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Eco-Innovation in Worker Cooperatives and Investor-Owned Industrial Firms: a Comparative Analysis

Eco-innovación en cooperativas y empresas de capital industriales: un análisis comparativo

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Abstract

The study examines eco-innovation in cooperatives and investor-owned firms, analysing their primary driving factors. After evaluating responses from 718 industrial establishments in the Basque Country, including 57 cooperatives, we conclude that cooperative principles do not guarantee success in eco-innovation. The voluntariness of eco-innovation is no more relevant in cooperatives than in other firms; instead, regulatory pressures and market forces are the primary drivers. Despite facing greater limitations, cooperatives achieve similar environmental benefits. The results reinforce the importance of public policies for an effective ecological transition, and support the need for a re-evaluation based on empirical evidence of certain postulates in social economy literature.

Keywords: Eco-innovation, Innovation, Cooperatives, Ecological Transition.

Resumen

El estudio examina la ecoinnovación en cooperativas y empresas de capital, analizando sus factores impulsores. Tras evaluar respuestas de 718 establecimientos industriales vascos, incluyendo 57 cooperativas, se concluye que los principios cooperativos no aseguran el éxito en ecoinnovación. La voluntariedad de la ecoinnovación no es más relevante en las cooperativas, siendo las presiones regulatorias y fuerzas del mercado los principales impulsores. A pesar de enfrentar mayores limitaciones, las cooperativas logran beneficios medioambientales similares. Los resultados refuerzan la importancia de las políticas públicas para una efectiva transición ecológica. Así mismo, instan a reevaluar con evidencia empírica algunos postulados de la literatura de la economía social.

Palabras clave: Ecoinnovación, Innovación, Cooperativas, Transición Ecológica.

JEL Classification/ Clasificación JEL: J54; O25; O32

1. Introduction

In response to several decades of globalisation, environmental sustainability has become a central aspect among development issues. Rockstrom et al. (2009) and subsequent studies such as those by the Stockholm Resilience Centre show that planetary boundaries are being exceeded, demonstrating an overall negative environmental trend.

Within this framework, the difficulties in combining economic and social development with environmental sustainability are evident. In practice, the countries with the highest rankings in the Human Development Index are also the largest consumers of resources and generators of emissions per capita, and the contradictions between economic growth and global development objectives are becoming increasingly apparent (Hickel, 2019).

Thus, a transition towards other models of production and consumption is inevitable, the question being how to address this issue fairly and based on a vision of sustainability. The 2030 Agenda (UN, 2015) establishes in its SDG 12 the need to move towards sustainable consumption and production patterns. Its goals make abundant references to resource and waste management, and the adoption of sustainable business practices. In fact, SDG 9, linked to the industry, stresses that innovation and technological progress is fundamental for responding sustainably to economic and environmental challenges.

Given these shortcomings, eco-innovation presents itself as an interesting tool to help reduce the use of resources, facilitate their recycling and reduce pollution (García-Granero et al., 2018). However, eco-innovation is still a poorly studied aspect, especially in the case of cooperatives, and warrants greater attention from the field of research. Current literature defends an innate 'green' condition of cooperatives based on their values and principles. However, highly cited and influential papers within this body of literature are purely theoretical and lack any evidence supporting this assumption (see, for example, Mozas and Bernal, 2006 or Puentes and Velasco, 2009) or they simply present the link between cooperative principles and environmental concern as a conjecture (Novkovic, 2008). When these papers are subsequently cited by other researchers (see, for example, Fernández et al., 2020), they are often referred to as previous evidence of a link between cooperative principles and environmental performance rather than conjectures. The few empirical studies that exist are based on agricultural cooperatives (Rabadan et al., 2021; Calle et

al., 2020; Carchano et al., 2023). Thus, further research is needed to contrast the green innateness hypothesis.

Our study considers the role of cooperatives as part of the social economy, and their possible contribution to eco-innovation as a means of promoting the transitions necessary to address environmental matters.

The questions that guide this study are the following: Are industrial cooperatives contributing to an improvement in environmental impacts? What are the reasons that drive or limit these entities to eco-innovate? Are there differences in the above aspects between cooperatives and other companies? Can exposure to external markets be a relevant factor in this framework?

To answer these questions, the paper begins by explaining the framework and concept of eco-innovation, analysing its background, and looking more closely at eco-innovation in cooperatives. We then analyse data from the 2021 Innovation Survey carried out by the Basque Institute of Statistics on industrial firms (with a methodology common to the Community Innovation Survey of the European Commission). This is followed by a discussion of the results and, lastly, the conclusions, limitations, and future lines of research.

2. Eco-innovation in cooperatives: Literature framework.

2.1. Eco-innovation: definition and framework

The opportunity that innovation offers for achieving sustainable development, or for reducing the environmental impact of economic activity, is increasingly recognised both at institutional and academic levels.

The studies and initiatives within this framework include diverse denominations, such as "eco-innovation", "ecological innovation", "green innovation", or "environmental innovation", as reflected in various bibliographical and general studies (Afeltra et al., 2023; Bossle et al., 2016; Díaz-García et al., 2015; García Granero et al., 2018). A broader concept, incorporating social aspects that go beyond environmental concerns, is that of "sustainable innovation", which has followed its own evolutionary path (Afeltra et al., 2023).

Although the theoretical debate is still ongoing, in this study we adopt the widely used term "eco-innovation", which focuses on environmental impacts, as this corresponds to the data we use in the empirical analysis. In 2007, based on the OECD definition of innovation, Kemp and Pearson proposed a commonly accepted definition of eco-innovation:

> "the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organisation (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." Kemp and Pearson (2007: 7)

The definition includes a reduction in negative environmental consequences as a result of these innovations. This requires a vision of new process and product lifecycles, modifying management systems and leading to new business models (OECD, 2009).

Along these lines, the European Commission launched the Eco-Innovation Action Plan (EcoAP) in 2011, in which it defines eco-innovation as follows:

> "any form of innovation resulting in or aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment, enhancing resilience to environmental pressures, or achieving a more efficient and responsible use of natural resources." (EC, 2011: 2)

Along with the need to reduce negative impacts as stated by the OECD, the approach by EcoAP introduces sustainable development, resilience, and the efficient use of resources as goals. More recently, the drive for eco-innovation can be found in relevant European initiatives such as Horizon Europe or the European Green Deal itself.

Eco-innovation has begun to attract more interest as a topic in the innovation literature (Aboelmaged, 2018) and is recognised by the European Union (EU) as an important contributor to green growth and sustainability (Melece & Hazners, 2017).

The positive impact of eco-innovation on business sustainability has been widely debated (He et al., 2018). In practice, eco-innovation can be associated with reducing the use of water, materials or energy, with improvements related to recycling or the use of less polluting materials, or with reducing pollution in different ways. These environmental benefits can occur in different phases of the production and consumption process, both within the company and during consumption or use by the end user. Along these lines, eco-innovation measurement studies cover areas as diverse as those related to products, processes, organisational issues and marketing (García-Granero et al., 2018)

2.2. The drivers for eco-innovation

Within the framework of eco-innovation, knowing the motivation for these processes, and their drivers, is fundamental for promoting their implementation. It is important, therefore, to distinguish between external and internal factors, as pointed out in studies by Bossle et al. (2016). External factors include regulatory and normative pressures (the latter related to legitimacy and behaviour in accordance with the standards of their field of action), cooperation (with suppliers, clients, etc.), expanding market, and the characteristics of technology at industry level. Internal factors include efficiency, adoption of certifications, environmental managerial concerns, environmental leadership, culture and capability, as well as questions related to human resources and skills.

Regulatory pressure appears as a predominant and essential driver of eco-innovation (see Bossle et al., 2016, Horbach, 2016 and Afeltra et al., 2023, for reviews). Specific regulatory backing is deemed essential for fostering eco-innovation, since relying solely on the factors of technology push and market pull is not enough (Afeltra et al., 2023). Besides actual regulations, expected future regulations also have a significant positive effect on the development of eco-innovations (Díaz-García et al., 2015). Current and future legislation is highly correlated to certain eco-innovation results such as CO^2 and pollution reduction (Horbach, 2016). Aside from regulation, market demand is the second most cited driver of eco-innovation (Doran & Ryan, 2012; Horbach et al., 2012; Horbach, 2016; Díaz-García et al., 2015).

A significant variation among countries regarding their eco-regulation, the enforcement of these regulations, technological development and demand for eco-innovative products and services leads to divergent findings in studies that link exports with eco-innovation.

For example, Horbach (2016) finds a negative effect of exports on eco-innovation, particularly in relation to environmental benefits from the after-sales use of products by end users. These results can be explained by the fact that the firms in Horbach's sample belong to the EU. The majority of their exports go to other EU countries with a similar regulatory environment. The remaining exports go to countries with lower regulatory requirements and a weaker market pull for eco-friendly products. Along the same lines, Chiarvesio et al. (2015) find that Italian firms engaged in export activities are less likely to adopt eco-friendly practices, and Wang et al. (2020) also find a negative impact of export diversification on CO^2 emissions in G7 economies. For the specific case of Spanish industrial firms, research offers contradictory results. De Marchi (2012) finds that environmentally innovative firms are more likely to export but, at the same time, serving an international market is significantly and negatively correlated with green innovation. However, Torrecillas and Fernández (2022), find a positive effect of exports on eco-innovation.

Conversely, studies in countries exporting their products to markets which are leaders in ecological innovations find that export firms are positively associated with cleaner production (see Galbreath et al., 2021, and Tsai and Liao, 2017 for the case of Taiwan, or see Hanley and Semrau, 2022, for Eastern Europe countries).

A number of studies of key factors affecting eco-innovation identify those linked to normative pressures and the need for efficiency, such as cost reduction (Demirel & Kesidou, 2011; Horbach, 2008, 2016; Horbach et al., 2012). Other studies cite factors such as firm size, and sector or public financing (Bossle et al., 2016).

Table 2 shows a summary of the drivers appearing in the survey we use for our study. As can be seen, these are mainly external drivers.

2.3. Environmental performance and eco-innovation in cooperatives

While specific literature on cooperatives and eco-innovation is limited to a few studies (Rabadan et al., 2021; Calle et al., 2020; Carchano et al., 2023), research is much more extensive on the environmental performance of cooperatives (see Candemir et al., 2021 and Liang et al., 2023, for literature reviews). Environmental issues are also analysed in a greater number of studies on sustainability in cooperatives (see Lafont et al., 2023, for a literature review). A common axis of this literature is that cooperatives are socially responsible (and thus, greener) by nature. This innate condition implies that cooperatives are inherently sustainable, since they are based on principles and values which differ from capitalist enterprise models (Calle et al., 2020; Henrÿ, 2017). These researchers often cite the "concern for community" cooperative principle as the cornerstone of this innate greener condition. This principle states that "cooperatives work for the sustainable development of their communities through policies approved by their members" (ICA, 2015, 86). In its guidance notes on cooperative principles, the International Cooperative Association explains its three-dimensional concern for sustainability (economic, social, and environmental) and also adheres to the innate hypothesis: "It is hard-wired in our genes. There is a clear and demonstrable advantage to cooperatives which flows from the three-dimensional commitment to the sustainable development of the communities in which cooperatives operate" (ICA, 2015, 93).

Some researchers highlight that other cooperative principles, such as collective ownership and democratic governance, and values, such as mutual help, responsibility, democracy, equality, equity and solidarity, make it "reasonable to expect that cooperatives will move towards inclusive, sustainable, and environmentally friendly growth models" (Carchano et al., 2023, 3). While some of these principles and values could hypothetically have an impact on eco-innovation in certain kinds of cooperatives (for example in green energy cooperatives created by energy consumers with a greater concern for ecology), it is difficult to see how they could significantly influence eco-innovation in industrial cooperatives.

In fact, the literature that defends the innate greener condition of cooperatives does so in a naïve way: cooperatives endorse the "concern for community" principle, therefore they have greater concern for the environment (Mozas and Bernal, 2006; Puentes and Velasco, 2009) or at least we conjecture that they are likely to be concerned (Novkovic, 2008).

Evidence that supports the innate environmentally-friendly condition comes solely from limited studies of Chinese agricultural cooperatives. According to these studies, cooperative membership significantly improves the probability of farmers adopting green control techniques (Yu et al., 2021; Zhang et al., 2023); substantially influences farmers' decisions to invest in organic soil amendments (Ma et al., 2018; Dong et al., 2023); reduces the overuse of chemical fertilizers and pesticides (Liu and Wu, 2022; Zhou et al., 2019); and increases the adoption of water-saving irrigation technologies (Dong et al.,

2023). Furthermore, training and technical services provided by cooperatives enhance farmers' capacity and knowledge to adopt green technology (Zhang et al., 2023; Luo et al., 2022). While most researchers find positive effects, Abebaw and Haile (2013) find detrimental impacts on the environment of belonging to an Ethiopian agricultural cooperative and Li et al. (2021) report an insignificant relationship between cooperative membership and safe production behaviours in the use of fertilizers and pesticides.

Despite the relevance of agricultural cooperatives all over the world, almost all publications on their environmental performance are based on Chinese samples. Furthermore, to the best of our knowledge, no research has been conducted on other kinds of cooperatives, such as worker cooperatives.

When it comes to studies on eco-innovation and cooperatives, the scarce research that exists again focuses on agricultural cooperatives of a single country: Spain.

Calle et al. (2020) study 251 Spanish firms in the wine sector (51 of them cooperatives) and find no significant differences between cooperative and non-cooperative firms concerning their environmental behaviour. They also find that the cooperatives are divided in their commitment to these issues. Half of the cooperatives in their sample demonstrate a strong commitment to environmental issues by prioritising them in their strategies and organisational structure. However, a similar proportion of cooperatives adopt a preventive environmental approach, considering potential environmental impacts, but this approach does not shape their core business strategies.

Carchano et al. (2023) also focus their research on eco-innovation in Spanish wine companies, with a sample of 239 firms, 53 of them cooperatives. They find that cooperatives address the environmental concerns of internal and external stakeholders to a greater degree and, consequently, they seem to adopt a more proactive position on eco-innovation. Nevertheless, they do not find support for the hypothesis of "being a cooperative moderates the relationship between eco-innovation and environmental performance".

Rabadán et al. (2021) analyse eco-innovation in a sample of 52 olive-oil sector firms (42 of them cooperatives) and find that large olive oil cooperatives producing high quality extra-virgin oil are the firms with greater involvement in eco-innovation. These authors consider that, although being a cooperative increases the likelihood of seeking greater eco-innovation, other causal conditions unrelated to the cooperative nature of the firms explain these results (large size, intense cooperation with stakeholders, high quality production, high percentage of exports, high R&D budgets, etc.).

Departing from the broader concept of social economy, Rousselière et al. (2024) find, based on a survey carried out on 16,000 European firms, that social economy enterprises (defined as those with non-profit orientation and those with collective ownership) have a higher probability of developing environmental innovation.

Despite the optimist view of much of the literature on cooperatives and environmental sustainability, given that eco-innovation is highly correlated

with non-environmental innovation, it can be assumed that some limitations of innovation seen in cooperatives will also be reflected in eco-innovation (Calle et al., 2020). These limitations include slower decision-making due to democratic processes, greater risk aversion among members compared to capitalist owners, limited access to capital, and small organisational size (Basterretxea and Martínez, 2012).

Drawing from this literature overview, the following hypotheses are proposed:

- H1: Being a cooperative has a positive and significant effect on eco-innovation.
- H2: Exports have a positive and significant effect on eco-innovation.
- H3: Regulatory pressures and market pull are the main drivers of eco-innovation.
- H4: Voluntary initiatives for environmental good practice are more important drivers of eco-innovation in cooperatives.

3. Data and methodology

The analysis uses data from the 2021 Innovation Survey, carried out by the Basque Institute of Statistics (Eustat, 2022). The survey questions are based on the Community Innovation Survey (CIS) of the European Commission. Since 2008, the CIS questionnaire includes specific questions on eco-innovation results and drivers, and defines eco-innovation as follows:

> "An innovation with environmental benefits is a new or improved product or business process of an enterprise that generates positive or lower negative environmental impacts, compared to the enterprise's previous products or processes, and that has been made available to potential users or brought into use. The environmental benefit can be the primary objective of the innovation or a by-product of other objectives. The environmental benefits of an innovation can occur during the production of a good or service, or during its consumption or use by the end user." (Eurostat, 2021)

The survey focuses on diverse business establishments across various sectors and sizes in the Basque Country. The data pertain to the year 2021, although specific inquiries on eco-innovation cover the 2019-2021 period.

The total sample of Eustat's Innovation Survey includes 3,777 establishments (196 of them worker cooperatives) in the services sector and industrial sector. We decide not to use the total sample of 3,777 firms, focusing instead on just industrial firms since it is easier to compare innovation drivers, practices and outcomes in this more homogeneous sample of industrial firms.

The sample of our study encompasses 718 industrial establishments (57 of them are worker cooperatives). Within our sample, 7.94% of establishments are affiliated with cooperative firms, contributing to 15.17% of the total

employment. This closely reflects the current proportion of cooperative industrial employment in the Basque Country, which stands at 12.4%. Consequently, our sample size is representative of the study universe.

Building on CIS's definition and existing literature (Table 1), eco-innovation is measured considering the outcomes of innovative endeavours. If innovations generate favourable environmental impacts, they are classified as eco-innovations. The firms were asked to respond to the following question:

"During the three years 2019 to 2021, did your enterprise introduce innovations with any of the following environmental benefits and, if yes, was their contribution to environmental protection rather significant or insignificant?"

Six variables measure environmental benefits within the firm and four measure benefits from after-sales use of goods by the end user. These variables are well-rooted in existing literature (see Table 1).

The questionnaire also asks about the importance of several factors in driving the firm's decision to introduce innovations with environmental benefits. These drivers of eco-innovation, which mainly refer to external factors, are also well-rooted in literature (see Table 2).

We include the dummy variable Coop to consider whether the entity is a cooperative. In addition, we take into account the level of the establishment's spending on R&D, both internal and external (Int-RD and Ext-RD) or the use of perceived public funding to innovate (Pub-aid). The size of the establishment's parent firm (Size) is also considered. The natural logarithm of the number of employees, commonly utilised in studies of firm innovation performance, is used as a proxy for firm size. The questionnaire details the percentage of

Table 1: Variables measuring environmental benefits and literature where mentioned

Variable	Sources (examples)
Reduced material or water use per unit of output (Material)	Hellstrom (2007), Alkaya & Demirer (2015).
Reduced energy use or CO^2 'footprint' (CO^2*)	Van Hemel & Cramer (2002), Alkaya & Demirer (2015), Doran & Ryan (2016), Castellacci & Lie (2017), Rodríguez & Wiengarten (2017).
Reduced soil, noise, water or air pollution (Pollution*)	Rodríguez & Wiengarten (2017).
Replaced a share of materials with less polluting or hazardous substitutes (Substitute)	Doran & Ryan (2016), Castellacci & Lie (2017), Rodríguez & Wiengarten (2017).
Replaced a share of fossil energy with renewable energy sources (Energy)	Nesta et al. (2014).
Recycled waste, water, or materials for own use or sale (Recycled)	Van Hemel & Cramer (2002), Doran & Ryan (2016), Castellacci & Lie (2017), Rodríguez & Wiengarten (2017).
Facilitated recycling of product after use (Recycled)	Dalhammar (2015), Castellacci & Lie (2017), Rodríguez & Wiengarten (2017).
Extended product life through longer-lasting, more durable products (Product life)	Van Hemel & Cramer (2002), Hellström (2007), Dalhammar (2015).

Source: compiled by the authors (*CO^2 and pollution reduction are gauged as benefits within the firm and by the use of the end user)

Table 2: Variables measuring drivers of eco-innovation

Drivers	Short name	Sources (examples)
Existing environmental regulations	Regulation	Demirel and Kesidou (2011), Horbach (2008), Horbach et al. (2012), Li et al. (2020), Mahmood et al. (2022).
Existing environmental taxes	Taxes	
Environmental regulations or taxes expected in the future	Future regulation	
Need to meet requirements for public procurement contracts	Public contracts	
Government grants, subsidies or other financial incentives for environmental innovations	Subsidies	Tsai and Liao (2017), Horbach (2016).
Current or expected market demand for environmental innovations	Market	Doran & Ryan (2016), Horbach et al. (2012), Horbach (2016), Díaz-García et al. (2015).
Improving the enterprise's reputation	Reputation	Li et al. (2020), Horbach (2016).
Voluntary actions or initiatives for environmental good practice within the sector	Voluntary	
High costs of energy, water or materials	Costs	Demirel & Kesidou (2011), Horbach (2008, 2016), Horbach et al. (2012).

Source: compiled by the authors

turnover coming from exportation, which allows us to analyse the effect of exports on eco-innovation.

Given the connections between variables revealed in the literature review, and since we propose that each eco-innovation is independent of the others, we estimate a Probit model for each eco-innovation using Maximum Likelihood method with robust standard errors to correct possible heteroscedasticity. The endogenous variable is defined as $Y_i = 1$, when the firm obtained environmental benefits. The model is formulated as follows (Greene, 2012, pp. 732-736):

$$(1) \qquad Pr(Y_i = 1) = F(X_i\,'\beta + Z_i\,'\gamma)$$

$$(2) \qquad Pr(Y_i = 0) = 1 - F(X_i\,'\beta + Z_i\,'\gamma)$$

Where: Y_i is the dependent variable: environmental benefits.
X_i is the matrix of the explanatory variables.
Z_i is the matrix of the control variables.
$F(\,)$ is the standard Normal Distribution.

It should be noted that the estimation parameters of the Probit model are not the marginal effect. In general, the marginal effects are $\partial Pr\,(Y=1)/\partial X = f(X_i\,'\beta)\,\beta$, and these values vary with the values of X (and Z). So, when interpreting the estimated model, it is necessary to calculate the marginal effects at the sample means of the data.

4. Results

4.1. Descriptive statistics

As Table 3 shows, the percentage of industrial establishments that have introduced innovations with environmental benefits is 21% higher among cooperative firms than among investor-owned firms.

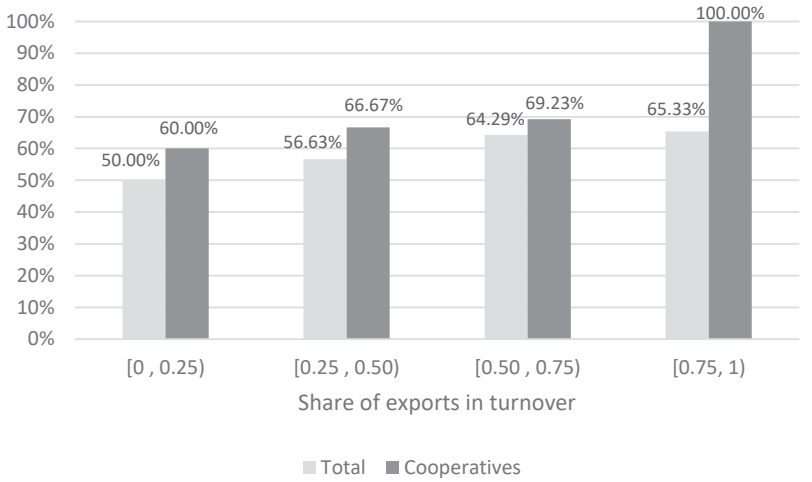
Table 3. Characterisation of the sample according to eco-innovation practices

	Full Sample	Cooperatives	Non-cooperatives	Exports/turnover (mean)	Employees (mean)
Eco-innovative establishments	54.32%	73.68%	52.65%	27.57%	105.55
Non eco-innovative establishments	45.68%	26.32%	47.35%	19.47%	47.48
Total	100%	100%	100%	23.87%	79.03

Source: compiled by the authors. The differences are statistically significant.

A similar scenario is seen when considering exports and size. Establishments with some sort of environmental benefit from their innovation activities exported more and were bigger than those without environmental benefits. These differences are statistically significant.

Figure 1. Percentage of eco-innovative establishments according to export intensity



Source: compiled by the authors

When relating eco-innovation and export intensity, we find that the higher the share of turnover exported by establishments, the higher the proportion of these establishments that introduce eco-innovation. This trend is clearer in the case of cooperatives, and all cooperatives that export more than 75% of their production are in the group of eco-innovative establishments (Figure 1).

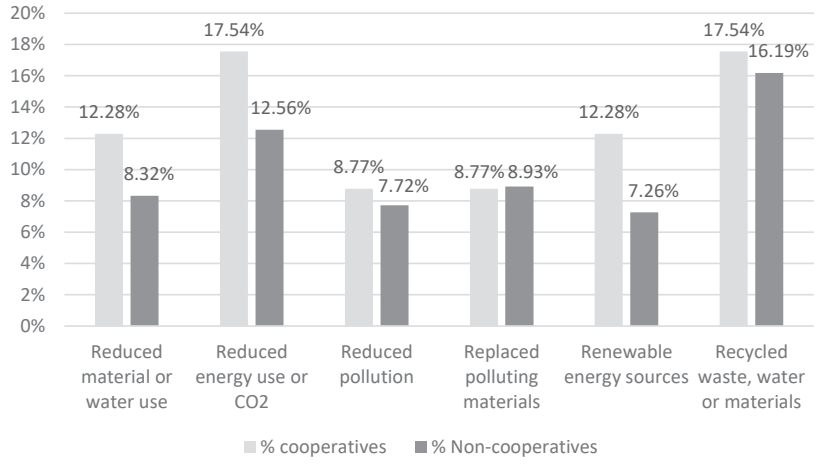
Figure 2 shows the differences between cooperatives and non-cooperative firms, using just the subsample of establishments that have achieved some environmental benefits within the enterprise, generated by innovation activities.

Looking at the trend seen in Table 3 in more detail, cooperatives show better results in five out of the six measured environmental benefits, even if differences are not statistically significant. The most important benefits for both cooperatives and non-cooperative firms are 'recycled waste, water, or materials for own use or sale' (16.30% of the total sample) and 'reduced energy use or CO^2 footprint' (12.95%).

In relation to the environmental benefits from after-sales use of products by the end user (see Figure 3), cooperatives achieve better outcomes in two out of four indicators; those of 'extended product life through longer-lasting, more durable products' and 'reduced soil, noise, water or air pollution'. Again, the differences shown in Figure 3 are not significant.

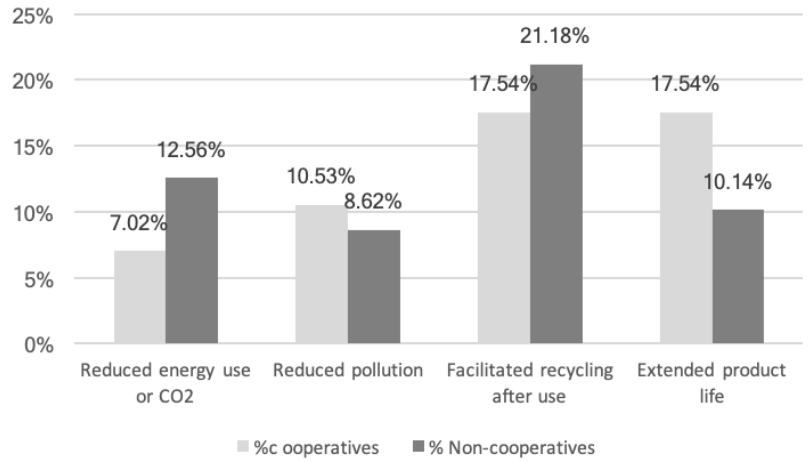
Figure 4 shows the importance firms give to different aspects as drivers of eco-innovation (the percentages have been calculated on the establishments that have actually achieved some sort of environmental benefit from their innovation activities).

Figure 2. Environmental benefits within the enterprise



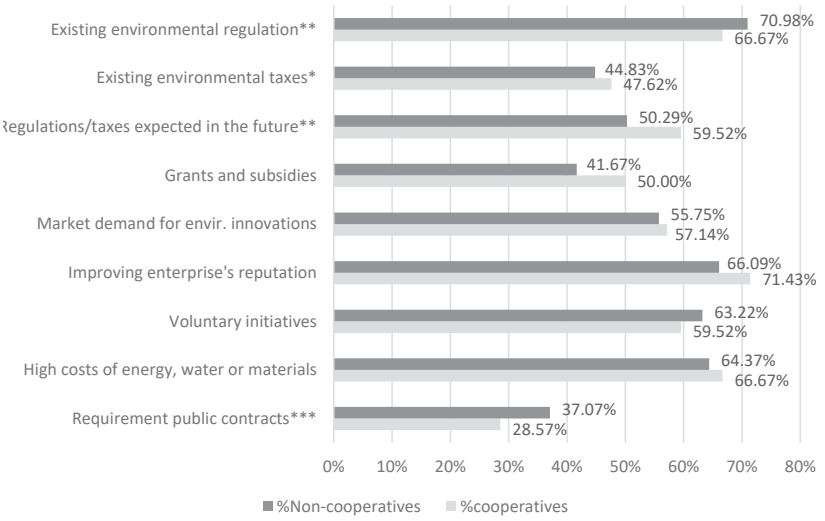
Source: compiled by the authors

Figure 3. Environmental benefits from after-sales use of products by the end user



Source: compiled by the authors

Figure 4. Drivers to introduce innovations with environmental benefits

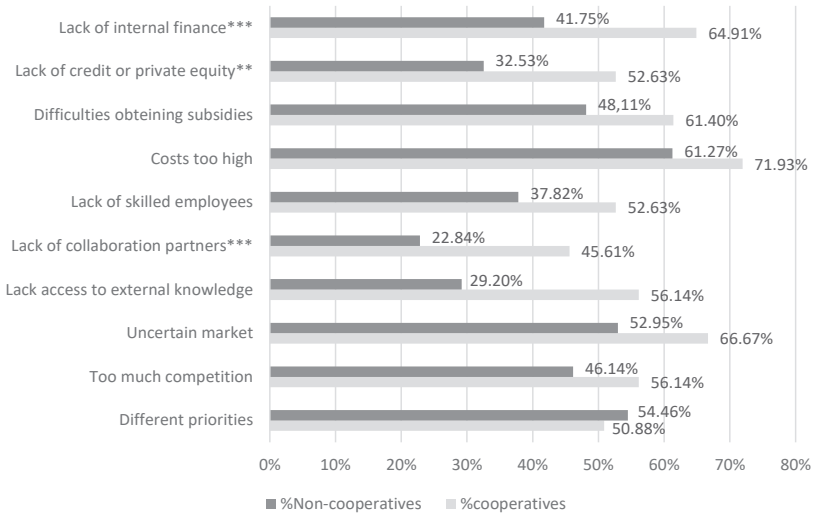


Source: compiled by the authors. Significance codes: *** 0.01; ** 0.05; * 0.1

With regard to the total sample (including both cooperatives and non-cooperatives), more than 70% of the industrial firms of the sample highlight existing environmental regulation as a driver of their eco-innovations. In second place, is improving the enterprise´s reputation (66.67% of the total), followed by high costs of energy, water or materials (64.62%) and voluntary good practices within the sector (62.82%). Close behind are issues such as market demand (55.90%), environmental regulations or taxes expected in the future (51.28%), existing environmental taxes, charges or fees (45.13%) and subsidies and financial incentives for environmental innovations (42.56%). The need to meet requirements for public procurement contracts is the least mentioned reason (36.15% of cases).

As can be seen in Figure 4, the differences between cooperatives and non-cooperative firms in terms of the relevance given to the drivers of eco-innovation are not substantial. The two drivers which are significantly more relevant for cooperatives are the existing environmental taxes and environmental regulations or taxes expected in the future. Government grants, subsidies and financial incentives for environmental innovations are also mentioned by 50% of cooperatives (versus 41.67% of non-cooperative firms). In contrast, the need to meet requirements for public procurement contracts and existing environmental regulations seem more important drivers for non-cooperative firms. The greater impact of taxes and subsidies on cooperatives can be explained, theoretically, in light of the greater limitations they face in financing

Figure 5. Factors hampering the decision to start or execute innovation activities



Source: compiled by the authors. Significance codes: *** 0.01; ** 0.05; * 0.1

their innovation (this is analysed later in the paper). Voluntary initiatives for environmental good practices appear to be no more relevant as drivers of eco-innovation in cooperatives than in non-cooperative firms. In fact, quite the opposite is seen, although the differences are not significant.

Finally, the survey asks what obstacles these industrial firms encounter when introducing or executing innovation activities. It should be noted that, in this case, the question refers to the factors that hinder innovation in general (not only eco-innovation).

With regard to the total sample, the three main obstacles to innovation, highlighted by more than half of the establishments, are high costs (62.12% of the total), the existence of other priorities (54.18%), and demand uncertainty (54.04%). These are followed by issues such as difficulties in obtaining subsidies (49.16%), excessive competition in the market (46.94%), and lack of internal finance for innovation (43.59%).

Figure 5 shows important differences between cooperatives and investor-owned industrial firms. Cooperatives place more importance on nine out of ten factors hampering innovation compared to investor-owned firms. The differences are large and significant when valuing certain factors such as the lack of access to finance (both internal and external) and the lack of collaboration partners. Two further factors which show substantial differences, although non-significant, are the lack of access to external knowledge and the lack of skilled personnel. All these barriers to innovation are widely acknowledged by the research literature on cooperatives.

In summary, Figure 5 shows that, despite greater limitations to innovation and eco-innovation, cooperatives are in a situation of parity or even comparative advantage when it comes to eco-innovation, as illustrated in Table 3 and Figures 2 and 3.

4.2. Estimation results

Taking into account the connections between variables identified by the relevant literature (with special emphasis on the study of Horbach, 2016, based on the same questions as the Community Innovation Survey) a Probit model is established to test our hypotheses (See Table 4).

While the percentage of industrial firms introducing innovations that generate environmental benefits is greater among cooperatives (table 3), when we analyse solely the subsample of firms that have some sort of eco-innovation, being a cooperative does not significantly influence eco-innovation performance. A similar result is seen in relation to the size of the firm, while level of exports is only significantly related to those innovations which achieve a reduction in pollution. Among the control variables, external R&D expenditure and having received public funding to innovate are the factors that positively and significantly affect more environmental benefits.

Environmental regulations or taxes expected in the future lead to a greater number of eco-innovation benefits than actual regulations or taxes. Future

regulations have positive and significant marginal effects on fields such as a reduction in pollution of soil, noise, water or air (pollution), replacing fossil energy with renewable energy sources, and recycling. Future regulations also pre-empt a reduction in pollution from use by the end user and help to extend product life.

Although the need to meet requirements for public procurement is the least mentioned driver for eco-innovation (Figure 4), this has a positive and significant effect in 6 out of 10 environmental benefits (Table 4). This is, therefore, another key driver of eco-innovation, positively related to reduced pollution, reduced use of material, water or energy, substitution of fossil energy with renewable energy and extended product life.

The factor Voluntary action is positively related to two after-sales environmental benefits, but has no clear effect on benefits within the firm. Improving the enterprise's reputation is also an important eco-innovation driver, which is mainly achieved within the firm via reduced use of materials, replacement of materials with less polluting substitutes and use of renewable energies. It is also linked to extended product life.

Current or expected market demand for environmental innovation also has positive marginal effects on eco-innovation within the firm (reduced CO^2

Table 4. Estimated Probit models

	Mean (SD)	Environmental benefits within the firm						Environmental benefits from after-sales use of product by end user			
		Material	CO^2	Pollution	Substitute	Energy	Recycled	CO^2	Pollution	Recycled	Product life
Coop	0.1094 (0.31)										
Size	3.778 (1.45)										
Pub-aid	0.6622 (0.47)		0.144 **					0.15 **	0.11 *		0.113 *
Int-RD	0.0157 (0.05)								-1.1 *		
Ext-RD	0.0049 (0.02)	3.402 **	3.038 *			4.59 **		5.66 **			3.177 *
Export	0.2782 (0.32)			0.214 **							
Regulation	0.7101 (0.45)							0.14 *	0.24 ***	-0.1 *	-0.14 *
Taxes	0.4548 (0.50)						0.13 *			0.19 ***	
Future Regulation	0.5186 (0.50)		-0.17 **	0.191 ***		0.21 ***	0.14 *		0.15 **		0.148 **
Subsidies	0.4308 (0.49)				-0.1 **	0.1 *				-0.1 *	
Market	0.5585 (0.50)		0.299 ***		0.14 *		0.2 ***	0.19 **			
Reputation	0.6596 (0.47)	0.28 ***			0.16 **	0.13 *					0.231 ***
Voluntary	0.6223 (0.48)	-0.17 **			0.13 *			0.13 *	0.17 **		
Costs	0.6489 (0.48)		0.143 *								
Public contracts	0.3670 (0.48)	0.112 *		0.185 ***	0.12 *	0.12 **		0.13 **			0.176 ***
Sample size		376	376	376	376	376	376	376	376	376	376
Endogenous variable: Mean (SD)		0.4840 (0.50)	0.6117 (0.49)	0.4654 (0.50)	0.5319 (0.50)	0.3378 (0.47)	0.5931 (0.49)	0.5612 (0.50)	0.4574 (0.50)	0.6968 (0.46)	0.4149 (0.49)
R^2-McFadden		0.112	0.175	0.122	0.14	0.16	0.09	0.19	0.16	0.1	0.133

Source: compiled by the authors. Significance codes: *** 0.01; ** 0.05; * 0.1

footprint within the firm and by the end user, replacement of materials and recycling of materials).

Even though respondents consider costs as an important eco-innovation driver (see Figure 5), high cost of energy, water or materials is not related to greater environmental benefits.

As mentioned earlier, firms that have actually received public funding (Pub. aid) for their innovation activities achieve greater environmental benefits. Nevertheless, when asked about the relevance of subsidies for their eco-innovation activities, this was among the least mentioned drivers (Figure 4), and we find no link between the importance given to this driver and eco-innovation benefits (Table 4).

5. Discussion

H1: Being a cooperative has a positive and significant effect on eco-innovation.

We find partial support for our first hypothesis. The percentage of Basque industrial firms that have introduced innovations with environmental benefits is significantly higher among cooperatives than among investor-owned firms. Nevertheless, when we analyse the subsample of eco-innovative firms and the joint effects of different variables, we find that being a cooperative has no significant effect on the introduction of any kind of eco-innovation. These results add to the evidence from previous empirical studies conducted in agricultural cooperatives with similar results (Rabadan et al., 2021; Calle et al., 2020; Carchano et al., 2023).

Nevertheless, it is extraordinary that industrial cooperatives achieve similar or even better eco-innovation benefits from their innovation activities, despite facing much greater obstacles to innovation. In fact, our research finds strong evidence of the greater relevance of factors hampering the decision to start or execute innovation activities among cooperatives. Lack of internal finance for innovation and lack of credit or private equity are significantly greater problems among cooperatives than among investor-owned firms, adding strong evidence to a persistent theme in the literature on cooperatives (see, for example, Basterretxea and Martínez, 2012; Bonin et al., 1993; Grashuis and Su, 2019; Maietta and Sena, 2010). In addition, cooperatives encounter greater difficulties when seeking partners to collaborate in R&D activities and in accessing external knowledge. A possible explanation proposed by some authors, such as Bonin et al. (1993), to explain the reluctance of creditors and financial markets to work with cooperatives could be the scarcity of information about cooperatives outside their environment. This reluctance may manifest as a lack of collaboration in innovation activities and may also affect other stakeholders. Lack of skilled employees, which is another problem highlighted more among cooperatives than among investor-owned firms, could

be explained by salary limitations and low wage differentials of these firms (Basterretxea and Martínez, 2012).

While our sample is limited to Basque industrial cooperatives, we consider that some of our findings could also apply to a much broader and more international spectrum of cooperatives. Basque industrial cooperatives are much bigger, on average, than industrial cooperatives elsewhere, and they have a long tradition of inter-cooperation to create joint investment funds such as Mondragon Inversiones and ULMA Inversiones, or banks such as Mondragon's bank Laboral Kutxa. But, despite this, we find evidence that these cooperatives are at a disadvantage in obtaining finance for their innovation activities. This financing would likely be even more difficult to come by in industrial cooperatives of other regions and countries where cooperatives have a weaker presence.

We also anticipate that other factors limiting innovation in our sample would be prevalent in international scenarios. Despite the fact that Basque cooperatives have created a corporate university (Mondragon Unibertsitatea), corporate vocational and management training centres and joint R&D units, the cooperatives in our sample still highlight the lack of collaboration partners, the limited access to external knowledge and not enough skilled personnel as factors limiting their innovation. These limitations would likely be even greater for industrial cooperatives elsewhere.

H2: Exports have a positive and significant effect on eco-innovation.

H2 is partially supported by our findings.

We find that the higher the export intensity of Basque industrial firms, the more likely these firms are to be eco-innovative. However, when we consider only the subsample of eco-innovative firms, we only find significant positive effects of exports on eco-innovation in the form of reduced pollution.

Our results go against other studies that find negative relationship between exports and eco-innovation in Europe (Horbach, 2016; Chiarvesio et al., 2015, De Marchi, 2012) and are more in accordance with those conducted in countries with lower regulatory requirements and weaker market pull for eco-friendly products (Galbreath et al., 2021; Tsai and Liao, 2017). Results are also coherent with those conducted among Spanish firms (Torrecillas and Fernández, 2022) and among Eastern European countries, where the increased exposure to environmentally more stringent markets enhances eco-innovation (Hanley and Semrau, 2022).

64% of Basque exports go to countries of the EU, and France and Germany are the main markets, with almost one third of Basque exports going to those two countries (Eustat, 2024). While eco-regulatory frameworks are similar in EU countries, market pull for eco-friendly products (and often more expensive products, as in the case of cars) is higher in richer countries. Exports to EU and other countries with high eco-regulatory pressure make up the vast majority of Basque industrial exports. In addition, the leading export sectors in the Basque

country — oil and petroleum products, cars, car parts — are heavily influenced by actual and future eco-regulations. All these factors support the logical assumption that there is a positive relationship between export intensity and eco-innovation. Similar results would likely be found in other European regions with comparable export profiles.

Our results also show that the relationship between export intensity and eco-innovation is higher among Basque industrial cooperatives than among investor-owned firms. Basque industrial cooperatives export more than investor-owned firms and the percentage of high-intensity exporters (those exporting more than 75% of their turnover) is four times higher among cooperatives. All of these high-intensity cooperative exporters show some sort of eco-innovation.

The industrial cooperatives belonging to Mondragon have enjoyed significant international exposure and their annual reports show that they have been exporting a large part of their production for decades. Other large Basque industrial cooperatives not belonging to Mondragon, such as IRIZAR, AMPO, ORONA, ULMA, RPK or GOIZPER export most part of their production. Thus, our findings cannot be easily projected to other regions with fewer, smaller and less export-oriented industrial cooperatives. Nevertheless, similar results can be seen in regions with large, high intensity, cooperative exporters. In fact, our results are coherent with those found in Spanish olive oil agricultural cooperatives; these cooperatives are more eco-innovative than their non-cooperative competitors, mainly due to their larger size and higher export intensity (Rabadan et al., 2021).

H3: Regulatory pressures and market pull are the main drivers of eco-innovation.

As previous analyses indicate, current regulation is key to driving eco-innovation (Bossle et al., 2016; Horbach, 2016; Afeltra et al., 2023), as well as the effect of expected future regulations (Díaz-García et al., 2015).

In this regard, we find that environmental regulations or taxes expected in the future are much more important eco-innovation drivers for Basque industrial firms than actual regulations or taxes. The importance of the oil and petroleum products and car parts industries in the Basque country —two industries that are facing huge changes given future eco-regulations— partially explains this phenomenon. Basque industrial cooperatives have a strong relationship with the car industry (both as car parts producers and as producers of machine tools for the car industry) and, consequently, actual and future eco-regulations and eco-taxes are clearly going to be very important drivers of eco-innovation for these firms.

A major driver of eco-innovation is the need to meet requirements for public procurement, yet this driver is less important for Basque industrial cooperatives, since they work mainly for business-to-business (B2B) private customers. The need to meet requirements for public procurement can be

more important in cooperatives operating in the service sector, where many cooperatives operate in activities such as recycling, waste management, housing, or care, highly dependent on public procurement. Another driver of eco-innovation, improving the firm´s reputation, is equally important for cooperatives and investor-owned firms.

The Basque Country is responsible for the legislative development and execution within its territory of Spanish regulation on environment and ecology, and the environmental challenge has been at the top of the agenda of successive regional governments since the early 1980s (Valdaliso, 2015; Tamayo et al. 2017). Basque public bodies also have autonomy when it comes to regulating and taxing cooperatives, and have developed laws, tax exemption or reduction systems and grant systems intended to help cooperatives overcome their limitations. Despite all this local public support, we still find that cooperatives face more limitations when it comes to eco-innovations, leading us to conjecture that these limitations would likely be greater in regions with lower legal and tax support for cooperatives and for eco-innovation.

H4: Voluntary initiatives for environmental good practice are more important drivers of eco-innovation in cooperatives

Our results are contrary to H4 and, to a great extent, contrary to the innate greener condition of cooperatives suggested by previous researchers despite limited empirical evidence. Voluntary initiatives as a driver for environmental good practices have no more relevance in eco-innovation in cooperatives than in other firms. Cooperative principles can be a potential source of positive attitudes towards eco-innovation. However, we lack sufficient empirical evidence to affirm that these principles are actually a real source of better eco-innovation performance.

The failure of our results to support hypothesis 4 could lead us to be critical of Basque industrial cooperatives for not fulfilling the prophecy of social economy literature or, alternatively, of the social economy literature for making theoretical predictions with scarce empirical evidence.

As Heras-Saizarbitoria (2014) highlights for the case of Mondragon cooperatives, cooperative principles can be symbolically adopted and decoupled from the daily activity of the cooperatives. As seen in the case of Heras-Saizarbitoria (2014), our findings also clash strongly with the utopic scholarly perspective described in the literature review. The drivers of eco-innovation in Basque industrial cooperatives are similar to those of non-cooperative firms and there is no evidence to suggest voluntary eco-innovation is motivated by cooperative principles.

Our results are in line with the few previous empirical studies conducted in agricultural cooperatives in Spain and in China. These studies show no clear evidence to support the eco-innovative innate condition of cooperatives. This emphasises the need for future advances in the social economy literature to ensure that any statements made are based on hard evidence.

Comparison of results with those obtained in other regions and countries

Based on the international framework, in which eco-innovation already has a certain theoretical and practical background, this section compares our results with those of other regions and countries.

Table 5 summarises the cases in which our paper adds evidence in line with previous studies, and those in which it provides contrary results. The information has been organised according to the study's hypotheses, to which we have added the question of financing, which is key to explaining some of the differences in terms of innovation in cooperatives. As Table 5 shows, the

Table 5: comparative results in different regions and countries

	Results	Adds evidence in line with previous research	Finds evidence contrary to other studies
H1: Being a cooperative has a positive and significant effect on eco-innovation.	Partially supported (cooperatives more eco-innovative, due to their size and other factors)	Calle et al. (2020): Spanish wine cooperatives Carchano et al. (2023): Spanish wine cooperatives Rabadan et al. (2021): Spanish olive oil agricultural cooperatives	
H2: Exports have a positive and significant effect on eco-innovation.	Partially supported	Galbreath et al. (2021): Taiwanese manufacturing and service companies Hanley and Semrau (2022): 14 European countries Rabadan et al. (2021): Spanish olive oil agricultural cooperatives Torrecillas and Fernández (2022): Spanish manufacturing firms Tsai and Liao (2017): Taiwanese manufacturing firms	Chiarvesio et al. (2015): Italian firms De Marchi (2012): Spanish manufacturing firms Horbach (2016): European countries
H3: Regulatory pressures and market pull are the main drivers of eco-innovation.	Supported	Key drivers present in empirical studies worldwide (see Horbach, 2016 for European countries, and Afeltra et al. (2023), Bossle et al. (2016) and Díaz-García et al. (2015): for literature reviews).	
H4: Voluntary initiatives for environmental good practice are more important drivers of eco-innovation in cooperatives	Rejected		No previous empirical evidence, but several influential academic papers suggest a more ecological innate condition of cooperatives (Mozas and Bernal, 2006; Novkovic, 2008; Puentes and Velasco, 2009)
Lack of internal finance, credit or private equity	Supported	Basterretxea and Martínez (2012): Basque industrial cooperatives Grashuis and Su (2019): Farmer cooperatives, review of the empirical literature. Maietta and Sena (2010): Italian producers˜ cooperatives	

Source: compiled by the authors

study reinforces in many cases the evidence from previous literature. The main differences concern the exports effect, which is still under debate, and the voluntary initiatives.

6. Conclusions

The need to move towards new forms of production and consumption, reducing environmental impacts, is currently a challenge at the core of many initiatives. Cooperatives can be a key player in this context.

Our study confirms the greater presence of eco-innovation among cooperatives compared to traditional firms. However, it raises doubts as to whether it is precisely this issue (being a cooperative) that makes a difference, or whether this is due to other factors, such as external R&D, or higher export intensity.

Nevertheless, the performance of cooperatives in terms of eco-innovation is particularly noteworthy, considering the greater difficulties or obstacles they encounter.

Our results could help guide policy makers towards promoting sustainable practices among both cooperative and non-cooperative firms. Given that future eco-regulations and taxes are the main driver of eco-innovation (even more so in the case of cooperatives), policymakers should provide clear signals about upcoming changes in regulations so that firms can align their strategies accordingly. Our study also highlights several factors which hamper innovation activities more acutely among cooperatives: lack of internal finance, lack of credit or private equity and lack of collaboration partners. In accordance, grants and subsidies for innovation activities are more important drivers of innovation among cooperatives and so policymakers should complement actual and future eco-regulations with specific aids for cooperatives (subsidies, access to credit, collaboration via public research partners, etc.).

7. Limitations and future research directions

Among the limitations of our study, we should mention that some factors which, according to our results, have little influence on eco-innovation could be highly context-dependent. For example, the high cost of energy, water or materials was not an important eco-innovation driver for the 2019-2021 period in which our data were gathered. However, surveys for the period 2021-2023 might show this factor as being more significant.

The Innovation Survey of the Basque Institute of Statistics from which the data were extracted included most of the relevant drivers of eco-innovation, but did not include some internal drivers discussed in other papers, such as environmental leadership and managerial concern, or questions related to human resources and capabilities. If we had developed our own ad-hoc survey, we would have included these questions, but it would have been difficult for us to achieve a similar response rate and such rich comparative data.

An interesting research direction would be to complete an international analysis of eco-innovation in agricultural cooperatives and investor-owned agricultural firms. This would enable eco-innovation to be researched from an international perspective, given that agricultural cooperatives are important in many different countries.

While we have studied eco-innovation in industrial cooperatives versus investor-owned firms, further studies could use the Eustat's innovation survey to analyse eco-innovation among cooperatives in the service sector. In fact, this survey offers data on 3,061 establishments in the service industry (139 of them cooperatives), a large source of data which was not used in our study.

Data availability

Data are available for research purposes upon request to the Basque Institute of Statistics (Eustat).

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References

Aboelmaged, M. (2018). Direct and indirect effects of eco-innovation, environmental orientation and supplier collaboration on hotel performance: An empirical study. *Journal of Cleaner Production,* 184, 537–549. doi: 10.1016/j.jclepro.2018.02.192

Afeltra, G., Alerasoul, S. A. & Strozzi, F. (2023). The evolution of sustainable innovation: from the past to the future. *European Journal of Innovation Management*, 26(2), 386-421. doi: 10.1108/EJIM-02-2021-0113

Alkaya, E. & Demirer, G.N. (2015). Reducing water and energy consumption in chemical industry by sustainable production approach: a pilot study for polyethylene terephthalate production. *Journal of Cleaner Production*. 99, 119e128. doi: 10.1016/j.jclepro.2015.02.087

Basterretxea, I. & Martínez, R. (2012). Impact of management and innovation capabilities on performance: Are cooperatives different? *Annals of Public and Cooperative Economics*, 83(3), 357-381. doi: 10.1111/j.1467-8292.2012.00467.x

Besio, C., Arnold, N. & Ametowobla, D. (2022). Participatory organizations as infrastructures of sustainability? The case of energy cooperatives and their ways for increasing influence. Historical Social Research/Historische Sozialforschung, 47(4), 91-113. doi: 10.12759/hsr.47.2022.40

Bokoumbo, K., Berge, S., Johnson, K. A., Yabi, A. J. & Yegbemey, R. N. (2023). Cooperatives and sustainability: The case of maize producers in the plateaux region of Togo. Heliyon, 9(6). doi: 10.1016/j.heliyon.2023.e17345

Bonin, J.P., Jones, D.C. &, Putterman, L. (1993). Theoretical and Empirical Studies of Producer Cooperatives: Will Ever the Twain Meet? *Journal of Economic Literature*, 31 (3). 1290-1320.

Bossle, M. B., de Barcellos, M. D., Vieira, L. M. & Sauvée, L. (2016). The drivers for adoption of eco-innovation. *Journal of Cleaner production*, 113, 861-872. doi: 10.1016/j.jclepro.2015.11.033

Calle, F., González-Moreno, Á., Carrasco, I. & Vargas-Vargas, M. (2020). Social Economy, Environmental Proactivity, Eco-Innovation and Performance in the Spanish Wine Sector. *Sustainability*, 12(15), 5908. doi: 10.3390/su12155908

Candemir, A., Duvaleix, S. & Latruffe, L. (2021). Agricultural cooperatives and farm sustainability — A literature review. *Journal of Economic Surveys*, 35(4), 1118-1144. doi: 10.1111/joes.12417

Carchano, M., Carrasco, I. & González, Á. (2023). Eco-innovation and environmental performance: Insights from Spanish wine companies. *Annals of Public and Cooperative Economics*. doi: 10.1111/apce.12421

Castellacci, F. & Lie, C.M. (2017). A taxonomy of green innovators: empirical evidence from South Korea. *Journal of Cleaner Production*, Vol. 143, pp. 1036-1047. doi: 10.1016/j.jclepro.2016.12.016

Chiarvesio, M. De Marchi, V. & Di Maria, E. (2015). Environmental innovations and internationalization: Theory and practices. *Business Strategy and the Environment*, (24), 790–801. doi: 10.1002/bse.1846

Dalhammar, C. (2016). Industry attitudes towards ecodesign standards for improved resource efficiency. *Journal of Cleaner Production*, 123, 155-166. doi: 10.1016/j.jclepro.2015.12.035

De Marchi, V. (2012). Environmental innovation and R&D cooperation: Empirical evidence from Spanish manufacturing firms. *Research Policy*, 41(3), 614-623. doi: 10.1016/j.respol.2011.10.002

Demirel, P. & Kesidou, E. (2011). Stimulating different types of eco-innovation in the UK: Government policies and firm motivations. *Ecological Economics*, 70(8), 1546-1557. doi: 10.1016/j.ecolecon.2011.03.019

Díaz-García, C., González-Moreno, A. & Sáez-Martínez, F. J. (2015). Eco-innovation: insights from a literature review. *Innovation: Management, Policy & Practice*, *17*(1), 6–23. doi: 10.1080/14479338.2015.1011060

Dong, C., Wang, H., Long, W., Ma, J. & Cui, Y. (2023). Can Agricultural Cooperatives Promote Chinese Farmers' Adoption of Green Technologies? *International Journal of Environmental Research and Public Health*, 20(5), 4051. doi: 10.3390/ijerph20054051

Doran, J. & Ryan, G. (2016). The importance of the diverse drivers and types of environmental innovation for firm performance. *Business Strategy and the Environment* (25), 102-119. doi: 10.1002/bse.1860

European Commission. (2011). *Innovation for a Sustainable Future — The Eco-Innovation Action Plan (Eco-AP)*. European Commission. Brussels. https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0899:FIN:EN:PDF (oct 2023)

Eurostat (2021). *Harmonised Data Collection for the CIS 2020*.

Eustat (2024). Tablas estadísticas. Comercio exterior en 2022.

Galbreath, J., Chang, C. Y. & Tisch, D. (2021). Are exporting firms linked to cleaner production? A study of eco-innovation in Taiwan. *Journal of Cleaner Production*, 303, 127029. doi: 10.1016/j.jclepro.2021.127029

García-Granero, E. M., Piedra-Muñoz, L. & Galdeano-Gómez, E. (2018). Eco-innovation measurement: A review of firm performance indicators. *Journal of Cleaner Production*, 191, 304-317. doi: 10.1016/j.jclepro.2018.04.215

Grashuis, J. & Su, Y. (2019). A review of the empirical literature on farmer cooperatives: Performance, ownership and governance, finance, and member attitude. *Annals of Public and Cooperative Economics*, 90(1), 77-102. doi: 10.1111/apce.12205

Greene, W. H. (2012). *Econometric analysis*. Prentice Hall, New Jersey, 7th Edition.

Hanley, A., & Semrau, F. O. (2022). Stepping up to the mark? Firms' export activity and environmental innovation in 14 European countries. *Industry and Innovation*, 29(5), 672-700. doi:10.1080/13662716.2021.2021865

He, F., Miao, X., Wong, C. W. Y. & Lee, S. (2018). Contemporary corporate eco-innovation research: A systematic review. Journal of Cleaner Production, 174, 502–526. doi: 10.1016/j.jclepro.2017.10.314

Hellström, T. (2007). Dimensions of environmentally sustainable innovation: the structure of eco-innovation concepts. Sustainable Development, 15 (3), 148-159. doi: 10.1002/sd.309

Henrÿ, Hagen. 2017. Co-Operative Principles and Co-Operative Law Across the Globe. In The Oxford Handbook of mutual, co-operative, and co-owned business, ed. Jonathan Michie, Joseph R. Blasi, and Carlo Borzaga. Oxford: Oxford University Press, 2017.

Heras-Saizarbitoria, I. (2014). The ties that bind? Exploring the basic principles of worker-owned organizations in practice. *Organization*, 21(5), 645-665. doi: 10.1177/1350508414537623

Hickel, J. (2019). The contradiction of the sustainable development goals: Growth versus ecology on a finite planet. *Sustainable Development*, 27, 2019, 873-884. doi: 10.1002/sd.1947

Horbach, J. (2008). Determinants of environmental innovation — New evidence from German panel data sources. *Research policy*, 37(1), 163-173. doi: 10.1016/j.respol.2007.08.006

Horbach, J. (2016). Empirical determinants of eco-innovation in European countries using the community innovation survey. *Environmental Innovation and Societal Transitions*, 19, 1-14. doi: 10.1016/j.eist.2015.09.005

Horbach, J., Rammer, C. & Rennings, K. (2012). Determinants of eco-innovations by type of environmental impact — The role of regulatory push/pull, technology push and market pull. *Ecological Economics*, 78, 112-122. doi: 10.1016/j.ecolecon.2012.04.005

ICA (2015). Guidance Notes to the cooperative principles https://ica.coop/sites/default/files/2021-11/ICA%20Guidance%20Notes%20EN.pdf [Last accessed 28/9/2023].

Kemp, R. & Pearson, P. (2007). *Final report of the MEI project measuring eco innovation*, UM Merit Maastricht, available at: https://www.oecd.org/greengrowth/consumption-innovation/43960830.pdf.

Li, D., Tang, F. & Zhang, L. (2020). Differential effects of voluntary environmental programs and mandatory regulations on corporate green innovation. *Natural Hazards*, 103, 3437-3456. doi: 10.1007/s11069-020-04137-y

Li, M., Yan, X., Guo, Y. & Ji, H. (2021). Impact of risk awareness and agriculture cooperatives' service on farmers' safe production behaviour: Evidences from Shaanxi Province. *Journal of Cleaner Production*, 312, 127724. doi: 10.1016/j.jclepro.2021.127724

Liang, Q., Ma, K. & Liu, W. (2023). The role of farmer cooperatives in promoting environmentally sustainable agricultural development in China: A review. *Annals of Public and Cooperative Economics*. doi: 10.1111/apce.12444

Liu, T. & Wu, G. (2022). Does agricultural cooperative membership help reduce the overuse of chemical fertilizers and pesticides? Evidence from rural China. *Environmental Science and Pollution Research*, 1–12. doi: 10.1007/s11356-021-16277-0

Luo, L., Qiao, D., Zhang, R., Luo, C., Fu, X. & Liu, Y. (2022). Research on the influence of education of farmers' cooperatives on the adoption of green prevention and control technologies by members: Evidence from rural China. *International Journal of Environmental Research and Public Health*, 19(10), 6255. doi: 10.3390/ijerph19106255

Ma, W., Abdulai, A. & Goetz, R. (2018). Agricultural cooperatives and investment in organic soil amendments and chemical fertilizer in China. *American Journal of Agricultural Economics* 100: 502–520. doi: 10.1093/ajae/aax079

Mahmood, N., Zhao, Y., Lou, Q. & Geng, J. (2022). Role of environmental regulations and eco-innovation in energy structure transition for green growth: Evidence from OECD. *Technological Forecasting and Social Change*, 183, 121890. doi: 10.1016/j.techfore.2022.121890

Maietta, O.W. & Sena, V. (2010). Financial constraints and technical efficiency: some empirical evidence for Italian producers' cooperatives. *Annals of Public and Cooperative Economics*, 81 (1): 21–38. doi: 10.1111/j.1467-8292.2009.00404.x

Melece, L. & Hazners, J. (2017). Factors influencing Latvian small and medium enterprises towards eco-innovation. Engineering for Rural Development, 16, 1466–1473. doi: 10.22616/ERDev2017.16.N333

Mozas, A., & Bernal, E. (2006). Desarrollo territorial y economía social. *CIRIEC-España, Revista de Economía Pública, Social y Cooperativa*, 55, 125-140.

Nesta, L., Vona, F. & Nicolli, F. (2014). Environmental policies, competition and innovation in renewable energy. *Journal of Environmental Economics and Management*, 67(3), 396-411. doi: 10.1016/j.jeem.2014.01.001

Novkovic, S. (2008). Defining the co-operative difference. *The Journal of Socio-Economics*, 37(6), 2168-2177. doi: 10.1016/j.socec.2008.02.009

Puentes, R. & Velasco, M.M. (2009). Importancia de las sociedades cooperativas como medio para contribuir al desarrollo económico, social y medioambiental, de forma sostenible y responsable. *REVESCO. Revista de Estudios Cooperativos*, 99, 104-129.

OECE (2009). *Sustainable manufacturing and eco-innovation. Framework, practices and measurement. Synthesis report.*

Rabadán, A., Álvarez-Ortí, M., Tello, J. & Pardo, J. E. (2021). 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,* 11(3), 447. doi: 10.3390/agronomy11030447

Rodrīguez, J. & Wiengarten, F. (2017). The role of process innovativeness in the development of environmental innovativeness capability. *Journal of Cleaner Production* 142, 2423-2434. doi: 10.1016/j.jclepro.2016.11.033

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E. F., ... & Foley, J. A. (2009). A safe operating space for humanity. *Nature*, 461(7263), 472-475. doi: 10.1038/461472a

Rousselière, D., Bouchard, M. J., & Rousselière, S. (2024). How does the social economy contribute to social and environmental innovation? Evidence of direct and indirect effects from a European survey. *Research Policy*, 53(5). doi: 10.1016/j.respol.2024.104991

Tamayo-Orbegozo, U., Vicente-Molina, M. A., & Villarreal-Larrinaga, O. (2017). Eco-innovation strategic model. A multiple-case study from a highly eco-innovative European region. *Journal of Cleaner Production*, 142, 1347-1367. doi: 10.1016/j.jclepro.2016.11.174

Torrecillas, C., & Fernández, S. (2022). Exports and outward FDI as drivers of eco-innovations. An analysis based on Spanish manufacturing firms. *Journal of Cleaner Production*, 349, 131243. doi: 10.1016/j.jclepro.2022.131243

Tsai, K. H. & Liao, Y. C. (2017). Innovation capacity and the implementation of eco-innovation: Toward a contingency perspective. *Business Strategy and the Environment*, 26(7), 1000-1013. doi: 10.1002/bse.1963

UN (2015). Transforming Our World: The 2030 Agenda for Sustainable Development. Resolution Adopted by the General Assembly on 25 September 2015, 42809, 1-13.

Valdaliso, J. M. (2015). The Basque Country: Past trajectory and path dependency in policy-and strategy-making. In *Strategies for shaping territorial competitiveness* (pp. 113-130). Routledge.

Van Hemel, C. & Cramer, J. (2002). Barriers and stimuli for ecodesign in SMEs. *Journal of Cleaner Production*. (10), 439-453. doi: 10.1016/S0959-6526(02)00013-6

Yu, L., Chen, C., Niu, Z., Gao, Y., Yang, H. & Xue, Z. (2021). Risk aversion, cooperative membership and the adoption of green control techniques: evidence from China. *Journal of Cleaner Production*. 279: 123288. doi: 10.1016/j.jclepro.2020.123288

Zhang, Y., Lu, Q., Yang, C. & Grant, M. K. (2023). Cooperative membership, service provision, and the adoption of green control techniques: Evidence from China. *Journal of Cleaner Production*, 384, 135462. doi: 10.1016/j.jclepro.2022.135462

Zhou J., Yang Z., Li K. & Yu X. (2019). Direct intervention or indirect support? The effects of cooperative control measures on farmers' implementation of quality and safety standards. *Food Policy* 86: 101728. doi: 10.1016/j.foodpol.2019.05.011