Stakeholder Engagement Mechanisms and their contribution to Eco-innovation: Differentiated Effects of Communication and Cooperation

Introduction

In the last few years, the pressing need to design new production and consumption systems compatible with sustainable development principles has conditioned decision-making in both public and private organisations, while remaining the focal point of the scientific discourse in numerous areas of knowledge. In the areas of knowledge related to business management, the eco-innovation concept was coined at the end of the last century by authors such as Fussler and James (1996) to refer to the business process of developing new products, processes or services that provide customer and business value but significantly decrease environmental impact. Some years later, authors such as Klemmer et al. (1999) and Rennings (2000) broadened this definition to refer to the fact that eco-innovation can be developed and applied by different agents (firms, policies, associations, private households, etc.) and can be of a technological, organisational, social or institutional nature. More recently, Kemp and Pearson (2007) interpret eco-innovation in the sense proposed by the OSLO Manual[1], defining it as the production, assimilation or exploration of a product, production process, service or management method or business that is new for the organisation (development or adoption) and, in comparison with the pertinent alternatives, generates less environmental risk and pollution and negative impacts derived from the use of resources and energy during its life cycle. This definition shows that any significant novelty for the firm, established in order to reduce environmental impact, can be considered eco-innovation. Although there is a somewhat more radical interpretation of the eco-innovation concept, which focuses on invention in the sense of obtaining tangible results from new ideas and their application

[1] The innovation consists of the implementation of a new, or significantly improved product (good or service) or process, a new marketing method or a new organisational method in business practice.

(Carrillo-Hermosilla et al., 2010), this study uses the term eco-innovation in the sense proposed by Kemp and Pearson (2007).

According to current management literature, the implantation of such eco-innovative practices can be interpreted as a response to stakeholders' environmental demands and preferences (Ayuso et al., 2006; Yarahmadi & Higgings, 2012; Ryszko, 2016; Cunico et al., 2017). Several studies provide empirical evidence showing that intensity of stakeholder pressure is a factor that promotes proactive environmental strategies, based on technological and organisational environmental improvement measures that exceed regulator requirements (Christmann 2004; Sharma & Henriques, 2005; Murillo-Luna et al., 2008; Ferrón-Vilchez et al., 2017; Valero-Gil et al., 2017). The literature that analyses the conditions in which this stakeholder pressure affects the application of specific environmental measures is also extensive[2]. However, there is still room for studying the effectiveness of different stakeholder engagement mechanisms for integrating stakeholders' environmental demans in eco-innovation processes in firms, in other words, the mechanisms on which so-called "stakeholder integration capacity" is generated in eco-innovation matters. Sharma & Vrenderburg (1998) define stakeholder integration capacity as "*the ability to establish trust-based collaborative relationships with a wide variety of stakeholders"* and establish that this capacity is required in order to reduce environmental impacty. Plaza-Úbeda et al. (2010), conclude that the stakeholder integration construct comprises three dimensions: knowledge of stakeholders, interactions with stakeholders and adaptation of firm behaviour to stakeholders' demands. According to the literature, different stakeholder engagement mechanisms enable the consolidation of these dimensions, from simple unilateral informative communication mechanisms to sophisticated participative stakeholder collaboration and cooperation systems

[2] See for example Delmas & Toffel (2004), Sharma et al. (2007), Rueda-Manzanares et al. (2008), Darnall et al. (2010), Delgado-Ceballos et al. (2012), Garcés-Ayerbe et al. (2012) or Valero-Gil et al. (2017) for a review of factors that moderate the relationship between stakeholder pressure and the adoption of proactive environmental practices.

(Green & Hunton-Clarke, 2003; Reed, 2008; Scandelius & Cohen, 2016; Lane & Devin, 2017; Moratis & Brandt, 2017; Vollero et al., 2018). However, the different effectiveness of these mechanisms, and their mutual dependence, for fostering the adoption of proactive environmental strategies based on eco-innovation have hardly been studied in the literature. Our study attempts to learn more in this line of research. Its objective is to analyse the specific contribution of two types of stakeholder engagement mechanisms, communication and cooperation, in the adoption of eco-innovation business measures.

This study provides three types of contribution to the literature. In the first place, the effects of two types of stakeholder engagement mechanisms, communication and cooperation, on a firm's eco-innovation strategy are separately analysed, as is the interconnection between the two mechanisms. As far as we can see, there are no previous studies analysing the effects of these engagement mechanisms in detail and using a single relational model. Secondly, the study proposes a novel way of measuring eco-innovation that enables us to consider different degrees of eco-innovative intensity based on a capital model that includes the accumulation of tangible and intangible assets derived from activities recently adopted by firms to reduce environmental impact. Among others, these activities include those that aim to reduce environmental impact through the development or acquisition of R&D, training, market innovations or the acquisition of machinery, know-how or innovations. Thirdly, this study provides the empirical literature with evidence, generally case study-based, of the effect that the stakeholder integration process has on eco-innovation, through communication and cooperation mechanisms.

The paper is structured as follows: the following two sections include a literature review that shows the need for stakeholder integration in eco-innovation processes through different stakeholder engagement mechanisms; the fourth section presents the empirical study, followed by the discussion and conclusions section.

2.1. Stakeholder integration in eco-innovation processes

Since the original definition of eco-innovation proposed by Fussler and James (1996) as innovations in products and processes that improve environmental outcomes while providing consumer and business value, many authors have attempted to add information and detail to the concept. Klemmer et al. (1999), in their summary of the "Impacts of Innovation of Environmental Policy Instruments" interdisciplinary project commissioned by the German Ministry of Research and Technology, maintain that eco-innovation comprises all measures adopted by relevant agents (firms, politicians, associations, churches, private households) that: a) develop and apply or introduce new ideas, conducts, products and processes, and b) help to reduce environmental impacts or attain specific sustainability objectives.

Kemp and Pearson (2007) suggest in their definition of eco-innovation, detailed in the introduction section, that for a firm's pro-environmental changes to be classified as eco-innovative, it is sufficient for such changes to be new in the firm, even if not necessarily new for the industry or market. These authors' definition also shows that eco-innovative practices can be implemented throughout the life cycle and can be purchased or developed internally. Later, the OECD report on sustainable production and eco-innovation (2009) broadens this definition by adding that the environmental effects of eco-innovative practices can be intentional or not. In this case, practices aimed at attaining economic, organisational, market or other objectives, which collaterally improve an organisation's environmental impact, are also eco-innovative[3]. According to this broad interpretation, the application of eco-innovative measures could aim at different purposes, such as improving production efficiency, approaching new markets, accessing financial resources or integrating the view of clients,

[3] In relation to this idea, some authors tend to be somewhat more radical when determining the conditions in which practices can be classified as eco-innovative. For instance, some authors refer to a process of change that consists on invention of an idea and its application; in this case the results can be measured through green patents (Arundel y Kemp, 2009; Carrillo-Hermosilla et al., 2009; Oltra et al., 2010). This definition of the eco-innovation concept is more limited for the purposes of this study, as it only contemplates the possibility of internal development of environmental ideas or projects, and not their acquisition.

suppliers and other key agents in the firm. Therefore, firms must design their eco-innovation strategies considering their dynamic setting, and adapt measures to both legal requirements and stakeholders' environmental demands and preferences.

The need to integrate stakeholders in eco-innovation processes was implicitly suggested by Hart (1995) in his Natural Resource-Based View. In his view, Hart claims that the optimal design of a pollution prevention strategy requires reducing environmental impact in all the steps in the value chain. Therefore, what he calls the "voice of environment", meaning the perspective of stakeholders, has to be integrated in product design and process development aimed at pollution prevention.

With reference to Corporate Social Responsibility, Barnett (2007) maintains that it is distinguished from other corporate activities by two characteristics: social welfare orientation and stakeholder relationship orientation. This study adopts these two characteristics as pertaining to eco-innovation, which should be based on trust and collaboration with stakeholders to guarantee that their environmental and social welfare demands are met.

Some of the distinctive features or eco-innovation are what makes stakeholder integration so important in the process. For example, environmental innovations are characterized by long-term orientation and a high level of uncertainty compared with other innovations in the firm (Leyva-de la Hiz et al., 2018). In these conditions, to drive environmental innovations to obtain positive results requires detailed knowledge and adaptation to the socio-cultural setting and the present and future tastes, interests and needs of stakeholders. The complexity involved in issues related to sustainability also demands efficient and effective stakeholder integration (Scandelius & Cohen, 2016). This complexity is another feature of eco-innovation processes that make learning shared with stakeholders particularly useful. In this respect, Plaza-Úbeda et al. (2010) argue that interactions between a firm and its stakeholders facilitate

the creation of shared values and trust, necessary for the generation of collective knowledge through an organisational learning process.

Reed (2008) divides the arguments for stakeholder integration in environmental decision-making into two types, normative and pragmatic. Normative arguments focus on benefits for democratic society, citizenship and equity. Stakeholder participation increases the likelihood of obtaining these benefits. Pragmatic arguments focus on the quality and durability of environmental decisions. Stakeholder integration enables intervention and technologies to be better adapted to local socio-cultural and environmental conditions. The arguments reviewed in this section for stakeholder integration in eco-innovation process include both types of argument. In this respect, we believe that a firm's eco-innovation strategy depends on stakeholders' environmental concerns, objectives and preferences, and that their appropriate development largely depends on stakeholder integration capacity, defined by Sharma & Vrendenburg (1998) as the ability to establish trust-based collaborative relationships with stakeholders with regards to environmental issues.

2.2. Communication and cooperation as engagement mechanisms and their contribution to eco-innovation

Plaza-Úbeda et al. (2010) interpret stakeholder integration as a gradual process. According to these authors, *identification and knowledge of stakeholders* is the first step for a company to determine which stakeholders it must engage. Greater integration requires *interaction between stakeholders and company,* through reciprocal relationships. Finally, *adaptational behaviour* refers to the set of changes made in the company's behaviour with a view to meeting its stakeholders' demands. The key to this highest level of stakeholder integration is the responsiveness idea, which implies translating stakeholders' knowledge and interaction into actions. Progressing through these levels of integration requires the implementation of engagement mechanisms. The implementation of basic engagement mechanisms, such as

unilateral communication, guarantees reaching the first level of integration, *identification and knowledge of stakeholders* and their preferences. The second step, *interaction*, requires the implementation of more advanced bilateral communication systems, guaranteeing reciprocal relationships and feedback. The last step of integration, *adaptational behaviour*, requires effective collaboration and stakeholder participation in decision-making processes through mechanisms such as active bilateral communication, association or cooperation.

Following the idea that different levels of integration are possible, Green & Hunton-Clarke (2003) propose three possible stakeholder participation systems: i) *informative participation*: requiring unilateral or bilateral communication engagement mechanisms, involving no more than the transmission of information; ii) *consultative participation*: facilitating a higher level of stakeholder integration and requiring communication mechanisms that involve interviewing stakeholders at a deeper and more exploratory level; iii) *decisional participation*: facilitating the greatest degree of stakeholder integration in a firm, as stakeholders directly participate in the decision-making process. Several authors have supported the idea that stakeholder integration in the development of sustainability and corporate social responsibility strategies involves the gradual development of different engagement mechanisms, such as communication, consultation, dialogue, collaboration, association or cooperation (Morsing and Schultz, 2006; Lane & Devin, 2017; Moratis & Brandt, 2017; Vollero et al., 2019). In the previous literature, however, we have found very little empirical evidence showing the relative effectiveness of these engagement mechanisms that facilitate stakeholder integration for the development of corporate social responsibility strategies, and much less specifically eco-innovation strategies.

As far as we know, Ayuso et al. (2006), from two case studies, highlight stakeholder dialogue and stakeholder knowledge integration as capabilities for sustainable innovation. Agudo-Valiente et al. (2015), based on a sample of 416 Spanish firms, show the importance of

establishing channels of communication with stakeholders in order to adopt corporate social responsibility measures, but do not analyse the differentiated effect of different engagement mechanisms. Salem et al. (2016), based on 226 industrial corporations, consider different degrees of stakeholder integration in environmental matters, know-how and interaction, but their objective differs from that of our study, as they study the effects on a firm's competitiveness, measured through three constructs: profits, satisfaction and image-related aspects. Finally, Cunico et al. (2017) studied the effect of technological cooperation (as the highest degree of integration) on eco-innovation strategy in cassava processing companies. Using a sample of 33 questionnaires, the authors conclude that firms do not have the necessary competencies for an efficient eco-innovation strategy alone, and require cooperation with other organisations. They do not analyse, however, the impact of communication.

This study contributes to the literature with a differentiated analysis of the effects of two types of engagement mechanisms for stakeholder integration in eco-innovation processes, communication and cooperation. In the context of the research, based on authors such as Green and Hunton-Clarke (2003) and Plaza-Úbeda et al. (2010), we define communication as an engagement mechanism that enables information to be transmitted between the firm and its stakeholders; it can take on different forms (unilateral or bilateral, formal-informal, regular-ocsasional, structured or otherwise),and it reduces or eliminated information asymmetries between the parties. The contribution of this engagement mechanism to eco-innovation processes can be seen from the perspective of Institutional Theory. According to this theory, pressure groups and the general public bring pressure to bear for organisations to rationalise their businesses, strategic practices and outcomes (Meyer and Rowan, 1977; Di Maggio and Powell, 1983). Based on this approach, communication mechanisms that identify and describe stakeholder preferences and interests will promote the adoption of relatively standard eco-

innovation measures, to respond to objectives such as compliance with regulations and obtaining legitimacy or credibility from stakeholders. For example, firms often adopt the ISO 14001 standard in anticipation of, or in response to, customer demand (Delmas & Toffel, 2008). Therefore, as a result of communication with stakeholder groups, firms can be expected to adopt standard and institutionalized environmental management practices in a search for social legitimacy, such as environmental certifications, the establishment of environmental criteria for supplier selection, participation in voluntary environmental associations or programmes, or even greenwashing practices.

Hypothesis 1 is established based on the above arguments:

H1: Communication with stakeholders has a direct positive effect on eco-innovation intensity in firms.

Organisations that face common institutional pressure, however, often adopt different environmental practices (Delmas & Toffel, 2008). In the context of eco-innovation, we explain these differences as the result of different stakeholder integration levels. Indeed, communication with stakeholders forms the foundation for more advanced collaboration and cooperation engagement mechanisms (Scandelius & Cohen, 2016), which will result in a greater development of eco-innovation in the firm. Based on Lozano (2008), our study sees cooperation as a mechanism that allows stakeholders to get involved in the eco-innovation process through monitoring and evaluation, learning from each other and sharing experiences and objectives. From this perspective, cooperation with stakeholders in environmental matters shows a higher degree of stakeholder integration than communication, so more intense eco-innovation efforts can be expected in the firm.

The contribution of cooperation mechanisms to the development of eco-innovation measures can be considered based on the Resource Based View. This perspective is based on the premise that the firm can gain a sustainable competitive advantage if its resources and

capabilities are valuable, non-substitutable, rare and not imitable by their competitors (Barney, 1991). From this viewpoint, certain alliances with partners or other market agents can lead to both parties benefitting from access to heterogeneous resources that can be essential to apply an environmental innovation strategy, besides reducing the costs of these resources (Yarahmadi & Higgins, 2012). On the other hand, in the context of sustainability, cooperation engagement mechanisms facilitate the coordination of several intangible assets (such as know-how, for example), so the complexity involved in completing and coordinating the integration process makes it a strategic capacity that is difficult to imitate (Plaza-Úbeda et al., 2010). Also important in this regard is the capacity to generate eco-innovation information and know-how in a reciprocal manner, sharing both environmental risks and learning. Unlike those promoted by communication mechanisms, the eco-innovation results promoted by cooperation are path-dependent and favour competitiveness because they are difficult to replicate and socially complex. In this respect, Salem et al. (2016) provide empirical evidence that knowledge of stakeholders' environmental interests has no impact on a firm's competitiveness, interaction with stakeholders in environmental protection matters does improve competitiveness. This shows that eco-innovation activities derived from cooperation differ from those that result from the most basic communication engagement mechanisms.

Based on the above arguments, and considering that communication is a basic aspect of cooperation, we formulate the hypothesis that communication has a positive indirect effect on eco-innovation, through the cooperation activities that it promotes:

H2: Communication with stakeholders has an indirect positive effect on eco-innovation intensity in firms, through the mediator effect of cooperation.

Empirical study

Sample

This study is based on information obtained from the Spanish Technological Innovation Panel (PITEC[4]) conducted by the Spanish National Statistics Institute (INE) in collaboration with the Spanish Science and Technology Foundation (FECYT) and the Foundation for Technological Innovation (COTEC). Data have been collected yearly since 2003, and the last available year is 2014. This study used data for 2014, and our sample consists of 3998 firms all of which should have answered at least two questions, regarding total innovation expenditure and environmental importance[5]. The sample is distributed in 18 sectors, according to the National Classification of Economic Activities (CNAE-2009 classification) as shown in Tables 1 and 2.

Insert Tables 1 and 2 here

Table 1 shows the descriptive statistics of the sample relative to sector. Following the National Classification of Economic Activities (CNAE-2009), it can be seen that more than 60% of the sample is in the manufacturing sector. This reflects the sector's importance in Spanish economic activity, covering activities that range from food, beverages, textiles or wood to metalwork or motor vehicles (codes 10 to 33). Other important sectors in the sample are Information and Communication and Professional, Scientific and Technical Activities, rep`resenting 9.8% and 9.1%, respectively. The Information and Communication sector includes activities related to telecommunications and programming or computing consultancy, while Professional, Scientific and Technical Activities includes assays and technical analyses in biotechnology or natural and social sciences and humanities. Finally, a small number of sectors have a reduced need for technological innovation, including Real Estate Activities (0.1%) or Arts, Entertainment and Recreation (0.2%). Table 2 shows the distribution of the firms in the sample according to size, following the European Commission Recommendation

[4] The PITEC is the database of reference in Spain, due to numerous advantages, such as easy access, comparability with the statistics of other OECD countries, panel structure, etc. The data set is available free of charge at the http://icono.fecyt.es website.
[5] This question was added to the survey in 2008.

of 6 May 2003 concerning the definition of micro, small, medium-sized and large enterprises in relation to annual turnover. This distribution is homogeneous in size, with special importance given to small and medium-sized firms (28.1% and 30.4%, respectively), which represent more than 50% of the sample. The annual turnover of these firms ranges from 2 to 50 million euros[6].

Variable design

The Communication with stakeholders, Cooperation with stakeholders and Eco-Innovation Intensity variables are calculated from the survey's questions about the firm's innovations; these data are collected and published by the National Statistics Institute (INE) for 2014. Following is a description of the endogenous and exogenous variables[7].

Endogenous variable:

Eco-Innovation Intensity (EII)

Following the methodology used by Garcés-Ayerbe & Cañón-de-Francia (2017) and Pakes & Schankerman (1984), we consider that the eco-innovation process generates intangible assets that can be cumulative, so Eco-Innovation Intensity (EII) is measured through *Environmental Technology Capital* (ETC) corrected for size; *Environmental Technology Capital* (ETC) is a direct function of the firm's environmental investment in previous periods, as well as environmental investment in the current period, and is calculated using a stock measure constructed from a formulation of depreciated sums of the *Environmental Investments* (EI) made in the last few and current periods, using Koyck lags:

$$EII = \frac{ETC}{Size}$$

[6] Following the publication of the OECD (2017), 95% of companies in OECD member countries are small and medium-sized enterprises (SMEs) and, as Ormazabal et al. (2018) mentioned, 99% of companies in the EU are SMEs.

[7] For more detail see Appendix 1

$$ETC = \sum_{p=0}^{p} (1-\delta)^p * EI_{t-p}$$

where *p* is the number of years before the current year *t* in which environmental investments affected the stock of *Environmental Technology Capital* (ETC). Following the approach of Hirschey and Weygandt (1985) for R&D investments, the useful life of investments in environmental technology is considered to be five years. Therefore, following Henderson and Cockburn (1994)[8], the depreciation rate δ is considered to be a constant 20%.

To measure *Environmental Investment* (EI) we use a proxy variable based on the information provided by the PITEC database. This proxy variable is calculated as follows:

$$EI = TIE * EIMP$$

Where *Total Innovation Expenditure* (TIE) is total expenditure[9] in innovation*;* and *Environmental Importance* (EIMP) is a measure of the importance[10] that the firm gives to the innovation objective aimed at "reducing environmental impact".

Exogenous variables:

Communication with stakeholders (COMM): it is calculated from the survey question about firm innovations related to information sources for technological innovation activities. The survey specifically asks about the importance of different information sources for the firm's innovation activities in the last three periods (including the current period), where

[8] There is no consensus regarding the value of the depreciation rate and the number of periods that should be used to calculate stock. Hirschey and Weygandt (1985) estimate an annual depreciation rate of 10−20%, and a useful life of investment of 5−10 years; Griliches (1984) recommends a 15% ratio and a four-year lag; Cockburn and Henderson (1994) assume a 20% depreciation rate.

[9] Total innovation expenditure includes: a) in-house R&D; b) acquisition of R&D; c) acquisition of advanced machinery, equipment, hardware or software and buildings for the production of new or significantly improves products or processes; d) acquisition of know-how for innovation; e) training for innovation activities; f) market introduction of innovations; g) design, other production and/or distribution preparations.

[10] The way to measure the importance of the "reduce environmental impact" objective from the PITEC database is as follows: 1=High importance; 2= Medium importance; 3= Low importance; 4= Not significant/not applicable. This variable was re-calculated with the following values: 1=High importance; ½= Medium importance; 1/3= Low importance; 0= Not significant/not applicable.

0=Non-significant/not used; 1= Low importance; 2= Medium importance; 3= High importance. The variable is calculated by the mean degree of importance of eight information sources related to different stakeholder groups: a) in the firm or business group, departments, employees, etc.; b) equipment, material, component or software suppliers; c) clients; d) competitors or other firms involved in the same activity; e) consultants, commercial laboratories or private R&D institutes; f) universities or other higher education centres; g) public research agencies; h) technological centres. As a result, we obtain a quantitative variable with values ranging from 0 to 3.

Cooperation with stakeholders (COOP): variables that measure cooperation with stakeholders are calculated from the information available in the firm innovation survey. It defines cooperation for innovation as active participation with other agents, companies or non-commercial organisations in innovation activities, adding that both parties do not necessarily obtain commercial benefits from this cooperation. The variable is calculated by the sum of eight dummy variables that have a value of 1 if the firm cooperated with the stakeholder in the last three periods (including the current period) and 0 otherwise. The eight stakeholder groups are as follows: a) other firms from the same group; b) equipment, material, component or software suppliers; c) private sector clients; d) public sector clients; e) competitors or other firms involved in the same activity; f) consultants, commercial laboratories or R&D institutes; g) universities or other higher education centres; h) public or private research centres. As a result, we obtain a discrete quantitative variable with values ranging from 0 to 8.

Control variables:

As the design of the endogenous variable corrects firm size effects, but not sectoral effects, the analyses are corrected through sectoral variables:

Sectoral dummies: *N-1* dummy variables are used to correct the model for sectoral effects; they have a value of 1 if the company is in the sector, and 0 otherwise, where *N* = 18 is the total number of sectors[11].

Methodology:

The *Eco-Innovation Intensity* (EII) model is shown in equations 1 to 3:

$$\mathrm{EII} = \mathrm{i}_1 + \mathrm{c} * \mathrm{COMM} + * \sum_{\mathrm{n}=1}^{\mathrm{N}-1} \mathrm{d}_\mathrm{n} * \mathrm{D}_\mathrm{n} + \varepsilon_1 \quad (1)$$

$$\mathrm{EII} = \mathrm{i}_2 + \mathrm{c}' * \mathrm{COMM} + \mathrm{b} * \mathrm{COOP} + \sum_{\mathrm{n}=1}^{\mathrm{N}-1} \mathrm{d}_\mathrm{n} * \mathrm{D}_\mathrm{n} + \varepsilon_2 \quad (2)$$

$$\mathrm{COOP} = \mathrm{i}_3 + \mathrm{a} * \mathrm{COMM} + \sum_{\mathrm{n}=1}^{\mathrm{N}-1} \mathrm{d}_\mathrm{n} * \mathrm{D}_\mathrm{n} + \varepsilon_3 \quad (3)$$

Where EII is the dependent variable, COMM is the independent variable, and COOP is the mediator; coefficients i_1, i_2, i_3 are intercepts in each equation; and ε_1, ε_2, ε_3 are residuals. D_n are *(N-1)* dummy control variables for N=18 sector of activity. In Equation 1, coefficient c represents the total effect that COMM can have on EII. In Equation 2, coefficient c' denotes the relation between COMM and EII controlling for COOP, representing the direct effect of COMM on EII that is not intervened by COOP. Coefficient b denotes the relation between COOP and EII controlling for COMM. Finally, in Equation 3, coefficient a indicates the relation between COMM and COOP (MacKinnon, 2008). Equations 2 and 3 are represented in Figure 1.

Insert Figure 1 here

The traditional Baron & Kenny (1986) method used Sobel's Z test as the inferential test for the indirect effect of how much X (COMM) affects Y (EII) through M (COOP). Sobel's Z test is calculated as follows:

[11] See Tables 1 for more information about the 18 sectors

$$\text{Sobel Z} = \frac{(ab)}{\sqrt{b^2 s_a^2 + b^2 s_b^2}}$$

Where a and b are the unstandardized coefficients from the Baron & Kenny (1986) method; s_a is the standard error estimated of a and b and s_b is the standard error estimated of b. Until about ten years ago this method was considered best practice, although it is starting to become less popular, as the Sobel test used to test the indirect effect assuming normality, and this may not always hold. Most of the alternative methods rely on bootstrapping because no assumption about normality is required. The bootstrapping method uses a resampling procedure to form sampling distribution. It involves repeatedly drawing samples from the original sample in order to create an empirical approximation of the sampling distribution of the indirect effect under study and it was used in this study to test mediation.

In testing mediation, the relationship among the variables must satisfy the following conditions (Sarkis et al., 2010): 1) the independent variable must influence the dependent variable; 2) the independent variable must influence the mediator; 3) the mediator must influence the dependent variable and 4) the effect of the independent variable on the dependent variable must diminish after controlling for the effects of the mediator. According to Baron and Kenny, 1986, Tepper et al., 1996 and Sarkis et al., 2010, if all of these conditions are satisfied and the influence of the independent variable becomes non-significant in the presence of the mediator, the effects of the independent variable are said to be "completely" or "fully" mediated by the mediator. Otherwise, if all the conditions are satisfied, but the influence of the independent variable remains significant in the presence of the mediator, the effects of the independent variable are said to be "partially" mediated.

Insert Table 3 here

Results

The mediation model results are shown in Table 1. We can see the effects of the exogenous variables (communication and cooperation) on the endogenous eco-innovation intensity variable, which are positive and statistically significant. Specifically, the effect of communication with stakeholders on eco-innovation intensity is positive and significant, enabling us not to reject proposed hypothesis 1. The table also shows that the indirect effect of communication through cooperation is also positive and statistically significant, so we do not reject hypothesis 2. This means that communication with stakeholders has a positive effect on eco-innovation intensity; this effect will be greater if communication eventually leads to cooperation (greater stakeholder integration). Therefore, considering that stakeholder integration capacity is developed through stakeholder engagement mechanisms that are measured through communication, feedback and cooperation, it can be concluded that stakeholder integration has a positive effect on eco- innovation intensity.

Regarding testing mediation, as is shown in Table 1, the model fulfils the four considerations proposed by Sarkis et al., (2010). The model meets the first of the conditions, where COMM is the independent variable and influences dependent variable EII. The second and third conditions are also met, as the independent COMM variable influences the COOP mediator in a positive and significant manner, and the COOP mediator variable influences the dependent variable. Also, when the mediator variable is added to the model, the influence of COMM on independent variable EII diminishes, that is, the direct effect of COMM is lower than the total effect, so the fourth condition is also met. Given that all the conditions are satisfied, but the influence of COMM remains significant in the presence of the mediator COOP, we are facing a partially mediated model.

Conclusions

This study analyses the effect of communication and cooperation as engagement mechanisms on stakeholder's integration on eco-innovation intensity in firms. The results add to previous literature that interprets firms' eco-innovation strategy as the result of the process of adapting to stakeholders' knowledge, requirements and expectations in environmental matters. This study provides empirical evidence in this respect and suggests that firms implementing eco-innovation activities integrate stakeholder's environmental interests and knowledge through communication and cooperation engagement mechanisms.

Consistent with the statements originally made by Hart (1995), this study concludes that firms that develop greater stakeholder integration capacity make greater efforts in eco-innovation. The results of an empirical analysis of information relating to a sample of Spanish firms provide more empirical evidence to support the results previously obtained by Plaza-Úbeda et al. (2009), who argued that stakeholders' integration requires a firm's strategic objectives to be in line with stakeholders' goals so that economic, environmental or reputation-related results could be obtained.

In the previous environmental management literature, stakeholder integration was presented by some authors as a gradual process in which the firm starts to involve stakeholders through low involvement mechanisms aimed at obtaining information and know-how and then, after learning about their demands, adapts decisions through high involvement or interaction mechanisms (Green & Hunton-Clarke, 2003; Plaza-Úbeda et al., 2010). Some authors have shown how stakeholder integration capacity has a positive effect on competitiveness (Salem et al., 2016). Other authors have shown the effect of stakeholder engagement mechanisms on eco-innovation strategy through case studies but, to the best of our knowledge, none have shown empirical evidence of the differentiated effect of communication and cooperation mechanisms on eco-innovation strategy. The results of this study show that communication, as the first stakeholder engagement mechanism, has a positive effect on eco-innovation

strategy. This suggests that the information obtained from communication with stakeholders is directly useful for advancing in eco-innovation strategy design. It would therefore appear to be advisable for firms that aim to be eco-innovative to enable information channels for not only informing stakeholders, but also for learning about their environmental preferences through surveys, suggestion boxes, interviews, events, fairs, etc. As Agudo-Valiente et al., (2015) suggested, the more information a firm has, the better equipped it will be to make decisions and apply the tools, activities and processes that best satisfy its stakeholders. A firm is then able to accumulate knowledge that can be used to understand stakeholder preferences and take them into account when designing eco-innovation strategy.

This study has also confirmed that communication with stakeholders is a step that comes before cooperation. The results also show that cooperation with stakeholders also supports eco-innovation strategy development. It is therefore concluded that, when firms reach the greatest degree of stakeholder integration, through cooperation mechanisms, eco-innovation strategy is greater than when there is only communication. This result is consistent with what Salem et al., (2016) say about the advantages of achieving high levels of stakeholder integration, supported by empirical evidence.

Communication with stakeholders is a mechanism through which a firm acquires and transmits information to stakeholders, acquiring know-how and reducing information asymmetries. Cooperation is a mechanism that involves the use of acquired information to create something new, to jointly develop a proposal, to share information and to plan joint workshops, among other activities, so cooperation with stakeholders will steer environmental objectives towards satisfaction of their demands. Both stakeholder engagement mechanisms enable the firm to gradually make environmental decisions based on stakeholder demands, through low and high involvement mechanisms. The results obtained show that, when a firm implements both mechanisms, first by establishing communication and subsequently through

cooperation with stakeholders in eco-innovation matters, the eco-innovation process is of a higher level. It can be assumed that much more environmental technological capital can be accumulated with the integration of cooperation than only through communication. Cooperation with stakeholders enables a firm to integrate their preferences in its decision-making processes, such that eco-innovation practices will be adhered to the firm's strategic objectives.

This study considers that the eco-innovation process produces intangible assets (capabilities, know-how, etc.) that can be cumulative, so we do not only measure eco.-innovation by firm investments in the current year, but also consider the previous period. Due to how we measure eco-innovation, the results suggest that when stakeholder integration is reached (when communication mechanisms precede cooperation mechanisms), the firm learns more about stakeholders' eco- innovation preferences, and implements those learnings in its eco-innovation strategy.

From a practical point of view, the results could be taken into account by managers who want to improve their eco-innovation strategy. Integrating stakeholders' preferences into eco-innovation objectives has to be carried out through a gradual process of engagement, where acquiring relevant eco-innovation information through communication mechanisms as a first step will develop into an accumulation of stakeholders environmental preferences. The next step would be the use of that information to create and accumulate eco-innovation knowledge and jointly develop an eco-innovation strategy in line with stakeholders' preferences. This joint process involving the firm and its stakeholders will be through cooperation mechanisms that will results in a more advanced environmental strategy through eco-innovation.

Finally, to complement our work, future research would benefit from gaining a deeper understanding by analysing several concerns and limitations that have emerged from this

study. First, although the sample is representative of Spanish industrial activity, further studies should increase the sample by including international firms in order to obtain more generalised results. Secondly, future studies could broaden the range of stakeholders, considering different stakeholders and the effect of different groups on a firm's eco-innovation strategy. Such studies, for example, could analyse the different effects of internal and external stakeholders on eco-innovation strategy, and how stakeholder engagement mechanisms regarding eco-innovation strategy vary according to different stakeholders. Thirdly, future studies could analyse the effect of relations of trust with stakeholders in the long term, and whether they have a greater effect on eco-innovation strategy through stakeholder engagement mechanisms. Finally, future studies could analyse the effect of the integration of stakeholder preferences in eco-innovation strategy on the firm's financial performance and whether firms that more integrate stakeholder preferences are more profitable.