

Article

Tradition vs. Eco-Innovation: The Constraining Effect of Protected Designations of Origin (PDO) on the Implementation of Sustainability Measures in the Olive Oil Sector

Adrián Rabadán , Manuel Álvarez-Ortí , Jacinto Tello and José E. Pardo

Higher Technical School of Agricultural and Forestry Engineering, University of Castilla-La Mancha, 02071 Albacete, Spain; manuel.alvarez@uclm.es (M.Á.-O.); jtello@agroalimentariasclm.coop (J.T.); jose.pgonzalez@uclm.es (J.E.P.)

* Correspondence: adrian.rabadan@uclm.es

Abstract: Although eco-innovation in the agri-food sector is receiving increasing attention, the heterogeneity of firms operating in the sector encourages the development of specific sub-sectoral studies to define specific strategies. In this regard, the main goal of the present study is to evaluate the drivers of eco-innovation in the olive oil production sector. Our empirical method relies on data from Spanish olive oil mills, and uses qualitative comparative analysis (QCA). The results show that large olive oil cooperatives have an important commitment to sustainability, and that cooperation with a wider range of different agents encourages the implementation of eco-innovation, particularly among smaller firms. However, the main finding of the study is the limiting effect of belonging to a protected designation of origin (PDO) on the implementation of eco-innovative measures. Although traditional production of olive oil (production under a PDO) is still perceived as a central competitive advantage in olive oil firms, further efforts should be made to coordinate traditional elaboration with production under a more sustainable management approach.

Keywords: quality label; geographical indication; cooperatives; olive oil mills; traditional production; cooperation



Citation: Rabadán, A.; Álvarez-Ortí, M.; Tello, J.; Pardo, J.E. Tradition vs. Eco-Innovation: The Constraining Effect of Protected Designations of Origin (PDO) on the Implementation of Sustainability Measures in the Olive Oil Sector. *Agronomy* **2021**, *11*, 447. <https://doi.org/10.3390/agronomy11030447>

Academic Editor: Paulina Rytkönen, Theodosia Anthopoulos, Karin Dahlström and Håkan Tunón

Received: 22 January 2021

Accepted: 24 February 2021

Published: 27 February 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The concern about the impact of company performance on the environment has increased in recent decades [1]. Studies have traditionally focused on the analysis of the drivers on the implementation of pro-sustainable measures in large companies operating in high-tech sectors [2,3]. However, in recent years, the study of companies operating in traditional sectors, such as the agri-food sector, has increased [4–6]. The agri-food sector, more than any other sector, is characterized by a direct dependence on natural resources [7]. This dependence and the increasing concern of consumers about the environmental impact of their food choices [8,9] has encouraged agri-food companies to consider sustainability as an important factor in their production strategies. The heterogeneity of the companies operating in the food sector [10] suggests conducting sub-sectoral studies to develop specific approaches. In this regard, few studies have specifically addressed the implementation of eco-innovation practices in the olive oil production sector [11].

The demand for olive oil in countries that are not traditional consumers is increasing rapidly as a result of growing interest in the Mediterranean diet worldwide [12]. The benefits of olive oil consumption range from the reduction of LDL cholesterol levels [13] to increased longevity from the reduced risk of cardiovascular disease and certain types of cancer [14–16]. Moreover its production, mainly developed in rural areas, increases incomes and retains population in these disadvantaged areas [17]. However, this increasing demand for olive oil presents certain environmental problems that need to be addressed. Olive oil production requires energy (electricity and fuel), water and chemical products (pesticides

and fertilizers) during farming [17]. However, the main environmental impact of olive oil production is the generation of olive oil waste in mills [18]. The correct management of this waste (e.g., olive oil pomace) is crucial to ensure the sustainability of the sector and reduce its impact on the environment.

Geographically, olive oil production is mainly concentrated in the Mediterranean basin, with the European Union (EU) producing 69% of olive oil worldwide [19]. Within the EU, Spain is the main olive oil producer, with 63% of the total EU production on average in the last few years, followed by Italy (17%), Greece (14%) and Portugal (5%) [19]. Due to the long tradition of olive oil production, the EU has created up to 112 Geographical Indications (GI) for oils [20] in order to protect their names and promote their unique characteristics, linked to their geographical origin and their traditional know-how [21]. In the EU, the main GIs are protected designations of origin (PDO) and Protected Geographical Indications (PGI). Although Spain dominates the production of olive oil in the EU, if PDOs are considered, Italy is the country with most denominations (38% of the total) followed by Spain (26%) and Greece (17%). The production of olive oil under these widely used labels involves production under traditional elaboration principles, which may limit the implementation of innovative, more sustainable, production practices.

Different effects have been reported regarding the impact of GIs on the promotion of sustainability, depending on the product evaluated and the methodology used [22–25]. In their study on the GIs used in the French Alps, Lamarque and Lambin [22] found that GIs were useful to promote sustainable land use. In a work on olive-oil GIs based on the analysis of indicators, Belletti, Marescotti, Sanz-Cañada and Vakoufari [25] concluded that GIs play indirect environmentally positive roles, although these effects differ across countries. Higher values of sustainability awareness were reported in GIs from Italy, France and Greece in comparison to those from Spain, Portugal and Slovenia. Conversely, Marescotti et al., [23] evaluated the changes developed in GIs due to environmental concerns, concluding that, although environmental concerns have been widely used to justify amendments intended to increase competitiveness in the fruit and vegetable sector, only small changes have been made to improve sustainable productions. Similar results were obtained in the GI for tequila, showing that this GI had failed to improve social and environmental sustainability [24].

The purpose of this paper is to evaluate the effect of different drivers in the implementation of eco-innovation in olive oil mills, paying specific attention to the effects of GIs. Specifically, the causal conditions of companies that most result in greater involvement in a wide range of eco-innovations will be identified. Within the proposed drivers, some well documented variables affecting eco-innovation will be used (e.g., firm size or R&D) [26,27], together with others whose importance has not been completely identified, such as belonging to a PDO or the effect of being a cooperative or a private capital company [28].

This paper contributes to the eco-innovation literature in different ways. First, it evaluates the drivers of eco-innovation using a sample of agri-food companies operating in a very specific sector and administering an ad hoc survey developed for this purpose. Currently, little information exists on the drivers that promote eco-innovation using data from the olive oil industry [11,29]. Secondly, within the variables included, the effects of belonging to a PDO on the implementation of eco-innovative strategies has been evaluated. While PDOs are useful to ensure the traditional production of a product (olive oil in this paper), these quality labels and their restrictive technical production rules [30] could be constraining the development of eco-innovations within this sector. Finally, to analyze the database, a novel methodology, qualitative comparative analysis (QCA), has been used. This method is useful when analyzing databases that account for a reduced number of total companies, even when data from a significant percentage of the existing companies within the initial population have been obtained [31,32].

The paper is structured as follows. Section 2 includes the theoretical framework and the literature review on the drivers of eco-innovation. Section 3 presents the information

about the database and the methodology used to analyze the data. Then, Section 4 describes the results and discusses their implications. Finally, Section 5 includes the conclusions, limitations and future lines of research.

2. Theoretical Framework

The implementation of innovative measures that respect the environment has received different names in the literature, from green innovation to environmental innovation or eco-innovation [1]. However, in recent years, the term eco-innovation has been consolidated. Eco-innovation is defined in the Oslo Manual as “the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organization (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives” (p. 8) [33]. There are two main kinds of eco-innovations: technological and non-technological innovations. The former refers to the production of eco-innovative products and the use of novel and more sustainable production methods [34], while the latter refers to new management, marketing or business practices intended to reduce the impact of the company performance on the environment [33,35].

Some firms recognize that the implementation of eco-innovation can lead them to maintain or obtain competitive advantages [1]. In this regard, a recent study developed in the Spanish agri-food sector showed that implementing technological eco-innovations is one of the conditions that greatly benefits firm performance [35]. However, the literature also shows that small companies find it difficult to convert sustainable practices into competitive advantages [36], reducing their implication in eco-innovation processes [7]. If eco-innovation can improve the performance of agri-food firms in the market, specific studies focused on the drivers that promote these environmentally friendly practices are needed.

In recent years, three different groups of drivers of firms’ eco-innovation have been identified: the technology push [34,37–40], the market pull [41–43] and the regulatory push/pull [6,44] (Figure 1).

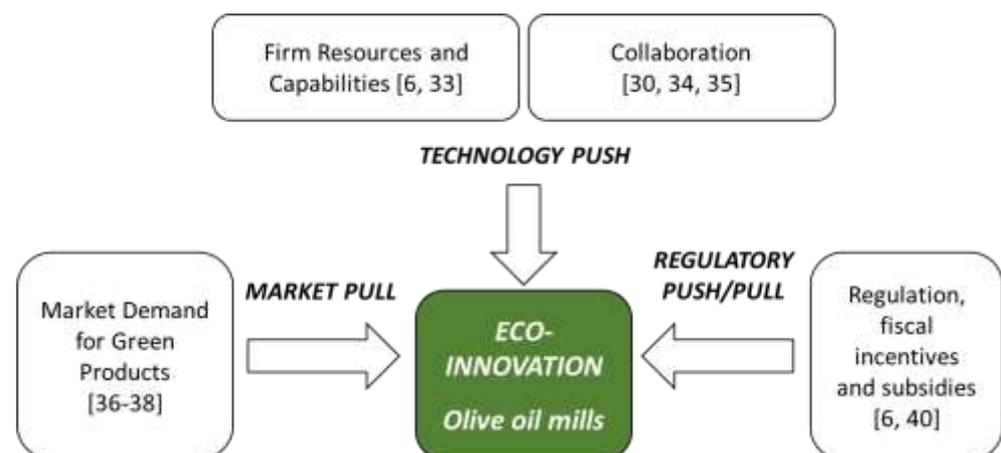


Figure 1. Drivers of eco-innovation. Adapted from Triguero et al. [5].

The market pull towards eco-innovation is based on the increasing demand for green products and services [41–43]. Some studies have shown that consumers are willing to pay more for products that are produced in a more sustainable way [45]. Accordingly, in order to produce eco-innovative products, the percentage of surface area dedicated to organic production has doubled globally in the last ten years [46]. This increase is the direct result of a higher demand from consumers that are more concerned about how their consumption affects the environment [45,47–49]. In the demand for organic products, those with direct plant origin, mainly fruits and vegetables, are the most widely consumed products [47].

Within the olive oil sector, the number of consumers interested in more sustainable products has risen [50]. In this regard, there has been an increase in the acceptance of certified organic olive oils [51], or even the acceptance of foods obtained from upcycled ingredients of olive oil production [50].

The technology push includes the impact of a firm's resources and capabilities and the effects of collaboration with external agents. In order to develop and use different types of eco-innovations, firms must have adequate resources and capabilities [37]. Traditionally, larger companies have been expected to implement environmentally friendly measures to a greater extent. However, the effect of firm size is not always conclusive in the manufacturing sector [52,53]. Conversely, in a recent meta-analytical review on eco-innovation drivers, Bitencourt, de Oliveira Santini, Zanandrea, Froehlich and Ladeira [26] found that size and R&D were significant antecedents of eco-innovation. Previously, a positive effect of firm size on the degree of digital innovation in food cooperatives was found [54].

When firms are unable to build the necessary knowledge base to develop eco-innovations by themselves, cooperation with other agents is crucial [34]. Acosta et al. [55] argue that agri-food firms are aware of the importance of external sources of knowledge and benefit from a well-developed inter-industry and inter-sector network. In general, firms operating in the agri-food industry acquire innovations from external sources [1]. The development of collaborative networks is more important in small companies, which are unable to develop eco-product and eco-process innovations internally [34]. Regarding the optimal number of partners, González-Moreno, et al. [56] concluded that an inverted U shape appears in the relationship of breadth of external knowledge sources due to coordination difficulties and bounded rationality.

The literature has also identified regulation, fiscal incentives, and subsidies as eco-innovation drivers. Specifically, regulations about contaminant emissions or waste management encourage firms to reduce their impact on the environment, obtaining higher benefits than the costs of paying fines for non-compliance [57]. Regulation is mainly imposed by external agents, such as governments, but firms can also self-impose production rules to obtain specific benefits. This is the case of firms deciding to take membership of a GI. According to the European Commission "a geographical indication is a distinctive sign used to identify a product as originating in the territory of a particular country, region or locality where its quality, reputation or other characteristic is linked to its geographical origin" [58]. In order to make use of the GI label, firms must comply with the GI technical production rules [30]. Various studies have evaluated the effect of other quality certifications (not GIs) on firms' eco-innovation. For example, Godoy-Durán, et al. [59] included quality certifications (e.g., Integrated Pest Management) in their study about farm eco-efficiency and, later, García-Granero, Piedra-Muñoz and Galdeano-Gómez [4] used the number of quality certifications (e.g., GLOBAL G.A.P or GRASP) as a proxy to evaluate marketing eco-innovation in agri-food firms. Studies specifically involving GI labels have mainly been focused on the effects of labels on consumer preferences [60,61], but not on their effects on company management.

3. Materials and Methods

3.1. Database

The EU is the largest olive oil producer worldwide, with Spain being the largest olive oil producing country in the EU (63% of total production) [19]. Within Spain, Castilla-La Mancha is the second largest olive oil producing region, after Andalusia [62]. To develop this study, data from 52 olive oil mills in the Castilla-La Mancha region were obtained using an ad hoc survey. According to the database produced by the Iberian Balance Sheet Analysis System (SABI, in its Spanish acronym), up to 128 olive oil mills exist in the region. Considering that information, our sample includes data on 40.6% of companies operating in the region. Descriptive statistics from the database are shown in Table 1. Castilla-La Mancha has up to six different PDOs for olive oil, covering most of its territory [63]. The

sample includes data on olive oils mills from different PDOs operating in different parts of the region (Figure 2).

Table 1. Definition of variables and descriptive statistics.

Variable	Description	Mean	SD	Min	Max
Eco.Inn	Number of different types of eco-innovations developed in the last three years	1.8	1.6	0	5
Coop	Company is a cooperative (0, it is not; 1, it is)	0.8	0.4	0	1
PDO	Company belongs to a PDO (0, does not belong; 1, belongs)	0.6	0.5	0	1
Employ.	Number of employees	7.8	11.9	1	74
Supply	Number of olive suppliers	536	358.3	2	1,200
Quantity	Quantity of olive oil processed (Kgs)	673,225	690,432	30,000	1,600,000
Ext.Virgin	Extra virgin olive oil as percentage of total olive oil production	67.8	26.3	10	100
Porc.Inn.	R&D expenditure as percentage of sales (%)	2.0	4.0	0.0	16.0
Exports	Olive oil production exported (%)	31.1	31.4	0	100
Coop.Agents	Cooperation with different agents (number)	1.8	1.5	0	5

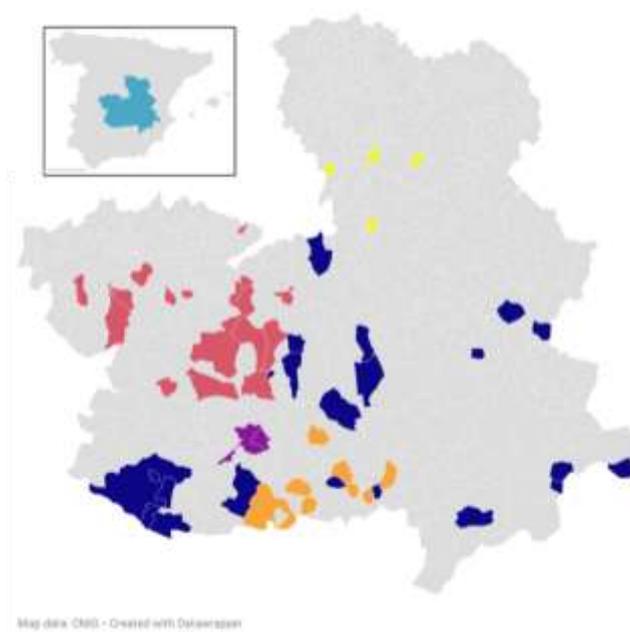


Figure 2. Location of the olive oil mills included in the study. Different colors indicate membership of different PDOs. Yellow is for PDO *Aceite de La Alcarria*; red is for PDO *Montes de Toledo*; purple is for PDO *Aceite Campo de Calatrava*; orange is for PDO *Aceite Campo de Montiel* and blue for oils mills without PDO certification.

3.2. Methodology

Qualitative Comparative Analysis (QCA) has been implemented in this study. This method uses small to intermediate samples and allows generalization (external validity) relying on a strong case orientation [64,65]. To ensure generalization, the selected cases should be specifically chosen and in-depth case knowledge is needed to ensure internal validity [31]. Although the present study could have been developed using traditional methodologies, QCA has advantages that encourage its use in organizational studies [66]. The main advantage of QCA is that it permits conjunctural causation and multiple causation [67]. This condition allows us to study the combination of causal attributes (independent variables in a traditional study) that generate the outcome (dependent variable) and, at the same time, evaluate whether that outcome could be achieved using a

different combination of causal attributes [68]. The presence or absence of each causal attribute is considered in each configuration that results in the studied outcome. Another of the advantages of QCA is that it relies on asymmetrical relationships, overcoming the limitations of linearity and complementary association between variables that appear in traditional methods [35,67].

Two specific QCA methods were used in this study: crisp-set qualitative comparative analysis (csQCA) and fuzzy-set qualitative comparative analysis (fsQCA) (Table 2). The former is used for binary variables which are calibrated using categorical conditions assigning full membership (value 1) or full-non membership (value 0) to the variable (e.g., the company belongs/does not belong to a PDO), while fsQCA is used for continuous variables (e.g., the R&D expenditure as percentage of sales). In fsQCA, the categorization of variables combines qualitative and quantitative methods, requiring theoretical and substantive knowledge of the cases and the context [65,69,70]. The quantitative cut-off values to create the groups range from full non-membership (percentile 5) to full membership (percentile 95) with percentile 50 representing the maximum ambiguity. For example, olive oil mills were classified according to the percentage of olive oil production exported on a continuous scale from 0 to 1, with companies with an exported percentage of more than 25% being classified as “higher exporters” and olive oil mills with less than 25% as “lower exporters”. Although percentile determination is the basis for the classification of the companies, the breakpoints obtained are then adjusted on the basis of substantive knowledge of the context [34,65,69,70] (Table 2).

Table 2. Calibration values.

Variable	Membership Threshold Values (Percentiles)			Membership Threshold Values (Selected)		
	Full Non-Membership (0.05)	Crossover Point (0.5)	Full Membership (0.95)	Full Non-Membership	Crossover Point	Full Membership
Eco.Inn	0	2	5	0	1.9	4.9
Coop	0		1	0		1
PDO	0		1	0		1
Employ.	1	4	27.4	1	4	27.4
Supply	3	480	1000	3	480	1000
Quantity	54,000	500,000	1,240,000	54,000	500,000	1,240,000
Ext.Virgin	22.5	75.0	99.0	22.5	75.0	99.0
Porc.Inn.	0	1	12.2	0	1	12.2
Exports	0.0	25.0	80.0	0.0	25.0	80.0
Coop.Agents	0	2	4	0	1.9	3.9

After calibrating the variables, the analysis of necessity is performed. The aim of this analysis is to evaluate whether one, or several, of the variables considered are necessary to achieve the outcome, which, in this study, is the intensity of involvement in eco-innovation practices. A condition is reported as necessary when its consistency is very high (>90–95%) and its coverage is not too low (>0.50) [32,35]. The results of our analysis of necessary conditions are shown on Table 3. The highest consistency value reported is 1 for the absence of membership of a PDO (~PDO). However, the coverage value for this condition is lower than 0.5, so it cannot be considered “necessary”. The results show that none of the variables considered is a necessary condition to increase the involvement of olive oil mills in eco-innovation strategies.

The following step is the creation of the truth table. The truth table contains all logically possible combinations (2^k) of causal conditions (k). Each case (in the present study each olive oil mill) is assigned to a row of the truth table (a configuration) depending on the antecedent conditions it meets. The commonalities that lead to the selected outcome are computed using Boolean algebra [32]. The logical minimization process that leads to the reduction of the cases is performed using the Quine–McCluskey algorithm [65]. Two

parameters are used to evaluate the goodness of fit of the final solution: coverage and consistency. Coverage refers to the percentage of cases (percentage of olive oil mills) for which a configuration is valid, while consistency quantifies to what extent cases with similar conditions obtain the same outcome [9,71]. Of the proposed solutions of the QCA, the intermediate solution was selected as it is that recommended in the literature to interpret the obtained results [72].

Table 3. Companies' valuation of their involvement in eco-innovation. Analysis of necessary conditions.

Conditions Tested *	Consistency	Coverage
Coop	0.719520	0.455600
~Coop	0.280480	0.555000
PDO	0.000000	1.000000
~PDO	1.000000	0.479697
Employ.	0.612129	0.662338
~Employ.	0.679090	0.585193
Suppy	0.694883	0.676923
~Suppy	0.550853	0.520597
Quant.	0.715730	0.598521
~Quant.	0.562855	0.633262
Ext.Virgin	0.698042	0.610497
~Ext.Virgin	0.530006	0.563087
Porc.Inn.	0.473152	0.773760
~Porc.Inn.	0.727101	0.493568
Exports	0.611592	0.610414
~Exports	0.561592	0.521102
Coop.Agents.	0.697410	0.690864
~Coop.Agents.	0.524321	0.487662

* The symbol (~) represents the negation of the characteristic.

4. Results and Discussion

The configurations that lead to higher involvement in different types of eco-innovation are shown in Table 4. In the configurations, black circles (●) indicate the condition is present, white circles, that it is absent (○) and no circle indicates that the condition is not binding for that specific configuration [35,72]. The results show that up to eight different configurations (causal paths) explain greater involvement in eco-innovation practices of olive oil mills. The coverage of the model is very high (0.634) and the consistency values for each configuration range between 0.815 and 1.000, higher than the minimum consistency values recommended in the literature (0.75–0.80) [68]. Following Ragin's recommendation [70], the configurations with the highest raw coverage should receive further attention as they comprise a larger number of cases.

Table 4. Models predicting the involvement of olive oil mills in different types of eco-innovations.

Configuration No.	Coop	PDO	Employ	Supply	Quant	Ext.Virgin	Porc.Inn	Exports	Coop.Agents	Coverage		Consistency
										Raw	Unique	
1	●	○	●	●	●	●		○	○	0.228680	0.12192	0.815315
2	●	○	●	●	●	○	○	●	●	0.185723	0.048010	0.910217
3	●	○	○	○	●	○	○	○	●	0.171826	0.045483	0.855346
4	●	○	○	●	●	●	●	●	●	0.156033	0.034744	0.972441
5	●	○	○	○	○	○	●	●	●	0.123816	0.059380	0.907407
6	○	○	○	○	○	○	●	●	●	0.120025	0.059380	1.00000
7	○	○	●	○	●	●	●	●	●	0.083386	0.019583	0.985075
8	○	○	●	●	●	●	○	●	○	0.058117	0.033480	0.968421
Solution coverage: 0.639293												
Solution consistency: 0.878472												

Frequency threshold = 1; consistency threshold = 0.805687.

The conditions that led to higher involvement in eco-innovation practices in the largest number of mills are those reported in Configuration 1 (coverage 22.9%). This configuration includes cooperatives with a high number of employees and olive suppliers that process high amounts of olives and whose production relies mainly on high-quality extra virgin

olive oil. However, this group of eco-innovative mills does not participate in a PDO, exports only a small part of its production and does not cooperate with a large number of different agents. According to previous studies, the high engagement of these olive oil mills with eco-innovation may be explained by their larger size [26]. In food production, large companies show advantages based on economies of scale and bargaining power with the highly concentrated food retail sector [73]. Specifically, large companies within the EU food industry usually obtain a higher level of profits [74,75] and higher financial performance has been proposed as a driver of eco-innovative behavior [76]. In a recent study, Rabadán et al. [35] found that large agri-food companies do not need to cooperate with stakeholders in order to develop and use eco-innovations. In our sample, most of the companies that make intense use of eco-innovation are large cooperatives (Configurations 1 and 2).

Although being a cooperative increases the likelihood of making intense use of eco-innovation (Configurations 1 to 5), causal conditions vary. Under close-to-perfection conditions, a large cooperative that produces high quality olive oil, invests highly in R&D, exports a large percentage of its production and shows intense cooperation with stakeholders, has up to a 97.2% chance of showing intense eco-innovation behavior (Configuration 4). The percentage of extra virgin olive oil produced is used as a proxy for the mills' concern about the quality of their production. Previously, links between improved quality and superior environmental performance in manufacturing firms have been reported [77]. García-Granero, Piedra-Muñoz and Galdeano-Gómez [4] found that Spanish agri-food companies with greater commitment to the environment showed a higher tendency to meet quality market standards using a higher number of certifications. In this regard, it was expected that eco-innovative mills would produce oil with the highest possible quality (extra virgin olive oils) [78], in order to meet the standards of those more demanding consumers.

Within privately owned olive oil mills, those that are larger (higher number of employees and higher quantity of olives processed) also show high chances (96.8%) of being very active in the use of different types of eco-innovations (Configurations 7 and 8). On the other hand, companies that are smaller should have high investment in R&D, being export-intensive and show strong cooperation networks with different stakeholders in order to show a similar orientation towards eco-innovation (Configuration 6). However, and although cooperatives tend, by nature, to be larger, smaller cooperatives (Configuration 5) rely on the same conditions as small capitalist companies in order to be more eco-innovative. Previous studies have suggested that small companies cooperate with other agents to limit costs [79] and reduce the risks and uncertainty associated with the innovation process [27]. Within the proposed configurations, only the small mills that cooperate intensively make intense use of eco-innovation.

Focusing on the effect of specific conditions (variables) on eco-innovation, the configurations show that cooperation with a large number of stakeholders and intense exports boost the chance of olive oil mills making intense use of eco-innovation. Previous studies have suggested that cooperation with different external sources has a positive effect on the adoption of eco-innovations in manufacturing companies [80,81]. Regarding exports, Keshminder and Rio [82] found that exporting behavior had an indirect effect on eco-innovation through the environmental strategy of the company. However, counterintuitive results are obtained regarding the effect of R&D-to-sales ratio on eco-innovation (Configurations 1 to 3). Traditionally, the agri-food sector has been defined as a low-technology sector with reduced R&D-to-sales ratio [83]. Although investment in R&D has been considered a crucial antecedent of eco-innovation in most manufacturing sectors [26], specific results obtained for the agri-food sector suggest that the effect of R&D on the development of eco-innovations in this sector is limited [6]. It should be considered that eco-innovations in this sector are mainly incremental [5] and these cheaper innovations, mainly copied from other companies or sectors, do not require great R&D investment.

Important conclusions can be obtained from the absence of the condition of PDO membership in all the configurations explaining the intense involvement in eco-innovation of olive oil mills. The results suggest that to actively develop different types of eco-

innovation, olive oil mills should not belong to a PDO. This condition applies for the eight reported configurations. Previously a positive effect of different quality certifications, such as integrated pest management labels or private labels, such as GLOBAL G.A.P, on eco-efficiency and eco-innovation of agri-food companies was proposed [4,59]. This result has significant implications for the role that PDO certifications should have in the development of sustainable products within the EU. Although this conclusion should be specifically addressed in future studies, some ideas to explain this result are presented. Production under a PDO is severely controlled under the provisions of the PDO technical production rules [30] and these restrictive rules may be limiting the implementation of eco-innovations. However, it should also be considered that this constraint may not be the result of technical production rules, but the result of the company manager's vision. The production of olive oil under a PDO is restricted to areas with a strong tradition of olive oil production under long-established production conditions [84]. Arguably, that vision of traditional production is understood as a mills' competitive advantage, constraining their commitment to innovative strategies.

5. Conclusions

Due to the expanding demand for olive oil worldwide and the increasing environmental awareness of consumers, the olive oil production sector should pay specific attention to its environmental sustainability in the long term. The implementation of eco-innovation measures is crucial to ensure the production of high-quality products, reducing the environmental impact of their production. This study has specifically studied the drivers of eco-innovation in olive oil mills operating in the Castilla-La Mancha region (Spain) in order to develop specific strategies to encourage the sustainability of the sector.

The results show that olive oil cooperatives are substantially committed to sustainability and also underline the crucial role of cooperation in small mills that find it difficult to implement eco-innovation by themselves. In this regard, the public authorities should continue to encourage the creation of larger olive oil cooperatives as these companies make more intense use of eco-innovation. The creation of clusters among firms operating in the olive oil sector and with external agents, should also improve the performance of olive oil firms and, at the same time, increase their sustainability. Nevertheless, the most important finding of the study is regarding the constraining effect of belonging to a PDO on the implementation of eco-innovation. This is attributed to the restrictive technical production rules that apply to a PDO or to the perception of the "traditional elaboration of the product" as a competitive advantage in those firms. Further analysis of the reasons for this finding should be conducted, as under no circumstances should the environmental sustainability of this sector be compromised by a more traditional production of olive oil. If PDO technical production rules are limiting the implementation of eco-innovation, an effort should be made to adapt those specific rules without compromising the integrity of the label.

The present study has some limitations. First, although the consistency and coverage of the models are adequate, the question regarding whether the variables used are the best proxies to identify the drivers of eco-innovation in olive oil mills remains. Second, our study only includes data on Spanish olive oil mills and the stability of the obtained results in other countries and other agricultural sectors must be proven. In this regard, future research should include the study of the effects of GI labels and more specifically PDOs, on the implementation of eco-innovation measures in the olive oil sector in other countries and, in general, in other agri-food subsectors.

Author Contributions: Conceptualization, A.R.; methodology, A.R., and J.T.; formal analysis, A.R., M.Á-O. and J.E.P.; resources, J.T. and J.E.P.; writing—original draft preparation, A.R., M.Á.-O., J.T. and J.E.P.; writing—review and editing, A.R.; supervision, A.R., M.Á.-O., and J.E.P.; funding acquisition, J.E.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research was partially funded by the University of Castilla-La Mancha and the European Regional Development Fund. Grant number 2018/11744.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

References

- Díaz-García, C.; González-Moreno, Á.; Sáez-Martínez, F.J. Eco-innovation: Insights from a literature review. *Innov. Manag. Policy Pract.* **2015**, *17*, 6–23. [CrossRef]
- Schiederig, T.; Tietze, F.; Herstatt, C. Green innovation in technology and innovation management—Exploratory literature review. *R D Manag.* **2012**, *42*, 180–192. [CrossRef]
- Segarra-Onã, M.; Peiró-Signes, A.; Payá-Martínez, A. Factors influencing automobile firms' eco-innovation orientation. *EMJ-Eng. Manag. J.* **2014**, *26*, 31–38. [CrossRef]
- García-Granero, E.M.; Piedra-Muñoz, L.; Galdeano-Gómez, E. Multidimensional assessment of eco-innovation implementation: Evidence from Spanish agri-food sector. *Int. J. Environ. Res. Public Health* **2020**, *17*, 1432. [CrossRef] [PubMed]
- Triguero, A.; Fernández, S.; Sáez-Martínez, F.J. Inbound open innovative strategies and eco-innovation in the Spanish food and beverage industry. *Sustain. Prod. Consum.* **2018**, *15*, 49–64. [CrossRef]
- Cuerva, M.C.; Triguero-Cano, Á.; Córcoles, D. Drivers of green and non-green innovation: Empirical evidence in Low-Tech SMEs. *J. Clean. Prod.* **2014**, *68*, 104–113. [CrossRef]
- Revell, A.; Rutherford, R. UK environmental policy and the small firm: Broadening the focus. *Bus. Strategy Environ.* **2003**, *12*, 26–35. [CrossRef]
- Piester, H.E.; DeRieux, C.M.; Tucker, J.; Buttrick, N.R.; Galloway, J.N.; Wilson, T.D. "I'll try the veggie burger": Increasing purchases of sustainable foods with information about sustainability and taste. *Appetite* **2020**, *155*. [CrossRef] [PubMed]
- Rabadán, A.; Díaz, M.; Brugarolas, M.; Bernabéu, R. Why don't consumers buy organic lamb meat? A Spanish case study. *Meat Sci.* **2020**, *162*. [CrossRef]
- Negra, C.; Remans, R.; Attwood, S.; Jones, S.; Werneck, F.; Smith, A. Sustainable agri-food investments require multi-sector co-development of decision tools. *Ecol. Indic.* **2020**, *110*. [CrossRef]
- Labella, R.C.; Fort, F.; Rosa, M.P.; Armenteros, E.M.M. *Determining Factors of Voluntariness in Sustainable Environmental Innovation (Eco-Processes) and Their Certification: Agri-Food Sector*; Academic Conferences International Limited: Reading, UK, 2017; pp. 125–132.
- Martínez-González, M.Á.; Hershey, M.S.; Zazpe, I.; Trichopoulou, A. Transferability of the Mediterranean diet to non-Mediterranean countries. What is and what is not the Mediterranean diet. *Nutrients* **2017**, *9*, 1226. [CrossRef]
- Hernández, A.; Farràs, M.; Fitó, M. Olive oil phenolic compounds and high-density lipoprotein function. *Curr. Opin. Lipidol.* **2016**, *27*, 47–53. [CrossRef]
- Ostrowska, E.; Gabler, N.K.; Ridley, D.; Suster, D.; Eagling, D.R.; Dunshea, F.R. Extra-virgin and refined olive oils decrease plasma triglyceride, moderately affect lipoprotein oxidation susceptibility and increase bone density in growing pigs. *J. Sci. Food Agric.* **2006**, *86*, 1955–1963. [CrossRef]
- Chin, K.Y.; Ima-Nirwana, S. Olives and bone: A green osteoporosis prevention option. *Int. J. Environ. Res. Public Health* **2016**, *13*, 755. [CrossRef]
- Del Río, L.F.; Gutiérrez-Casado, E.; Varela-López, A.; Villalba, J.M. Olive oil and the hallmarks of aging. *Molecules* **2016**, *21*, 163. [CrossRef] [PubMed]
- Banias, G.; Achillas, C.; Vlachokostas, C.; Moussiopoulos, N.; Stefanou, M. Environmental impacts in the life cycle of olive oil: A literature review. *J. Sci. Food Agric.* **2017**, *97*, 1686–1697. [CrossRef]
- Antónia Nunes, M.; Costa, A.S.G.; Bessada, S.; Santos, J.; Puga, H.; Alves, R.C.; Freitas, V.; Oliveira, M.B.P.P. Olive pomace as a valuable source of bioactive compounds: A study regarding its lipid- and water-soluble components. *Sci. Total Environ.* **2018**, *644*, 229–236. [CrossRef] [PubMed]
- EC. Available online: https://ec.europa.eu/info/news/producing-69-worlds-production-eu-largest-producer-olive-oil-2020-feb-04_en (accessed on 8 December 2020).
- EC. eAmbrosia. The EU Geographical Indications Register. Available online: <https://ec.europa.eu/info/food-farming-fisheries/food-safety-and-quality/certification/quality-labels/geographical-indications-register/> (accessed on 13 December 2020).
- EC. Quality Schemes Explained. Available online: https://ec.europa.eu/info/food-farming-fisheries/food-safety-and-quality/certification/quality-labels/quality-schemes-explained_en (accessed on 13 December 2020).
- Lamarque, P.; Lambin, E.F. The effectiveness of marked-based instruments to foster the conservation of extensive land use: The case of Geographical Indications in the French Alps. *Land Use Policy* **2015**, *42*, 706–717. [CrossRef]
- Marescotti, A.; Quiñones-Ruiz, X.F.; Edelmann, H.; Belletti, G.; Broscha, K.; Altenbuchner, C.; Penker, M.; Scaramuzzi, S. Are Protected Geographical Indications Evolving Due to Environmentally Related Justifications? An Analysis of Amendments in the Fruit and Vegetable Sector in the European Union. *Sustainability* **2020**, *12*, 3517. [CrossRef]
- Bowen, S.; Zapata, A.V. Geographical indications, terroir, and socioeconomic and ecological sustainability: The case of tequila. *J. Rural Stud.* **2009**, *25*, 108–119. [CrossRef]
- Belletti, G.; Marescotti, A.; Sanz-Cañada, J.; Vakoufaris, H. Linking protection of geographical indications to the environment: Evidence from the European Union olive-oil sector. *Land Use Policy* **2015**, *48*, 94–106. [CrossRef]

26. Bitencourt, C.C.; de Oliveira Santini, F.; Zanandrea, G.; Froehlich, C.; Ladeira, W.J. Empirical generalizations in eco-innovation: A meta-analytic approach. *J. Clean. Prod.* **2020**, *245*, 118721. [[CrossRef](#)]
27. Van Kranenburg, H.; Hagedoorn, J.; Pennings, J. Measurement of International and Product Diversification in the Publishing Industry. *J. Media Econ.* **2004**, *17*, 87–104. [[CrossRef](#)]
28. Luo, J.; Guo, H.; Jia, F. Technological innovation in agricultural co-operatives in China: Implications for agro-food innovation policies. *Food Policy* **2017**, *73*, 19–33. [[CrossRef](#)]
29. De Marco, E.; Savarese, M.; Ambrosone, A.; D’Antuoni, I.; Falco, S. Sustainability in the food oil sector: The experience of the oleifici mataluni in eco-innovation projects. In *Pathways to Environmental Sustainability: Methodologies and Experiences*; Springer: Berlin/Heidelberg, Germany, 2014; pp. 87–95. [[CrossRef](#)]
30. EC. Quality Schemes Explained. Available online: https://ec.europa.eu/info/food-farming-fisheries/food-safety-and-quality/certification/quality-labels/quality-schemes-explained_en#pdo (accessed on 11 December 2020).
31. Thomann, E.; Maggetti, M. Designing Research with Qualitative Comparative Analysis (QCA): Approaches, Challenges, and Tools. *Sociol. Methods Res.* **2020**, *49*, 356–386. [[CrossRef](#)]
32. Samara, G.; Berbegal-Mirabent, J. Independent directors and family firm performance: Does one size fit all? *Int. Entrep. Manag. J.* **2018**, *14*, 149–172. [[CrossRef](#)]
33. Kemp, R.; Pearson, P. Final Report MEI Project about Measuring Eco-Innovation. Available online: <http://www.oecd.org/env/consumption-innovation/43960830.pdf> (accessed on 7 December 2020).
34. Rabadán, A.; Triguero, Á.; Gonzalez-Moreno, Á. Cooperation as the secret ingredient in the recipe to foster internal technological eco-innovation in the agri-food industry. *Int. J. Environ. Res. Public Health* **2020**, *17*, 2588. [[CrossRef](#)]
35. Rabadán, A.; González-Moreno, Á.; Sáez-Martínez, F.J. Improving firms’ performance and sustainability: The case of eco-innovation in the agri-food industry. *Sustainability* **2019**, *11*, 5590. [[CrossRef](#)]
36. del Río González, P. Analysing the factors influencing clean technology adoption: A study of the Spanish pulp and paper industry. *Bus. Strategy Environ.* **2005**, *14*, 20–37. [[CrossRef](#)]
37. Segarra-Oña, M.V.; Peiró-Signes, A.; Mondéjar-Jiménez, J. Identifying variables affecting the proactive environmental orientation of firms: An empirical study. *Pol. J. Environ. Stud.* **2013**, *22*, 873–880.
38. De Marchi, V. Environmental innovation and R&D cooperation: Empirical evidence from Spanish manufacturing firms. *Res. Policy* **2012**, *41*, 614–623. [[CrossRef](#)]
39. Sáez-Martínez, F.J.; González-Moreno, Á.; Hogan, T. The role of university in eco-entrepreneurship: Evidence from the euro-barometer survey on attitudes of european entrepreneurs towards eco-innovation. *Environ. Eng. Manag. J.* **2014**, *13*, 2541–2549. [[CrossRef](#)]
40. Triguero, A.; Córcoles, D.; Cuerva, M.C. Persistence of innovation and firm’s growth: Evidence from a panel of sme and large spanish manufacturing firms. *Small Bus. Econ.* **2014**, *43*, 787–804. [[CrossRef](#)]
41. Kesidou, E.; Demirel, P. On the drivers of eco-innovations: Empirical evidence from the UK. *Res. Policy* **2012**, *41*, 862–870. [[CrossRef](#)]
42. Triguero, A.; Moreno-Mondéjar, L.; Davia, M.A. Drivers of different types of eco-innovation in European SMEs. *Ecol. Econ.* **2013**, *92*, 25–33. [[CrossRef](#)]
43. McDonagh, P.; Prothero, A. Sustainability marketing research: Past, present and future. *J. Mark. Manag.* **2014**, *30*, 1186–1219. [[CrossRef](#)]
44. Ashford, N.A.; Hall, R.P. The importance of regulation-induced innovation for sustainable development. *Sustainability* **2011**, *3*, 270–292. [[CrossRef](#)]
45. Wier, M.; Calverley, C. Market potential for organic foods in Europe. *Br. Food J.* **2002**, *104*, 45–62. [[CrossRef](#)]
46. FIBL-IFOAM. *The World of Organic Agriculture*; IFOAM, Ed.; Medienhaus Plump: Rheinbreitbach, Germany, 2019.
47. Oates, L.; Cohen, M.; Braun, L. Characteristics and consumption patterns of Australian organic consumers. *J. Sci. Food Agric.* **2012**, *92*, 2782–2787. [[CrossRef](#)]
48. Magnusson, M.K.; Arvola, A.; Hursti, U.K.K.; Åberg, L.; Sjöden, P.O. Choice of organic foods is related to perceived consequences for human health and to environmentally friendly behaviour. *Appetite* **2003**, *40*, 109–117. [[CrossRef](#)]
49. Smith-Spangler, C.; Brandeau, M.L.; Hunter, G.E.; Clay Bavinger, J.; Pearson, M.; Eschbach, P.J.; Sundaram, V.; Liu, H.; Schirmer, P.; Stave, C.; et al. Are organic foods safer or healthier than conventional alternatives? A systematic review. *Ann. Intern. Med.* **2012**, *157*, 348–366. [[CrossRef](#)] [[PubMed](#)]
50. Perito, M.A.; Coderoni, S.; Russo, C. Consumer attitudes towards local and organic food with upcycled ingredients: An Italian case study for olive leaves. *Foods* **2020**, *9*, 1325. [[CrossRef](#)] [[PubMed](#)]
51. Bernabéu, R.; Oliveira, F.; Rabadán, A.; Díaz, M. Influence of ethnocentrism on consumer preference patterns: The case of olive oil in portugal. *New Medit.* **2020**, *19*, 55–68. [[CrossRef](#)]
52. Sanni, M. Drivers of eco-innovation in the manufacturing sector of Nigeria. *Technol. Forecast. Soc. Chang.* **2018**, *131*, 303–314. [[CrossRef](#)]
53. Horbach, J. Determinants of environmental innovation-New evidence from German panel data sources. *Res. Policy* **2008**, *37*, 163–173. [[CrossRef](#)]
54. Vázquez, J.J.; Cebolla, M.P.C.; Ramos, F.S. Digital transformation in the Spanish agri-food cooperative sector: Situation and prospects. *Ciriec-Esp. Rev. Econ. Publica Soc. Y Coop.* **2019**, 39–70. [[CrossRef](#)]

55. Acosta, M.; Coronado, D.; Ferrándiz, E.; León, M.D.; Moreno, P.J. The geography of university scientific production in Europe: An exploration in the field of Food Science and Technology. *Scientometrics* **2017**, *112*, 215–240. [CrossRef]
56. González-Moreno, Á.; Triguero, Á.; Sáez-Martínez, F.J. Many or trusted partners for eco-innovation? The influence of breadth and depth of firms' knowledge network in the food sector. *Technol. Forecast. Soc. Chang.* **2019**, *147*, 51–62. [CrossRef]
57. Frondel, M.; Horbach, J.; Rennings, K. What triggers environmental management and innovation? Empirical evidence for Germany. *Ecol. Econ.* **2008**, *66*, 153–160. [CrossRef]
58. EC. Geographical-Indications. Available online: <http://ec.europa.eu/trade/policy/accessing-markets/intellectual-property/geographical-indications/> (accessed on 27 March 2017).
59. Godoy-Durán, Á.; Galdeano-Gómez, E.; Pérez-Mesa, J.C.; Piedra-Muñoz, L. Assessing eco-efficiency and the determinants of horticultural family-farming in southeast Spain. *J. Environ. Manag.* **2017**, *204*, 594–604. [CrossRef]
60. Bernabéu, R.; Rabadán, A.; El Orche, N.E.; Díaz, M. Influence of quality labels on the formation of preferences of lamb meat consumers. A Spanish case study. *Meat Sci.* **2018**, *135*, 129–133. [CrossRef]
61. Aboah, J.; Lees, N. Consumers use of quality cues for meat purchase: Research trends and future pathways. *Meat Sci.* **2020**, *166*. [CrossRef] [PubMed]
62. MAPA. Anuario de Estadística. Available online: <https://www.mapa.gob.es/es/estadistica/temas/publicaciones/anuario-de-estadistica/2019/default.aspx?parte=3&capitulo=07&grupo=12&seccion=1> (accessed on 8 December 2020).
63. EU. Quality Labels. Available online: https://ec.europa.eu/info/food-farming-fisheries/food-safety-and-quality/certification/quality-labels_en (accessed on 8 December 2020).
64. Rihoux, B. Qualitative comparative analysis (QCA), anno 2013: Reframing the comparative method's seminal statements. *Swiss Polit. Sci. Rev.* **2013**, *19*, 233–245. [CrossRef]
65. Fiss, P.C. A set-theoretic approach to organizational configurations. *Acad. Manag. Rev.* **2007**, *32*, 1190–1198. [CrossRef]
66. Roig-Tierno, N.; Gonzalez-Cruz, T.F.; Llopis-Martinez, J. An overview of qualitative comparative analysis: A bibliometric analysis. *J. Innov. Knowl.* **2017**, *2*, 15–23. [CrossRef]
67. Woodside, A.G. Moving beyond multiple regression analysis to algorithms: Calling for adoption of a paradigm shift from symmetric to asymmetric thinking in data analysis and crafting theory. *J. Bus. Res.* **2013**, *66*, 463–472. [CrossRef]
68. Bedford, D.S.; Sandelin, M. Investigating management control configurations using qualitative comparative analysis: An overview and guidelines for application. *J. Manag. Control* **2015**, *26*, 5–26. [CrossRef]
69. Vis, B. The Comparative Advantages of fsQCA and Regression Analysis for Moderately Large-N Analyses. *Sociol. Methods Res.* **2012**, *40*, 168–198. [CrossRef]
70. Ragin, C.C. *Redesigning Social Inquiry Fuzzy Sets and Beyond*; University of Chicago Press: Chicago, IL, USA, 2008.
71. Wu, P.L.; Yeh, S.S.; Huan, T.C.; Woodside, A.G. Applying complexity theory to deepen service dominant logic: Configurational analysis of customer experience-and-outcome assessments of professional services for personal transformations. *J. Bus. Res.* **2014**, *67*, 1647–1670. [CrossRef]
72. Ragin, C.C.; Fiss, P.C. *Net Effects Analysis Versus Configurational Analysis: An Empirical Demonstration*; University of Chicago Press: Chicago, IL, USA, 2008.
73. Hirsch, S.; Schiefer, J.; Gschwandtner, A.; Hartmann, M. The determinants of firm profitability differences in EU food processing. *J. Agric. Econ.* **2014**, *65*, 703–721. [CrossRef]
74. Gschwandtner, A.; Hirsch, S. What Drives Firm Profitability? A Comparison of the US and EU Food Processing Industry. *Manch. Sch.* **2018**, *86*, 390–416. [CrossRef]
75. Hirsch, S.; Schiefer, J. What Causes Firm Profitability Variation in the EU Food Industry? A Redux of Classical Approaches of Variance Decomposition. *Agribusiness* **2016**, *32*, 79–92. [CrossRef]
76. Scarpellini, S.; Marín-Vinuesa, L.M.; Portillo-Tarragona, P.; Moneva, J.M. Defining and measuring different dimensions of financial resources for business eco-innovation and the influence of the firms' capabilities. *J. Clean. Prod.* **2018**, *204*, 258–269. [CrossRef]
77. Pil, F.K.; Rothenberg, S. Environmental performance as a driver of superior quality. *Prod. Oper. Manag.* **2003**, *12*, 404–415. [CrossRef]
78. Serrano, A.; De la Rosa, R.; Sánchez-Ortiz, A.; Cano, J.; Pérez, A.G.; Sanz, C.; Arias-Calderón, R.; Velasco, L.; León, L. Chemical components influencing oxidative stability and sensorial properties of extra virgin olive oil and effect of genotype and location on their expression. *LWT* **2021**, *136*. [CrossRef]
79. Hagedoorn, J.; Schakenraad, J. The effect of strategic technology alliances on company performance. *Strateg. Manag. J.* **1994**, *15*, 291–309. [CrossRef]
80. Ghisetti, C.; Mancinelli, S.; Mazzanti, M.; Zoli, M. Financial barriers and environmental innovations: Evidence from EU manufacturing firms. *Clim. Policy* **2017**, *17*, S131–S147. [CrossRef]
81. Marzucchi, A.; Montesor, S. Forms of knowledge and eco-innovation modes: Evidence from Spanish manufacturing firms. *Ecol. Econ.* **2017**, *131*, 208–221. [CrossRef]
82. Keshminder, J.S.; del Río, P. The missing links? The indirect impacts of drivers on eco-innovation. *Corp. Soc. Responsib. Environ. Manag.* **2019**, *26*, 1100–1118. [CrossRef]
83. Garcia Martinez, M.; Briz, J. Innovation in the Spanish food & drink industry. *Int. Food Agribus. Manag. Rev.* **2000**, *3*, 155–176. [CrossRef]
84. Erraach, Y.; Sayadi, S.; Gómez, A.C.; Parra-López, C. Consumer-stated preferences towards Protected Designation of Origin (PDO) labels in a traditional olive-oil-producing country: The case of Spain. *New Medit* **2014**, *13*, 11–19.