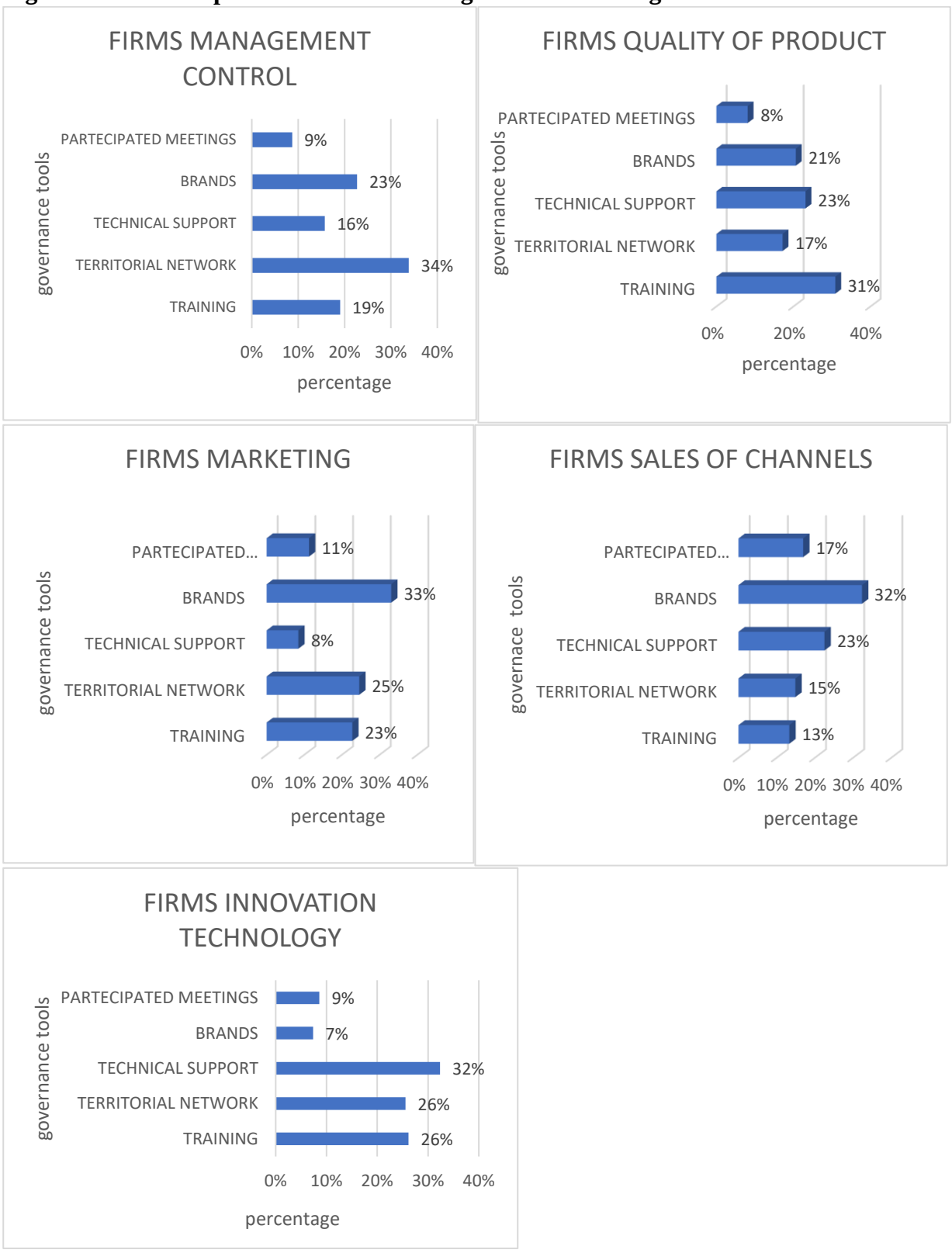
(32%) followed by training (27%), local brands and labels (17%) and participatory meetings (16%); the tool with the lowest percentage is territorial network 9%. For sales and distribution channels, the tool with the greatest weight is territorial networking (33%), followed by training and technical support (22%), local brands and labels (13%) and participatory meetings (11%). For technological innovation and management control, associations have similar preferences to the previous criteria; in fact, for technological innovation the best tool is training (30%), followed by technical support (29%), participatory meetings (18%), territorial network (13%) and brands (9%). In relation to management control, the main tool turns out to be technical support (37%) followed by brands (21%) while the other tools have similar percentages. In summary, for associations the best tools are territorial network, training and brands, as was already identified in the general analysis, to which technical support must be added. In fact, with reference to all three criteria, brands have a weight of 58% (marketing and communication 28%, product quality 17%, and distribution channels 13%), training turns out to be 62% while territorial network at 64%.

Figure 2.13: Institutions' preferences for governance strategies



With reference to institutions (fig. 2.13), the preferred criterion was product quality (66%). In relation to this criterion, the entities' preferred tool is territorial networking (29%) followed by training (28%), brands (23%), technical support (16%) and participatory meetings (4%). The sum of the first three tools is 80% relative to a criterion that weighs 66% alone, therefore, for this category of stakeholders, resources should be allocated to these three tools. In fact, the territorial network appears to be the main tool for all criteria except technological innovation and marketing. Brands present a solid weight as resulting as the second preferred tool within almost all criteria. Training plays a relevant role with reference to management control, product quality, marketing and technological innovation. Entities also give modest importance to technical support (16%).

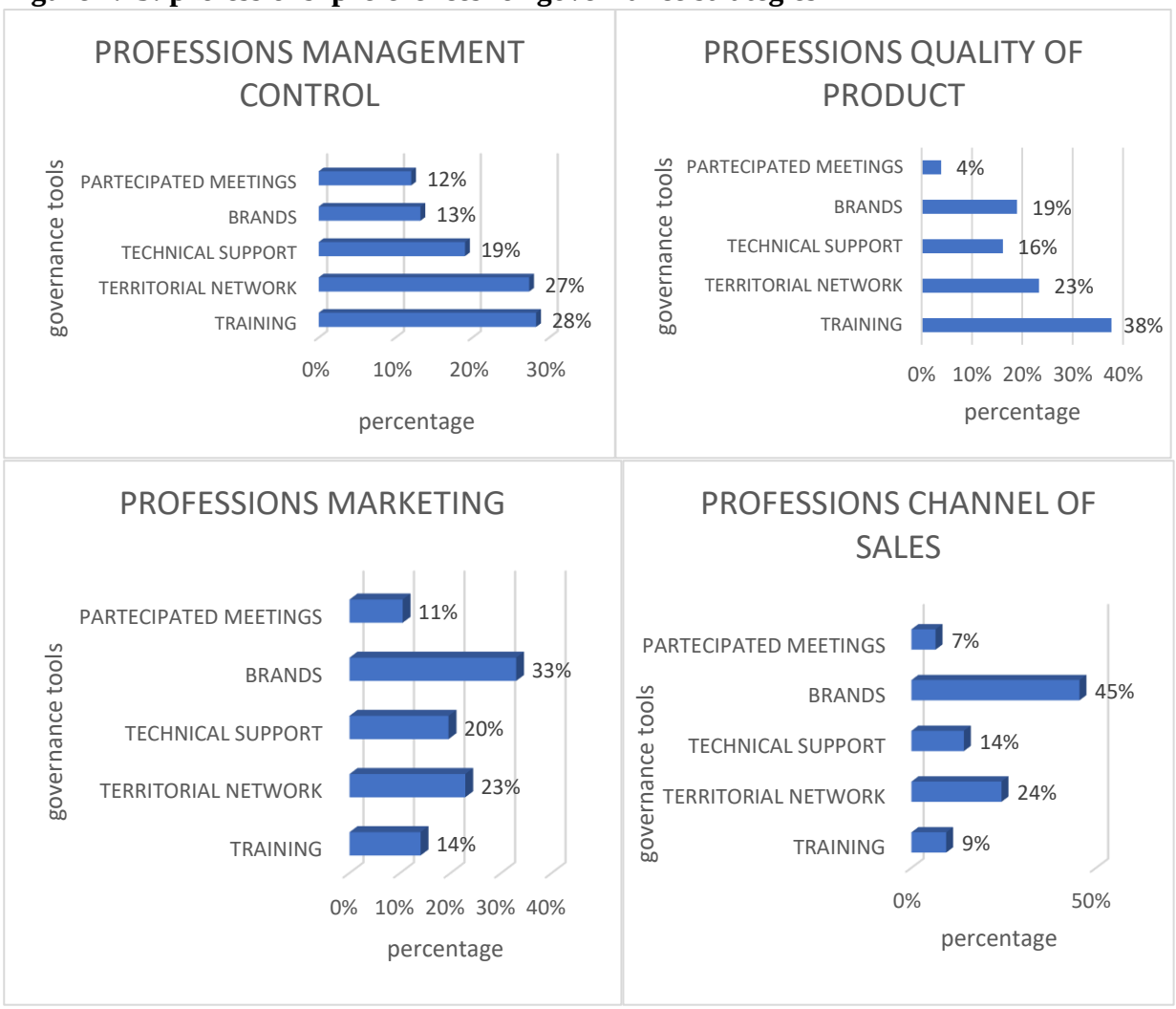
Figure 2. 14: firms' preferences related for governance strategies

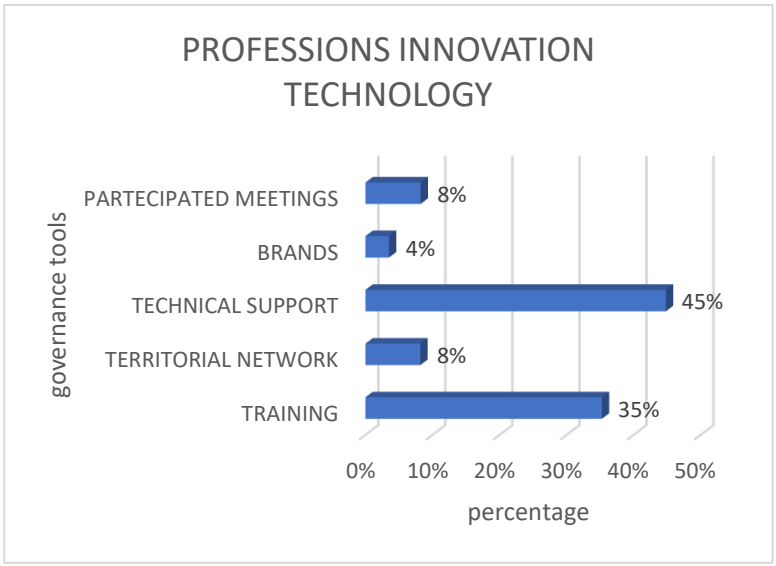


For firms (fig. 2.14), the criteria with the greatest weight appear to be product quality (42%), management control (18%) and marketing (17%). In relation to product quality, the tool with the greatest weight appears to be training (31%) followed by technical support (23%), brands (21%) and territorial network (17%). For management control, the preferences expressed were as follows: territorial network 34%, brands and labels 23%, training 19% and technical support 16%. And,

finally, the preferred tools with respect to marketing are: brands 33% followed by territorial network 25% and training 23%. In general, training and territorial network turn out to be the tools with the most solid weight (73% and 76%) of criteria that weight 80%. Also, not to be overlooked are local brands and labels, which have significant weight in all criteria, and technological innovation.

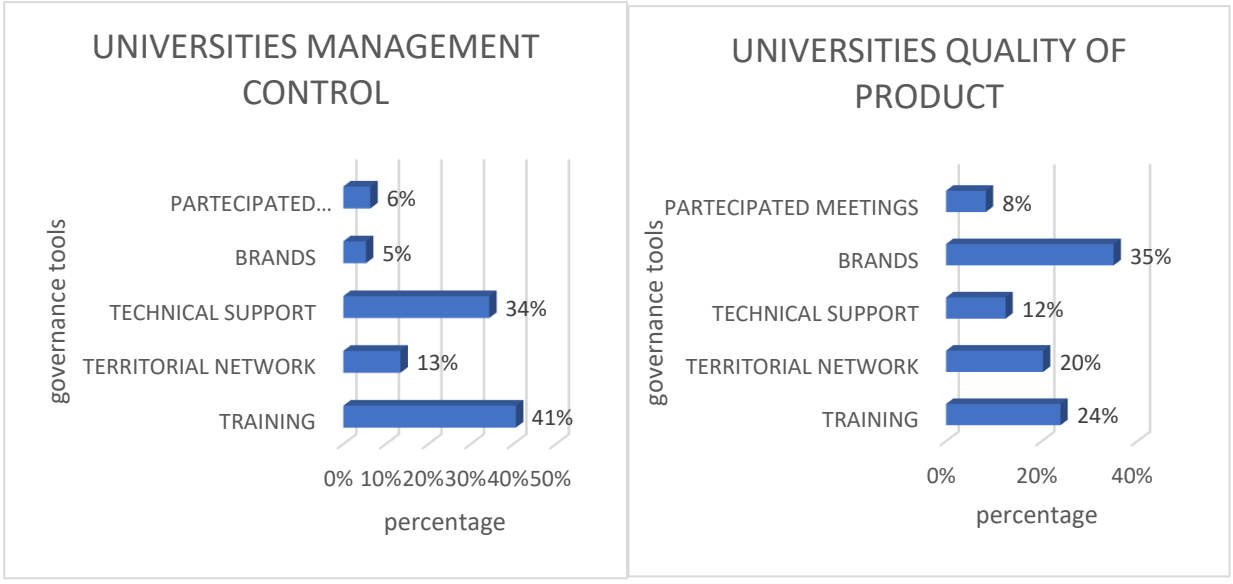
Figure 2.15: professions' preferences for governance strategies

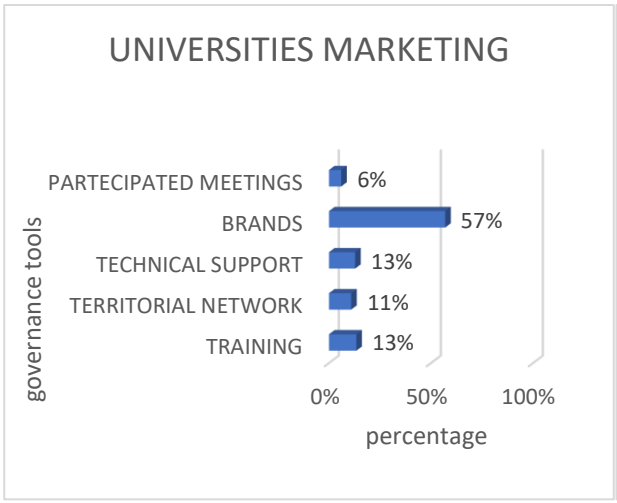


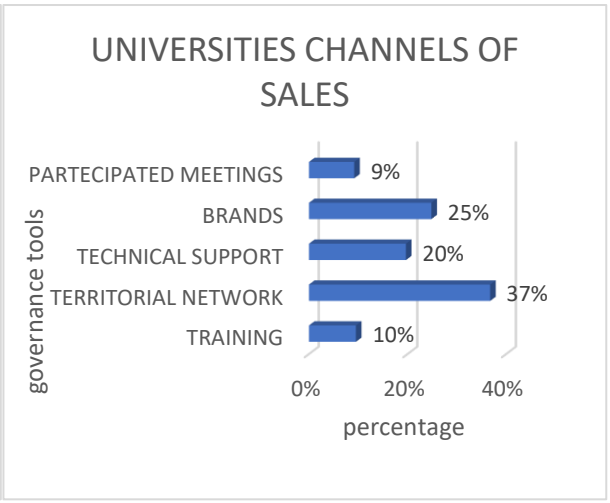


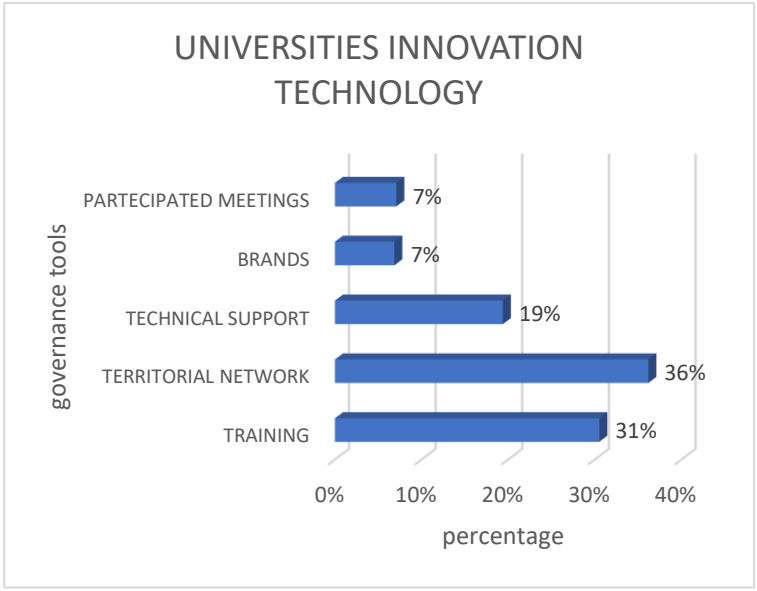
The analysis related to the category "professions", fig. 2.15, determined as the most important criteria: product quality (40%) and marketing 20%. For product quality the best tools turn out to be training 38%, territorial network 23% and brands 19%; while, in relation to marketing, brands present 33% of the preferences, followed by territorial network 23% and technical support 20%. Training, territorial network, brands and technical support turn out to be the tools with the solid weight. Suffice it to say that for management control and technological innovation, training reaches 63%; for sales channels and management control, territorial network reaches 51%; and, finally, brands reach 78% for marketing and sales channels. Also, technical support presents a great weight in especially for innovation technology.

Figure 2.16: universities' preferences for governance strategies









The last analysis is for the category called "university" (fig. 2.16). The preferred criteria noted previously were: product quality (47%) and marketing (19%). The tools with the greatest weight with regard to product quality once again turn out to be: brands 32%, training 24% and territorial network 20%. For marketing the preferred tool is brands 57% followed by the others showing similar preferences. Also, for this category the preferred tools turn out to be territorial network, which accounts for 73% considering technological innovation and sales channels, training, which accounts for 72% with reference to technological innovation and management control, and brands, which, on the other hand, accounts for 92% considering marketing and product quality. Technical support is also not to be underestimated, which turns out to have a relevant weight with regard to management control and the channels of sales.

Section 8: Conclusion

In this study we used an innovative method (POSET) never used before in environmental economy. The goal of this study is twofold: ranking 43 rural firms in term of ecological, economic and market sustainability and the identification of the best market-oriented governance tool that could increase the market-competitiveness of these firms. For the first goal we submitted to 43 rural firms, that participated to two Liguria Region project CAMBIOVIA and BIODIVALP, a questionnaire in relation to their economic, ecological and market situation, obtaining both qualitative and quantitative data; for this reason, we applied an innovative and never applied method in environmental economy field, that consider the different nature of data avoiding any sort of offset which is the POSET. The results demonstrated that companies differ in ecological and market aspects while presenting the same, not so good, results of the economic side. For the second goal we used a multi-criteria analysis derived from a questionnaire submitted to 59 stakeholders with the addition of a hierarchization approach for partially order set (POSET). The results show as the best market-oriented governance tools in that policymakers should invest: training, local brands and labels, and territorial networks. In relation to the latter, in addition to the sharing of costs and best practices, it also avoids the abandonment of areas necessary for environmental mitigation and adaptation processes. The findings underline that to improve the rural areas market competitiveness, policymakers shouldn't sustain them with subsidies but have to emphasize their market strengths, investing money on the previous governance tools (training, local brands and labels and territorial networks). The limitation of this study is related to the few firms that we analyzed due to the local implications of the projects and to the few stakeholders that we interpellated. For future development of research, we want to try to increase the sample of our firms maybe analyzing, also, the rural area firms of the other regions that are in CAMBIOVIA and BIODIVALP projects and to increase the number of stakeholders including, also, the ones whose regions participated to the previous projects.

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CHAPTER 3

THE IMPACT OF CONSUMERS' SOCIO-ECONOMIC-DEMOGRAPHIC FEATURES ON PRO-ENVIRONMENTAL BEHAVIOR: A LATENT CLASS ANALYSIS APPLICATION

Abstract

Pro-environmental behaviors (PEBs) have drawn growing attention from scholars. Different studies have shown how them are strongly influenced by the socio-economic-demographic characteristics of consumers. With the aim of providing relevant information to policymakers in relation to future policies, this study analyzes the impact of consumers' socio-economic-demographic characteristics on PEBs using a representative sample of the Italian population made up of 942 individuals. Latent class analysis was used. The results divided our sample into two groups in which the second distinguished consumers with more PEBs. The second group consisted of more educated individuals with more children and higher income. The first group, despite having fewer PEBs, emphasized the links with their socio-demographic characteristics. In fact, due to their lower income than the subjects in the second group, they were forced into such consumption behaviors, despite having a propensity for certain sustainable purchases (Protected Designation of Origin, organic products, informational labels, and an orientation toward workers and animal welfare).

Section 1: Introduction

Since 2014–2020, the study of pro-environmental behaviors (PEBs) has seen rapid growth (Lu et al., 2021) due to the climate and environmental crisis that has prompted policymakers and international organizations to rethink the human-ecosystem link and attempt to change people's environmental behaviors to ensure a more sustainable future (Kapecki, 2020; Blankenberg et al., 2019). This term was coined in the 1960s by scholars as a solution to the ecological crisis caused by maladaptive behavior (Maloney and Ward, 1973) and is defined as human behaviors that are conducive to the healthy development of the ecological environment (Lu et al., 2021). Over the years, this topic has been heavily studied in different fields (such as economics and psychology), and researchers have analyzed PEBs in relation to different issues. For example, they examined how PEBs vary according to people (residents, tourists, employees, and consumers) (Lu et al., 2019; Rezvani et al., 2018; Zhang et al., 2019; Wang et al., 2018), and they explored the impact of PEBs on the protection of different resources (such as the ocean, energy, water and soil). Another very important aspect strongly studied by scholars is the analysis of factors (such as the socio-economic-demographic characteristics of consumers) that influence PEBs (Exley and Christe, 2002; Blankenberg et al., 2019). It is very important to understand whether the above factors influence PEBs in order to provide information to policymakers on natural resource management (Enrlich et al., 2017). For example, a policy for

incentivizing sustainable behaviors (such as purchasing products directly from the producers) will have different impacts depending on the age of stakeholders or their level of education. On this basis, this paper analyzes the impact of the socio-economic-demographic characteristics of consumers on an unobservable variable represented by PEBs that we call "pro-environmental consumption behavior" (PECB). In other words, we study this latent variable to provide information to policymakers about consumers' socio-economic-demographic characteristics' influence on sustainable consumption habits. Through a latent class analysis (LCA), applied to a sample of 942 consumers representative of the Italian population, we identified different groups of consumers according to whether their consumption behavior was more or less pro-environment. The originality of this project stems from the fact that an LCA referring to the PEBs of a representative sample of the Italian population does not exist for Italy. This work is organized as follows: Section 2 presents a review of the impact of consumers' socio-economic-demographic characteristics on PEBs. Section 3 outlines the questionnaire and data used. In Section 4, we introduce the theory related to LCA. In Section 5, the results are analyzed and a discussion is presented. Finally, Section 6 concludes the paper.

Section 2: Socio-economic-demographic factors and PEBs

In this section, we review the existing literature on the impact of socio-economic-demographic characteristics on PEBs. In relation to age, PEBs seem to follow the life cycle, which has a negative impact (Johnson et al., 2004; McCluskey et al., 2009). In other words, older people seem not to care about environmental issues; consequently, environmental concern decreases as age increases; however, "home-based" PEBs (e.g., recycling) are higher (Blankenberg et al., 2019). Education, on the other hand, has a positive impact on PEBs. Higher education leads to greater concern for social welfare and a greater orientation toward certain behaviors (recycling, environmental reading, and nature participation), while lower education is associated with other PEBs such as greater use of public transportation (Lynn and Longhi, 2011). Moving to income, we can observe a small but positive correlation with PEBs (Hines et al., 1987). As reported by Diekmann and Preisendorfer (2003), people are more likely to engage in environmentally sustainable behavior if there is not a high cost in terms of money, time, and effort; therefore, consumers with higher incomes tend to have higher PEBs (Stern et al., 1999). Ferrara and Missios (2005) pointed out that higher income also leads to a decrease in free time and, consequently, a decrease in recycling, but other scholars pointed out the greater likelihood of their participation in green electricity programs (Bloankenberg et al., 2019). Gender, in general, presents a significant difference in PEBs (Eisler et al., 2003); women seem to have a greater environmental concern than men (Lynn and Longhi, 2011; Longhi, 2013). Specifically, women are more likely to adopt recycling behaviors, while men are more likely to adopt external behaviors (reading environmental materials or participating in environmental groups) (Jonhnson et al., 2004). Finally, for household size there is a negative impact on PEBs but a positive impact in relation to recycling and nature participation (Johnson et al., 2004). Household size strongly impact of gas emissions and energy consumption (Moll et al., 2005) and even though the presence of energy efficient thanks to technology innovations due to the increase of energy appliances the energy consumption increase (Abrahamse, 2011). Household size has a negative impact on PEBs (Clark et al., 2003; Johnson et al., 2004; Longhi, 2013), while has a positive impact on recycling and nature participation (Johnson et al., 2004). People living alone and couple without children have a higher PEBs that couple with children due to the presence constrains in term of time and practices (Longhi, 2013; Blankenberg et al., 2019).

Section 3: Questionnaire and data

In this section, we analyze our data and the questionnaire submitted to consumers. Our analysis is related to a Liguria region project called INTERREG ALCOTRA BIODIVALP, whose aim is the socio-economic valorization of the Ligurian Alps territories' biodiversity. The basic idea is that firms that produce within these areas support burden costs than competitors that operate in places with less biodiversity but easier logistic facilities and provide products with high ecosystem service content. The presence of ecosystem services, however, is not valued within the market price, which is lower than the optimal level. Therefore, with this project an attempt was made to estimate consumers' willingness to pay for ecosystem services contained within a particular dairy product linked to such territories: formaggetta (fat/semi-fat cheese made from cow's milk produced throughout Italy). This product was used because it is representative of the entire Ligurian Alps area, it has a sufficiently widespread consumption, and its production is strongly linked to the most relevant ecosystem services of the area. Therefore, a questionnaire was submitted to a representative sample of the Italian population in terms of age, sex, and region of residence; this means that the sample contained, for example, the same percentage of women residing in Lazio aged 40–49 years as that within the whole Italian population. The Italian population between the ages of 18 and 74 years was chosen as the reference population because this age group is more likely to do autonomous choices regarding food purchases and is less likely to have restrictions on their diet for health reasons. On the basis of this questionnaire, we concentrated on the socio-economic-demographic characteristics and consumption habits of the sample, composed of 942 consumers (see Table 3.1). To choose them we make use a firm specialized in market surveys through MEPA that administrated the questionnaire in two different moments:

- by 31 January 2021 pilot survey to 200 of consumers;
- by 28 February 2021 the rest ones.

Table 3.1: Data

SOCIO-ECONOMIC-DEMOGRAPHIC SECTION	
QUESTIONS	**ANSWERS**
Gender	0-male 1-female
Age	1=18–29 2=30–39 3=40–49 4=50–64 5=65–74
Residence	north-east north-west center islands and south foreign
Education	1-none 2-elementary school 3-average school 4-diploma from high school 5-graduate degree 6-postgraduate studies
Couple	1-do not live with partner 2-live with partner permanently

Children	1-do not live with children 2-live with one child 3-live with two children 4-live with three children 5-live with more than three children
Consumer	1-usual consumer of cheese (more than two servings per week) 2-occasional consumer of cheese (less than two servings per week)
Job (ISTAT classification of professions)	-out of jobs market (student, retired, unemployed) -craftsman/farmer/worker -business and service activities -entrepreneur and management -educational and specialized profession -executive office profession
CONSUMPTION HABITS SECTION	
QUESTIONS	**ANSWER**
Foodretail = When shopping for fresh groceries, you predominantly resort to:	1-Buying directly from the producer (including through a buying group) 2- Buying at market stalls or markets and fairs 3- Purchasing from stores and delicatessens 4- Buying from supermarkets or hypermarkets 5- Buying on internet sites
Farmshop = Buying cheese from the producer	1-never 2-rarely 3-at least once every 2–3 months 4-at least once a month 5-at least once a week
Farmersmkt = Purchasing cheese at market stalls or street markets or fairs	1-never 2-more rarely 3-at least 1 time every 2-3 months 4-at least once a month 5-at least 1 time a week
Localshop = Buying at neighborhood stores or delis	1-never 2-rarely 3-at least once every 2–3 months 4-at least once a month 5-at least once a week
Supermarket = Buying at supermarkets or hypermarkets	1-never 2-rarely 3-at least once every 2-3 months 4-at least once a month 5-at least once a week
Ecommerce	1-never 2-rarely 3-at least once every 2–3 months 4-at least once a month 5-at least once a week

PDO = choosing a product because it is a local artisanal product or one with a Protecting Designation of Origin or PGI	1-never 2-rarely 3-sometimes 4-often 5-always
Labelinfo = when buying alimentary products do you read the production logo and other information on the label?	1-never 2-rarely 3-sometimes 4-often 5-always
Organic = purchasing organic food products	1-never 2-rarely 3-sometimes 4-often 5-always
Palabel = Choosing a food product because it is produced with respect for the environment, human and workers' rights, or animal welfare	1-never 2-rarely 3-sometimes 4-often 5-always

In Table 3.2, we present a summary of the statistics on consumers' socio-economic-demographic variables, which are age, sex, number of children you live with, whether you live permanently with your partner or not, ZIP code, whether you consume cheese occasionally or habitually, and job.

For the job variable, we used the classification of occupations adopted by ISTAT: entrepreneurs/managers, artisans/farmers/workers, service and trade occupations (which includes traders, other self-employed, and free landers), out of the labor market (including students seeking first employment, housewives, retirees, unemployed, landowners, not employed), educational occupations (which are middle, high school, or elementary school teachers), and executive office occupations (which includes clerks and other office workers).

Table 3.2: Socio-economic-demographic statistics

Variable	Result
Age	18–29=10.51%; 30–39=20.81%; 40–49=21.87%; 50–64=37.58%; 65–74=9.24%
Sex	Female=50.53% male=49.47%
Number of children	1=51.38%; 2=25.16%; 3=18.90%; 4=4.03%; 5=0.53%
Couple	Do not live permanently with partner=70.49%; live permanently with partner=29.51%
Consumer	Consume cheese habitually=16.67%; consume cheese occasionally=83.33%
ZIP code	South=33.33%; north-east=25.48%; north-west=17.73%; center=20.28%; abroad=3.18%
Job	Outside=38.64%; executive office=31.53%; farmers/artisans/workers=10.72%; business or service=9.45%; entrepreneurs or managers=1.83%; education or specialized=7.86%

Tables 3.3 and 3.4 cover the relationship between our socio-economic-demographic variables, which is useful for the description of our results in the next sections. As can easily be seen, consumers with a higher-income job (entrepreneurs and managers but also educational professionals) had higher levels of education, with higher percentages of bachelor's and postgraduate degrees (47.06% and 11.76% for entrepreneurs and managers, and 44.59% and 25.68% for educational professionals, respectively). High education was also associated with educational professionals even though their income level was not associated with that of managers. For the number of children, again entrepreneurs and managers and educational professionals had a higher number of children, with the percentages of three, four, or five children being higher (29.41%, 5.88%, and 5.88% for entrepreneurs and managers, and 24.32% and 9.46% for three or four children for educational professionals, respectively), as more children means higher costs and so requires a higher income. So, we can understand that people with a higher income due to their work (as managers) consequently have a higher education, which permits them to have higher remuneration, and thus have a higher number of children.

Table 3.3: Jobs and education

	Education					
Job1	2	3	4	5	6	**Total**
Artisans, farmers and workers	0	33 (32.67%)	62 (61.39%)	4 (3.96%)	2 (1.98%)	**101 (100%)**
service and trade occupations	0	7 (7.87%)	39 (43.82%)	33 (37.08%)	10 (11.24%)	**89 (100%)**
Outside of labor market	7 (1.92%)	69 (18.96)	214 (58.79%)	68 (18.68%)	6 (1.65%)	**364 (100%)**
entrepreneurs/managers.	0	2 (11.76%)	5 (29.41%)	8 (47.06%)	2 (11.76%)	**17 (100%)**
Educational profession	0	0	22 (29.73%)	33 (44.59%)	19 (25.68%)	**74 (100%)**
Executive office	1 (0.34%)	13 (4.38%)	183 (61.62%)	87 (29.29%)	13 (4.38%)	**297 (100%)**
Total	**8 (0.85%)**	**124 (13.16%)**	**525 (55.73%)**	**233 (24.73%)**	**52 (5.52%)**	**942 (100%)**

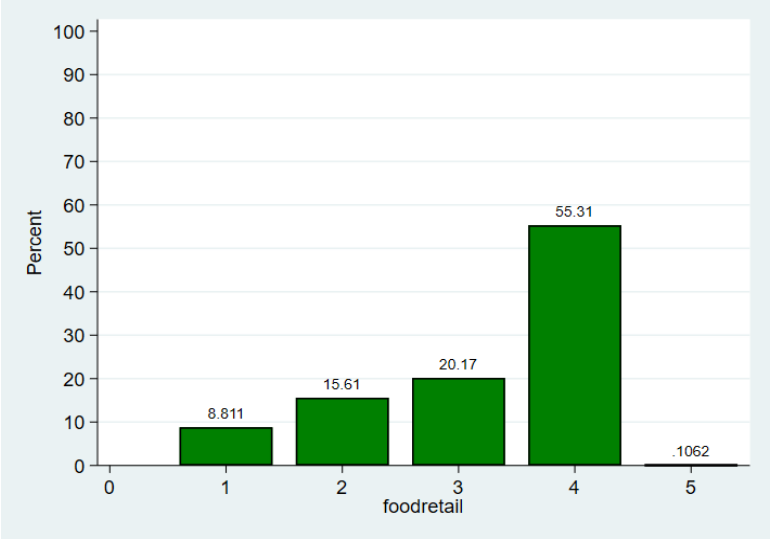
Table 3.4: Jobs and children

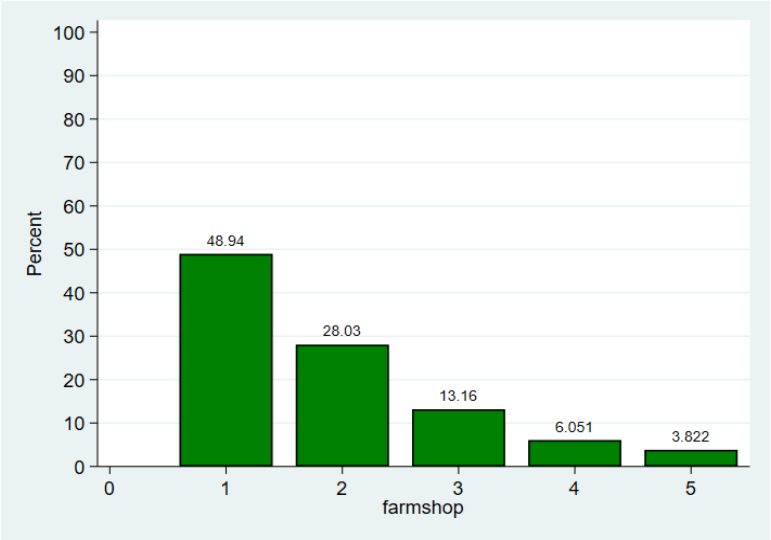
	Children					
Job1	1	2	3	4	5	**Total**
Artisans, farmers and workers	55 (54.46%)	21 (20.79%)	17 (16.83%)	7 (6.93%)	1 (0.99%)	**101 (100%)**
service and trade occupations	43 (48.31%)	26 (29.21%)	13 (14.61%)	7 (7.87%)	0	**89 (100%)**
Outside of labor market	210 (57.69%)	89 (24.45%)	54 (14.84%)	9 (2.47%)	2 (0.55%)	**364 (100%)**
entrepreneurs/managers.	5 (29.41%)	5 (29.41%)	5 (29.41%)	1 (5.88%)	1 (5.88%)	**17 (100%)**
Educational profession	30 (40.54%)	19 (25.68%)	18 (24.32%)	7 (9.46%)	0	**74 (100%)**

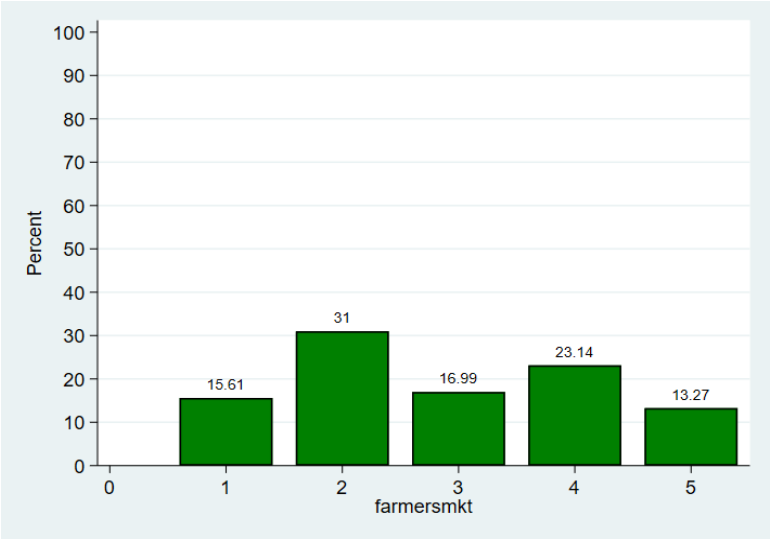
Executive office	141 (47.47%)	77 (25.83%)	71 (23.91%)	7 (2.36%)	1 (0.34%)	**297 (100%)**
Total	**484 (51.38%)**	**237 (25.16%)**	**178 (18.90%)**	**38 (4.03%)**	**5 (0.53%)**	**942 (100%)**

In relation to consumers' purchase behaviors, we used 10 variables that were discrete and ordinal with 5 categories on a Likert scale (1=never/strongly disagree to 5=always or at least one time a week/strongly agree). In Fig. 3.1, we present all of the graphs related to these variables. One can see that almost all respondents did not purchase cheese from the producer but preferred to buy it from supermarkets. Online purchases of this product do not seem to be widespread due to the many responses that they never resort to e-commerce. In relation to buying at markets and fairs or at local stores, most respondents said they buy it at least once every two to three months, once a month, or once a week. Most consumers stated that they sometimes buy organic or artisanal products or PDOs. Finally, consumers seemed to place a higher importance on the information on labels and especially on respect for animals and workers' welfare.

Figure 3.1: Graphs of consumers' purchase behaviors



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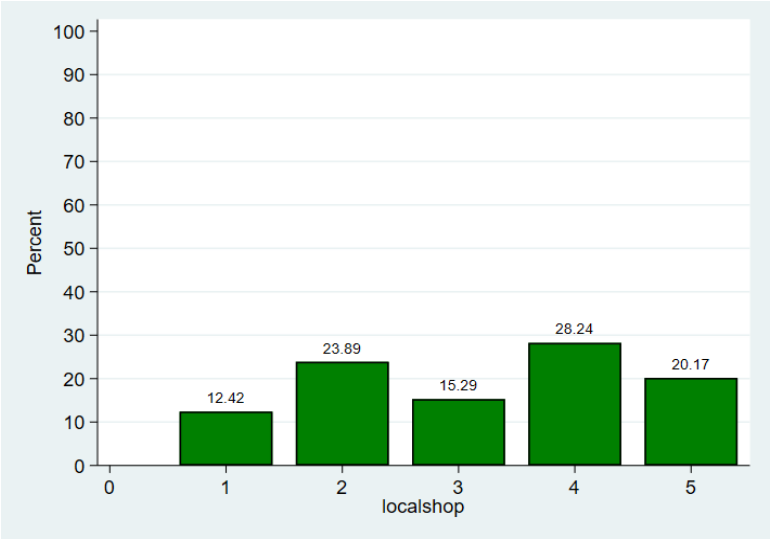
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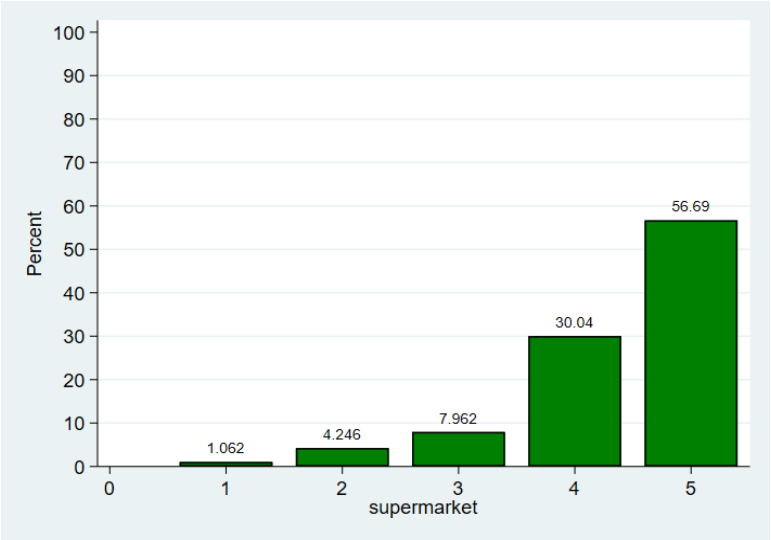
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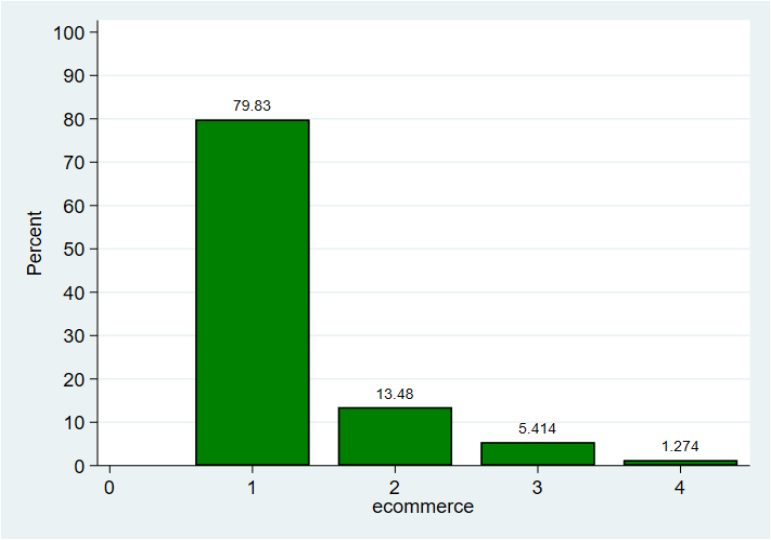
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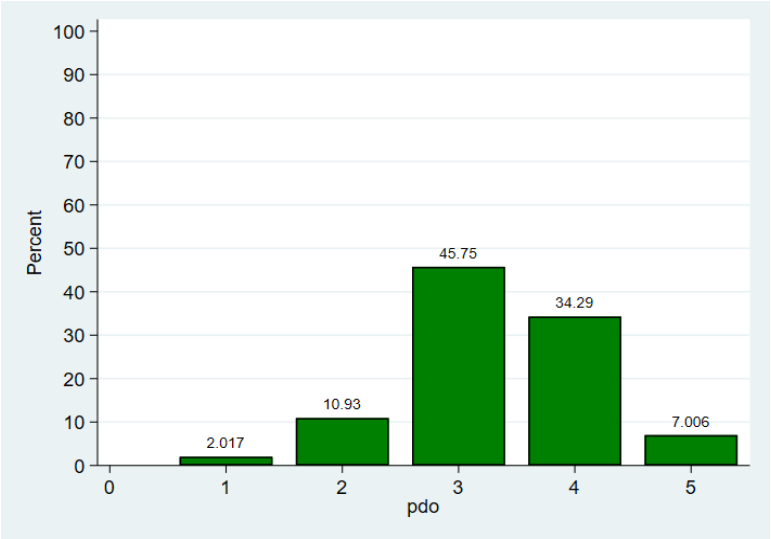
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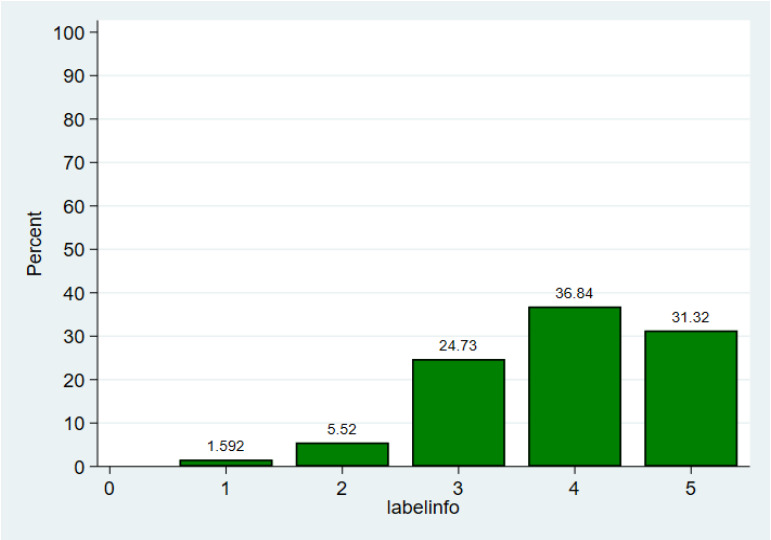
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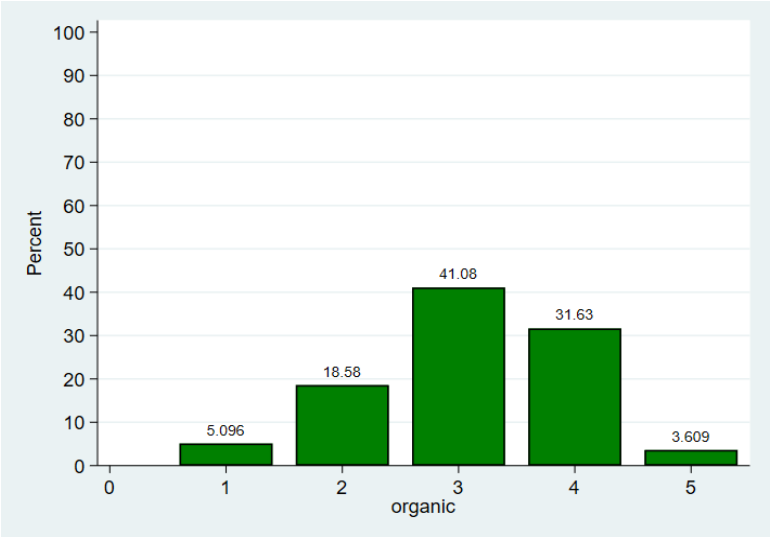
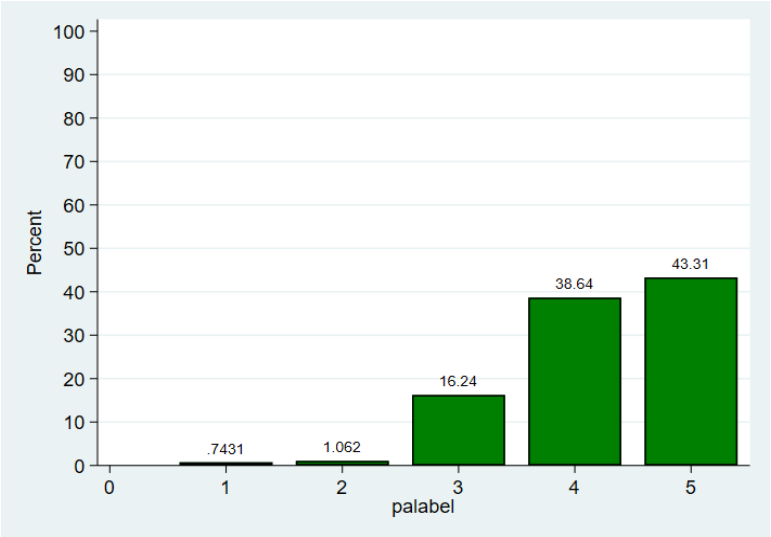


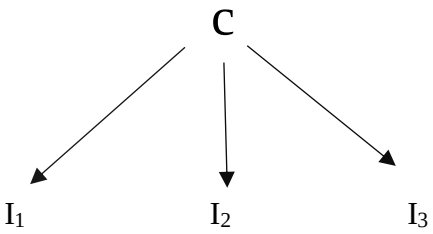


Section 4: Latent class analysis

Classifying or segmenting groups of individuals who are similar to others within a group but different from those of other groups has been the key interest of social science (Mun et al., 2008). The literature uses two different methods of segmentation: the model based and the non-model based methods. The first method assumes that the data are derived from a finite model mixture; in other words, there are subgroups described by different models and consequently the whole population is modeled by a mixture or a weighted sum of the subpopulations' models. The second method is referred to as the traditional clustering method (such as K-means clustering or hierarchical clustering), which is heuristic and not based on formal models. In this work, we used a model-based method, namely LCA, because in addition to having a reference model, our data were categorical and consequently the application of a model-based method was more viable (Andrews et al., 2010). LCA was devised in 1950 by Lazarsfeld and later developed from the 1970s onward by Goodman (1974) and Haberman (1979). It is currently applied in different fields, including consumer behavior (Chung et al., 2011; Reboussin et al., 2008), health economics (with the aim of identifying patients with different risk profiles for diseases) (Deb et al., 2002; Bago D'Uva et al., 2005a; Bago D'Uva et al., 2005b), transport mode choice (Shen, 2009), and marketing research by which different groups of customers and their buying habits are identified (Huber, 2019). LCA is a statistical method used to identify a set of

discrete, exclusive, and exhaustive latent classes of individuals based on their responses to a set of observed categorical variables (Ehrlich et al., 2017). In other words, LCA estimates an individual's probability of belonging to a latent class given their response pattern to a series of attitudinal questions by dividing the reference sample into homogeneous groups based, in our case, on their PEB (Enrlich et al., 2017). Fig. 3.2 shows the represented variables. Variable C is the latent variable that we tried to identify and I_1, I_2, and I_3 are the observed ones that depend on C.

Figure 3. 2: Latent Class Analysis (LCA)



In our model, our latent variable was consumers' PEBs, as described in Section 1, which we called PECB. This influenced consumers' purchase behaviors, which we called farmshop, farmermarket, local shop, supermarket, e-commerce, PDO, palabel, organic, and labelinfo (observable variables I_1, I_2, and I_3; see Fig. 3.3).

Figure 3.3: Our LCA representation

C=pro-environmental consumption behavior of consumers

X=farmshop, farmermarket, local shop, supermarket, e-commerce, PDO, palabel, organic, and label info

In LCA estimation, there is an assumption called local independence that says that observed variables are not correlated and, thus, are independent of each other within the same class (Vermut et al., 2004).

Assume that we have the following variables:

c=latent variables which are not observable,

c=1, ……C

q=questions for the respondents,

q=1,……Q,

s=levels of response to question q,

s=1,…….S,

i=individual

i=1,…….N

x_i=individual i's response pattern to a series of attitudinal questions, and

x_{iqs}=individual i's answer to attitudinal question q with the s level.

We therefore defined the probability that an individual i has a specific response pattern (x_i), as follows:

$$\Pr(x_i) = \sum_{c=1}^{C} \Pr(c) \Pr(x_i|c) = \sum_{c=1}^{C} \Pr(c) \prod_{q=1}^{Q} \prod_{s=1}^{S} (\pi_{qs|c})^{x_{iqs}} \quad (1)$$

where Pr(x_i) is the probability that an individual i has a response pattern Pr(c) is the probability that an individual i belonging to a particular group c, and Pr(x_i|c) represents the probability that an individual response pattern x_i is conditional on belonging to group c. It is both determined by the probability that individual i in a determinate group c responds to a particular question q with the level s ($\pi_{qs|c}$). If the individual i chooses the level s to the question q the x_{iqs}=1.

With LCA, we estimated two different parameters: the conditional probability of class membership and the item response probabilities; that is, the probability that members of a particular class will give x response to a particular indicator I (Rheard et al., 2020).

In general, estimation is done by maximizing the log-likelihood function, which is as follows:

$$\ln L = \sum_{i=1}^{N} \Pr(x_i) = \sum_{i=1}^{N} \ln \left(\Pr(c) \prod_{q=1}^{Q} \prod_{s=1}^{S} (\pi_{qs|c})^{x_{iqs}}\right) \quad (2)$$

$$\text{sub.to: } \sum_{s=1}^{S} \pi_{qs|c} = 1; \ \sum_{c=1}^{C} \Pr(c) = 1$$

With Eq. 2, we are able to estimate the parameters that maximize the log-likelihood function and so Pr(c|x_i) and $\pi_{qs|c}$. In particular, the function $\pi_{qs|c}$ is equal to

$$\pi_{qs|c} = \frac{\sum_{i=1}^{N} \Pr(c|x_i) x_{iqs}}{\sum_{i=1}^{N} \Pr(c|x_i)}. \quad (3)$$

Eq. 3 represents the proportion of the number of times that a respondent i within group c gives a particular answer s to a question q; its numerator, on the other hand, represents the number of times an individual i gives a particular answer s to an attitude demand q weighted by the conditional probability that the respondent belongs to class c, while its denominator is the number of individuals in our sample who belong to class c (Rheard et al., 2020). According to the outcome variables, which are the observable variables, we can apply different types of latent class model (such as a count model, ordinal model, multinomial logistic regression, gamma regression, and linear regression) (Stata, 2016). As already said in Section 3, for the LCA estimations we used nine variables that were discrete and ordinal, divided into five different possible answers on a Likert scale. For this reason, we applied an ordinal model in which observable variables were distributed as ordinal probit and estimated the probability that an individual would give response 1 or response 2 or response 3 or response 4 or response 5 to one of the nine outcome variables. In the following section, we discuss the results of the LCA estimation.

Section 5: Results and discussion

In this section, we will describe the results related to the application of LCA. To understand the predictive ability of the latent class model, we performed several tests in relation to the numerosity of latent classes. The model used in the end consisted of two classes, the first contained 48.94% of our sample and the second contained 51.06%. In Table 3.5, we report the estimates of the LCA made by the two classes in which the first was used as the base outcome. In relation to the consumers' socio-economic-demographic features, education children, out of labor market and executive office activities and consumer were significant; this means that the difference between the two classes was statistically significant and influenced consumers' PECB. Therefore, membership in the first or second class can be predicted based on these socio-economic-demographic variables. The other variables (age, gender, and other occupations included within jobs) were not statistically significant. From these estimations, we deducted that the second class had a high number of individuals that were more educated, had a higher habitual consumption of cheese, and had more children, with fewer individuals who were outside of the labor market. In fact, although it was non-significant given the higher education of the second class, the coefficient for entrepreneurs and managers was 0.89, which means there was a higher number of this profession in class 2. These results are in line with Tables 3.3 and 3.4 in the previous section. Class 2, in fact, had a higher number of consumers with a higher education level than class 1, but also higher income and a higher number of children than the first one; in the previous tables, in fact, we found that people with a higher income had higher education and a higher number of children. In relation to the results in Section 2, we can see that education, children, and jobs (although only in reference to "fuori") are in line with the PEB literature, underlining an impact of these variables on PEBs (at the end of this section we will understand whether they positively influence consumers' PECB or not), while age and female gender contrasted with the PEB literature, where age had a negative impact on PEBs and females adopted more PEBs, while in our case they did not have any impact.

Table 3.5: LCA covariates estimation

	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
1.C	(base outcome)					
2.C						
age	-0205013	.082687	-0.25	0.804	-.1825648	.1415622
education	.3185345	.1258804	2.53	0.011	.0718136	.5652555
children	.2244393	.0948783	2.37	0.018	.0384813	.4103972
job						
- service and trade occup.	-.5162602	.3710715	-1.39	0.164	-1.243547	.2110266
- out of the market	-.6699734	.2851651	-2.35	0.019	-1.228887	-.11106
- entrepreneurs and management	.8935774	.8744213	1.02	0.307	-.8202569	2.607412
-educational prof.	-.0712632	.4136334	-0.17	0.863	-.8819698	.7394435
-executive office	-.5778039	.2904612	-1.99	0.047	-1.147097	-.0085105
consumer	.5950802	.2239438	2.66	0.008	.1561584	1.034002
female	.0110848	.1748892	0.06	0.949	-.3316917	.3538612
_cons	-2.240118	.7489835	-2.99	0.003	-3.708098	-.7721368

Then, using the predict Stata code, for each individual we estimated the prediction probability of belonging to the first or second class, assigning to the classes with a probability greater than 0.5, in relation to significant socio-economic-demographic variables (education, children, job for "fuori"

only, and consumer). In the figures below, one can see the prediction density of consumers in each class in relation to the previous variables and can confirm what we said previously. From Fig. 3.4 we can see that class 2 had a higher number of subjects with a higher level of education than class 1; with reference to the number of children (Fig.3.5), class 2 had a higher number of respondents with more children than class 1. For labor, class 2 had a lower number of subjects out of the labor market than class 1, as can be seen from the graph below (Fig. 3.6). Finally, from Fig. 3.7, we can see that in class 2 there were a high number of people who habitually consumed cheese.

Figure 3.4: Education

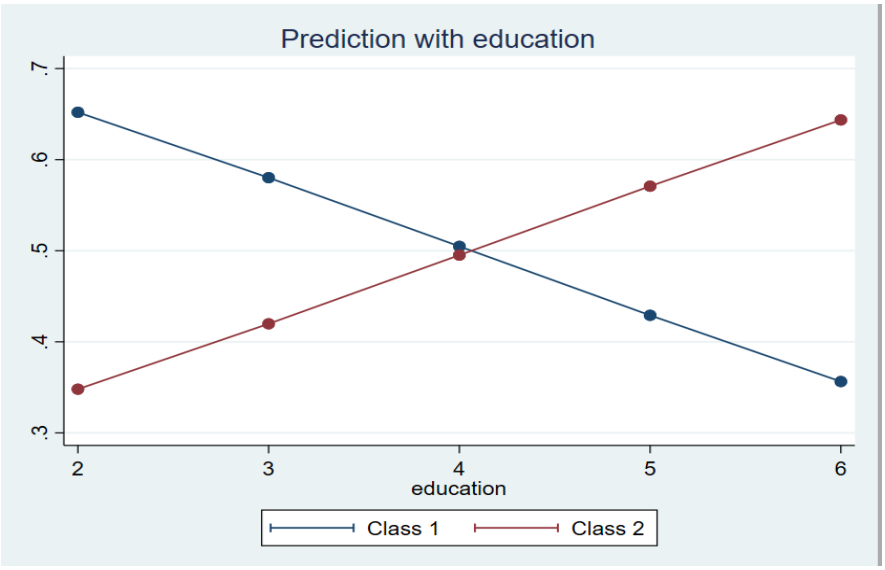


Figure 3.5: Children

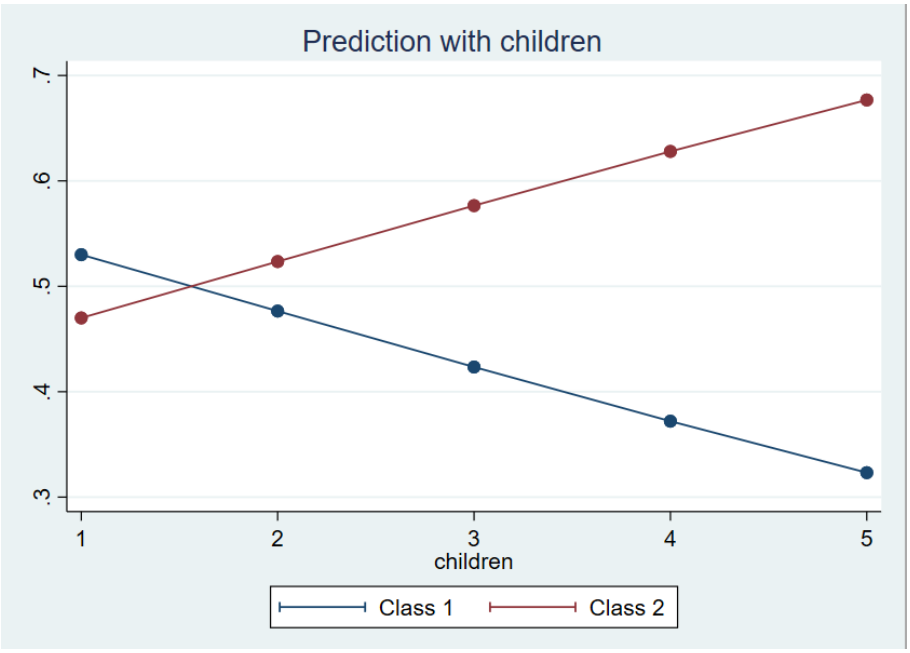


Figure 3.6: Job

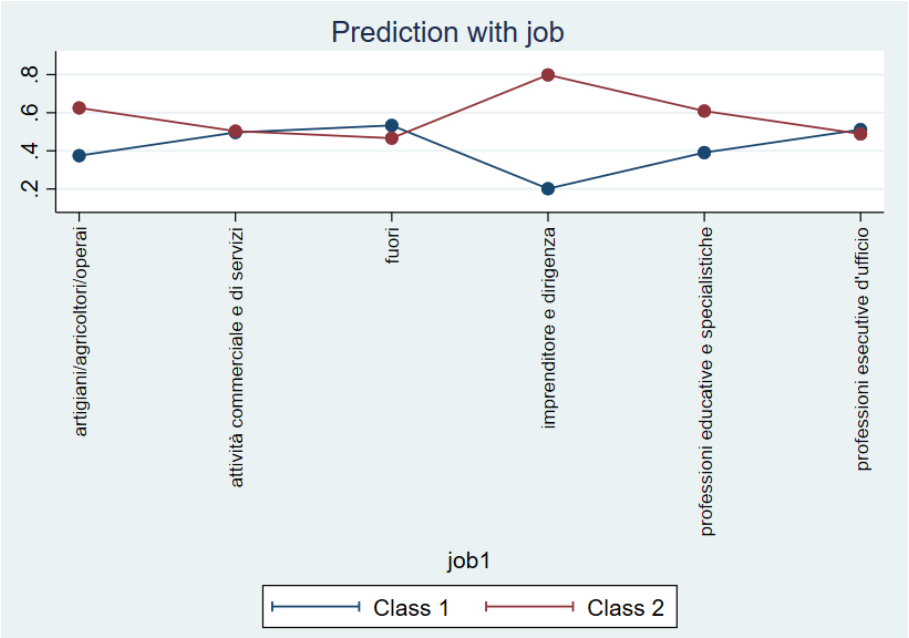
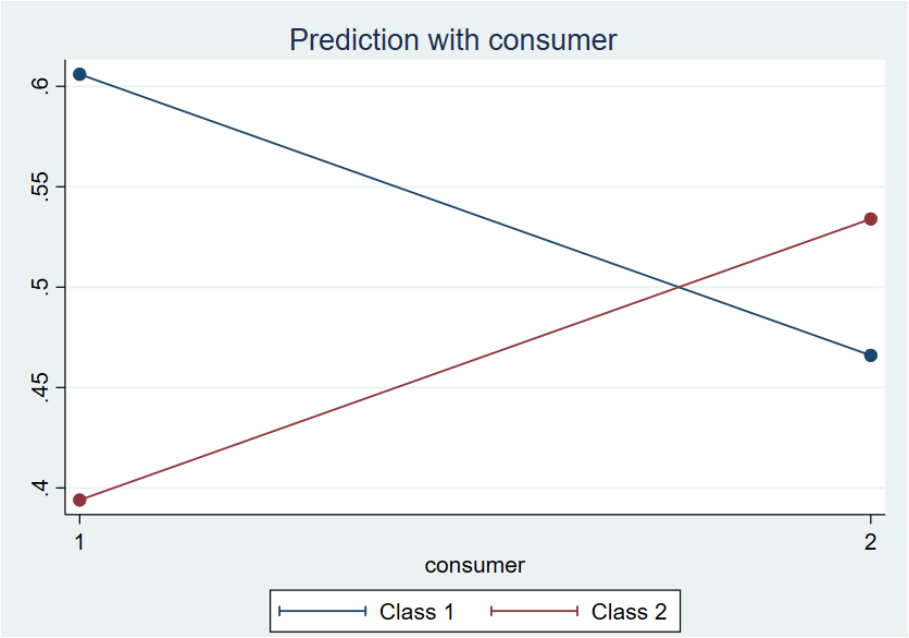


Figure 3.7: Consumer



In this last part, we will describe the behavioral variables for each class; using the Stata software, we calculated (with the lcmeans package) the marginal probability to answer 1, 2, 3, 4, and 5 related to all consumption habit variables. As can be seen from Table 3.6, in class 2 there was a greater percentage of consumers who bought cheese from the producer, with 86% of consumers in class 1 versus 67% in class 2 stating that they never or rarely bought cheese from the producer. As for buying at fairs and markets, class 2 had more individuals who bought cheese at these places. In fact, about 48% of consumers in class 1 versus about 23% in class 2 bought cheese once a month or once a week at such places. Also, as for local shops, the same situation was seen, with about 31% of class 1 versus 63% of class 2 stating that they bought cheese at least once a month or once a week at local stores.

As for buying at the supermarket, in this case a higher percentage of consumers in class 1 (about 91%) than in class 2 (about 81%) bought cheese from a supermarket once a week. When it came to e-commerce, consumers seemed not to resort to it often (about 89% of class 1 never made internet purchases of cheese; 70% for class 2). Shifting to labels, the situation was reversed so that class 2 had more consumers who always or often bought cheese because it was artisanal or PDO (10% for class 1 vs. 70% for class 2), by reading the information on the labels (48% for class 1 vs. 86% for class 2), because it was an organic product (8% for class 1 vs. 59% for class 2), or because it was produced with respect for animals' and workers' welfare (72% for class 1 vs. 89% for class 2). We will conclude by stating that class 2 had more consumers who practiced more PECBs than class 1. From the previous estimation, we know that people in class 2 had a higher level of education, higher level of income, and higher number of children. But our findings are partially in line with the PEB literature; education and income had a positive impact on PEBs, and thus people with a higher income and higher level of education had more of a propensity for PEBs, while for the number of children this was not so. The literature reports a negative impact of household size on PEBs; couples with children have lower PEB than couples without children, but in our case, it had a positive impact. These results, moreover, show the strong impact that socio-economic-demographic variables have on PEBs. We can see that consumers in class 1 had a partial propensity for PEBs; in fact, 64% of consumers said they sometimes buy PDOs, about 37% resorted to information on labels, 47% sometimes bought organic products, while about 48% often referred to information pertaining to animal and worker welfare. But they most likely cannot always apply these behaviors as they are too costly given their income.

Table 3.6: lcmeans results

VARIABLE	CLASS 1	CLASS 2
Farmshop	1- 62.42% 2- 24.53% 3- 7.92% 4- 2.40% 5- 2.73%	1- 36.03% 2- 31.37% 3- 18.18% 4- 9.53% 5- 4.89%
Farmermkt	1- 24.02% 2- 39.61% 3- 12.63% 4- 15.32% 5- 8.42%	1- 7.56% 2- 22.73% 3- 21.15% 4- 30.16% 5- 18.40%
Localshop	1- 21.05% 2- 32.55% 3- 14.35% 4- 20.57% 5- 11.48%	1- 4.13% 2- 15.56% 3- 16.19% 4- 35.58% 5- 28.54%
Supermarket	1- 0.28% 2- 3.20% 3- 4.43% 4- 28.97% 5- 63.12%	1- 1.85% 2- 5.24% 3- 11.34% 4- 31.06% 5- 50.51%
e-commerce	1- 89.84% 2- 6.72% 3- 2.48% 4- 0.96%	1- 70.23% 2- 19.95% 3- 8.23% 4- 1.59%
PDO	1- 4.12% 2- 20.95%	1- 0.03% 2- 1.32%

	3- 64.15% 4- 10.16% 5- 0.62%	3- 28.10% 4- 57.41% 5- 13.14%
labelinfo	1- 3.27% 2- 10.58% 3- 37.02% 4- 33.24% 5- 15.89%	1- 0.01% 2- 0.66% 3- 12.95% 4- 40.28% 5- 46.10%
Organic	1- 9.22% 2- 33.71% 3- 47.79% 4- 8.84% 5- 0.44%	1- 1.16% 2- 4.05% 3- 34.64% 4- 53.48% 5- 6.67%
palabel	1- 0.25% 2- 0.38% 3- 26.18% 4- 48.85% 5- 24.34%	1- 1.23% 2- 1.71% 3- 6.70% 4- 28.84% 5- 61.52%

Section 6: Conclusion

In this study we provide information to policymakers in relation to the impact of socio-economic-demographic characteristics on PECBs (pro-environmental consumption behaviors) of an Italian sample, not studied before by literature; we submitted a questionnaire to a representative sample of 942 individuals collecting information related to consumers' consumption habits and their socio-economic-demographic characteristics using, as statistical model, LCA. Our findings underlined what we expected and, so, two different types of consumers one showing less environmentally sustainable behavior and one showing more. Consumers in the second class were more educated, had more children, and had a higher income, and fewer people who were out of the labor market were present. But, not all the results obtained were as expected; in fact, in Class 1 64% of consumers said they sometimes bought PDOs, about 37% resorted to information on labels, 47% sometimes bought organic products, and about 48% often referred to information pertaining to animal and worker welfare. In order words the first class seemed to be more oriented to PECBS but, they can't apply always these behaviors due to lower income. Future policies should consider the consumers' socio-economic-demographic features as a real input of consumers' economics behaviors due to their high influence on consumption behaviors. For example, they can improve education level of consumers in order to increase income level obtaining a positive impact on environmental behaviors. A potential limitation of this study is the sample; we used a representative consumers of the population applied for another project, INTERREG ALCOTRA BIODIVALP, whose goal is the consumers' willingness to pay for "formaggetta" ecosystem services. In future developments we want to use a completely different sample properly build for this project and, also, take a representative population sample not only related to age, sex and region but to other socio-economic-demographic features with the aim to find results that can be apply to all Italian population.

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