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The Impact of Eco-Innovation on Performance Through the Measurement of Financial Resources and Green Patents

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Abstract

The main objective of this article is to contribute empirically to the understanding of the impact that eco-innovation has on firms' financial performance within the framework of the resources-based view. Specifically, eco-innovation is measured by using eco-innovative activities and financial resources applied to eco-innovation to argue that the identification and measurement of certain resources of firms allow companies that are particularly active in investing in eco-innovation to be more competitive. Furthermore, the analysis attempts to ascertain whether firms that own green patents and other characteristics exhibit different level of financial performance than firms without registered green patents. The empirical partial least squares structural equation modeling results indicate a positive relationship between the investment of resources and the financial performance of eco-innovative firms. The effects of involving managers in eco-innovative processes as an environmental capability of firms are also tested.

Keywords

eco-innovation, environmental strategy, financial resources, green patents, corporate finance

Introduction

It is generally accepted that innovation improves a firm's performance by increasing productivity, reducing costs, or opening up new markets (Crespi & Pianta, 2008), with the performance usually also influenced by the size of the company (Montresor & Vezzani, 2015; Segarra-Blasco, Garcia-Quevedo, & Teruel-Carrizosa, 2008) and the structure of the markets (Geroski, 1990).

Despite the growing interest of business in environmental issues and eco-innovation, as innovation that specifically seeks environmental improvement (Horbach, 2008; Scarpellini, Valero-Gil, & Portillo-Tarragona, 2016), some authors have suggested that environmental sustainability can have different effects on a company's competitiveness (Busch & Hoffmann, 2011; Zollo,

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Cennamo, & Neumann, 2013) and the impact of eco-innovation on the performance is still under discussion (Doran & Ryan, 2012; Ferreira Lopes Santos, Machado De Lima, Cruz Basso, Kimura, & Amorim Sobreiro, 2017; Przychodzen & Przychodzen, 2015; Rassier & Earnhart, 2010; Wagner, 2015).

Environmental performance in sustainable firms and the relation between environmental management and financial performance have been widely analysed (e.g., Albertini, 2013; Ortas, Moneva, and Álvarez, 2014; Porter & van der Linde, 1995) and, in the firm context, sustainability appears to be an opportunity to improve the competitiveness (Hart, 2005; Moneva & Ortas, 2010). Moreover, cost saving has been underscored as one of the key criteria in decision-making processes that also involve investment in eco-innovation (Pereira & Vence, 2012).

In the eco-innovation field, most studies have paid special attention to firm-external factors (Demirel & Kesidou, 2011) within the framework of institutional theory (Aragón-Correa & Leyva-de la Hiz, 2016; Coenen & Díaz López, 2010) or stakeholder theory (Henriques & Sadorsky, 1999; Paraschiv, Voicu-Dorobantu, Langa Olaru, & Laura Nemoianu, 2012; Wagner, 2007). The determinants of eco-innovation have been classified into the following categories: technology, market, regulation, and firm-specific factors (Horbach, Rammer, & Rennings, 2012). Firm-internal factors, such as eco-innovation resources and capabilities, have also been incorporated into the research agenda (Aragón-Correa & Rubio-López, 2007; de Jesus Pacheco et al., 2017; Del Río, Carrillo-Hermosilla, Könnölä, & Bleda, 2016; Demirel & Kesidou, 2011; González-Benito & González-Benito, 2006; He, Miao, Wong, & Lee, 2018; Portillo-Tarragona, Scarpellini, Moneva, Valero-Gil, & Aranda-Usón, 2018; Sharma & Sharma, 2011).

The theoretical approach of the resource-based view (RBV) argues that companies that gather scarce, valuable, inimitable, and non-substitutable resources and capabilities gain an advantage over the rest of their competitors (Barney, 1991). In fact, the RBV has been adopted by different authors to measure internal factors related to environmental management (Vera Ferrón, de la Torre-Ruiz, & Aragón-Correa, 2014), and it offers an adequate theoretical framework to analyse the resources for environmental innovation and financial performance, hence, eco-innovation. However, it can be assumed that the difficulty associated with analysing firms' internal factors makes the application of this theory more complex. Thus, eco-innovation studies focused on internal factors and RBV are less numerous than those analysis based on other theoretical approaches (Del Río et al., 2016).

In this research field, the role that resources and internal characteristics of companies play in eco-innovative processes have been analysed by some authors in large companies and in small- and medium-sized enterprises (SMEs), such as size and age (Aboelmaged, 2018; Bocken, Farracho, Bosworth, & Kemp, 2014; de Jesus Pacheco et al., 2017; Dong, Wang, Jin, Qiao, & Shi, 2014; Leoncini, Marzucchi, Montresor, Rentocchini, & Rizzo, 2017; Triguero, Moreno-Mondajar, & Davia, 2015; Weissbrod & Bocken, 2017; Zhang & Walton, 2017). The relevance of the financial resources for environmental R&D and eco-innovation has been also studied (Marzucchi & Montresor, 2017; Scarpellini, Marín-Vinuesa, Portillo-Tarragona, & Moneva, 2018) as well as previous innovative capability of companies (Cainelli, De Marchi, & Grandinetti, 2015; Rodriguez & Wiengarten, 2017) and human resources (Aboelmaged, 2018; Antonioli, Mancinelli, & Mazzanti, 2013).

With these premises, this study seeks to deepen the specific knowledge of the internal factors of eco-innovative companies that could have an impact on their financial performance because some of the available studies that have adopted the RBV are more related to the conventional innovation process and they are not specifically focused on eco-innovation activities. In fact, the isolation of eco-innovation–specific investment from investments devoted to innovation is a very complex task that must take into consideration factors such as corporate finance and environmental commitment. In this regard, the debate on the convenience of separating innovation and eco-innovation–specific resources remains open, and some authors have observed substantial overlap between the two types of innovation (Aragón-Correa & Leyva-de la Hiz, 2016; Ramanathan, Ramanathan, & Zhang, 2016).

Green patents have been considered an indicator of eco-innovation by some authors (Amore & Bennedsen, 2016; Brunnermeier & Cohen, 2003; Johnstone, Haščič, & Popp, 2010; Oltra, Kemp, & de Vries, 2010), and recent works have undertaken an in-depth analysis of the relationship between patented environmental and non-environmental innovations in companies (Aragón-Correa & Leyva-de la Hiz, 2016). These studies point out that attitudes toward industrial property can vary considerably across different sectors (Kemp & Pearson, 2007), making it more difficult to compare the results of different studies (Oltra et al., 2010) and perpetuating the debate about the convenience of using green patents as an indicator to measure eco-innovation.

In this context, this study aims to contribute to the knowledge about internal eco-innovation factors within the RBV framework. To this end, a cause-and-effect relationship model is developed to analyse the factors that determine eco-innovation, especially in terms of cost saving, financial resources invested in eco-innovation processes, eco-innovative activity, and related financial performance. A second objective is to analyse whether companies with green patents and other characteristics exhibit a different level of financial performance than firms without registered green patents to also consider the relationship between financial performance and ownership of green patents, size of the firms, and personal linkage of the managers with the eco-innovation activity implementation. The model used for empirical analysis was tested through partial least squares structural equation modelling (PLS-SEM) based on the data of 87 Spanish firms.

The remainder of the article is organised as follows. In the next section, the theoretical background underlying the research and the development of the hypotheses are summarised, while the "Method" section describes the sample and data collection methods. This is followed by the "Results" section, which reports the results of the analyses carried out. A discussion of the findings is presented in the final section that also concludes and suggests the main implications of the study.

Background

Eco-innovation can be defined as 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 resource use (including energy use) compared to relevant alternatives. (Kemp & Pearson, 2007, p. 7)

In a broad sense, innovations are considered eco-innovative when they are inspired by eco-design (A. Smith, Voß, & Grin, 2010) and when their goal is to reduce the environmental impact and to develop new technologies, products, or processes for the reduction of pollution in order to develop more renewable and sustainable technologies and to improve waste processing and sustainable services (Kemp & Pearson, 2007; Kemp & Pontoglio, 2011).

As noted by Carrillo-Hermosilla, Del Río, and Könnölä (2010), the conceptualisation of eco-innovation relies on a particular evolutionary perspective of innovation, according to which innovation arises through a systemic process that entails the interconnectedness and dynamic interaction among different actors—a process that is affected by both external and internal factors (Dosi, 1982; Nelson & Winter, 1982).

Thus, eco-innovation has a systemic condition and it is generally developed in a fast-changing environment that has fomented an ongoing debate in the literature in which different theoretical positions suppose the analysis of the internal factors which allow the competitive improvement of companies that carry out eco-innovative investments. The seminal contribution of Penrose (1959) that firms need to organise their resources and capabilities in order to become more competitive, was followed by several authors as Barney (1991, 2001) who have endorsed the RBV as a valid theoretical framework from which to undertake analyses of the resources and capabilities necessary for eco-innovation (Aragón-Correa & Leyva-de la Hiz, 2016; Carrillo-Hermosilla et al., 2010; Cheon & Urpelainen, 2012; Dangelico & Pujari, 2010; De Marchi & Grandinetti, 2013; Halila & Rundquist, 2011; Kesidou & Demirel, 2012; Lee & Kim, 2011; Lee & Min, 2015; Menguc & Ozanne, 2005; Segarra-Oña, Peiró-Signes, Albors-Garrigós, & Miret-Pastor, 2011). In addition, the natural-resource-based view introduced the adoption of more sustainable technologies and products in order to give a competitive edge to firms (Forsman, 2013; Hart, 1995, 2005; Hart & Dowell, 2011).

The RBV on strategy is discussed due to its static nature by authors who focused their discourse on dynamic capabilities to capture the changes coming from the environment (Judge & Elenkov, 2005; Katkalo, Pitelis, & Teecey, 2010; Ljubica & Cvelbar, 2016). In this framework, dynamic capabilities were proposed in the seminal study of Teece, Pisano, and Shuen (1997) to analyse the firm's ability to integrate, build, and reconfigure internal business competences to achieve innovative competitive advantage. In addition, dynamic capabilities capture proactive environmental strategy related to the sustainability of competitive advantage in dynamic environments (Garcés-Ayerbe & Cañón-de-Francia, 2017) and are considered particularly well suited to the study of clean technology (Aragón-Correa & Sharma, 2003).

Nevertheless, it can be stated that there is widespread agreement that in the framework of the RBV some resources and capabilities are particularly relevant for successful investment in eco-innovation, making companies more competitive in optimising both environmental and financial performance (Aragón-Correa & Leyva-de la Hiz, 2016; Cheon & Urpelainen, 2012; Coenen & Díaz López, 2010; Díaz López & Montalvo, 2015; Díaz-García, González-Moreno, & Sáez-Martínez, 2015; Ketata, Sofka, & Grimpe, 2015; Lee & Min, 2015). However, it has to be taken into account that the RBV framework could be self-limiting in jointly improving environmental and economic performance (Wagner, 2015).

In this context, this study tries to deepen knowledge of and more clearly identify the financial resources companies allocate to eco-innovation in order to study its relationship with performance, stressing resources that increase the competitiveness of firms.

With these premises, this article is about improving the knowledge around financial resources specifically applied to eco-innovation by firms and the related cost saving. The objective is to define if financial resources are part of the range of those strategic, unique, and inimitable resources that influence the eco-innovation level of a company, and therefore, its performance.

Resources, Capabilities, Eco-Innovation, and Performance

In general terms, eco-innovation activities are very diverse and occur at different levels and scales (Machiba, 2010) in response to an environmental strategy that firms adopt to improve environmental and economic performance simultaneously (Dangelico & Pujari, 2010; Triguero et al., 2013), which means taking decisions about financial resources that are invested in eco-innovation.

Academics are still working to identify and measure the financial resources allocated to eco-innovation, because firms do not always specify which resources are being invested in increasing their environmental performance (Lee & Min, 2015). The volume of R&D investment has been highlighted as a relevant resource in terms of eco-innovation (Ding, 2014; Ketata et al., 2015; Lee & Min, 2015), but the isolation of what specific resources are invested in eco-innovation, as opposed to overall R&D investment, remains under-researched.

Different studies have tried to find causal relationships between innovation and financial resources, analysed on the basis of the firm's financial structure, conceptualising the financial behaviour of firms that affects decisions concerning investment and innovation (Aghion, Bond, Klemm, & Marinescu, 2004; Ayyagari, Demirguc-Kunt, & Maksimovic, 2007; Bartoloni, 2013; Coad, Pellegrino, & Savona, 2016; D'Este, Iammarino, Savona, & von Tunzelmann, 2012; Friend & Lang, 1988; Magri, 2009; O'Brien, 2003; Schäfer, Werwatz, & Zimmermann, 2004). In this regard, financial resources are limiting the eco-innovative process (Demirel, Li, Rentocchini, & Tamvada, 2017), given that the degree of risk implicit in this type of investment exceeds that of innovations that do not incorporate the environmental component (Ghisetti, Mancinelli, Mazzanti, & Zoli, 2017; Scarpellini, Valero-Gil, & Portillo-Tarragona, 2016). Specifically, Ayyagari et al. (2007) argue that the possibility of increasing financial resources facilitates the adoption of new technologies and products (especially for large and young firms operating with foreign banks) and that the scarcity of resources limits the firm's innovative strategies (Brown, Fazzari, & Petersen, 2009; O'Brien, 2003; Pellegrino & Savona, 2017). In a different way, some authors analyse the firm's slack resources and its relationship with eco-innovations and financial performance (Leyva-de la Hiz, Ferron-Vilchez, & Aragon-Correa, 2018).

Previous research agrees that certain resources, such as investment in R&D for environmental innovation, give firms a competitive edge in eco-innovation (Lee & Min, 2015; Parthasarthy & Hammond, 2002) and that the analysis of these factors can help firms develop unique resources and capabilities that boost their financial and environmental performance. Although different articles argue that there is a relationship between financial and environmental performance, little evidence exists concerning funds allocated by firms to eco-innovation (Johnson & Lybecker, 2012), and this study aims to partially fill this gap.

It has to be taken into account that in many cases, positive returns can mainly be expected in the long term, so eco-innovation needs to be in line with the firm's strategic aims (O'Hare, Dekoninck, Turnbull, & McMohan, 2009). Positive environmental effects could be immediate, such as the reduction of emissions (Halila & Rundquist, 2011), or it take longer to achieve results, with environmental improvements occurring throughout the production life cycle (Aragón-Correa & Sharma, 2003; Shrivastava, 1995). In addition, these environmental improvements achieved through eco-innovation often imply cost saving that has been pointed out as one of the main criteria in the decision-making process for eco-innovative investments (Christmann, 2000; Maxwell, Lyon, & Hackett, 2000).

Studies focused on the capabilities of firms in terms of eco-innovation are actually more frequent than studies focused on financial resources, analysing the involvement of managerial structures in the process (Chang & Chen, 2013; Del Río et al., 2016) and the key role played by the responsible leadership in eco-innovation development as well as their experience or their environmental proactivity (Bartlett & Trifilova, 2010; Cameron, 2011; Groves & La Rocca, 2012; Pless, 2007; Pless & Maak, 2011). The adoption of environmentally friendly capabilities by firms has been highlighted by some authors mainly due to its potential positive impact on performance (Alvarez Gil, Burgos Jimenez, & Cespedes Lorente, 2001; Angell & Klassen, 1999; Hart, 1995). Leadership and organisational culture (Epstein, Buhovac, & Yuthas, 2010), the introduction of new environmental accounting methods and accountability (Mirchandani & Ikerd, 2008; Székely & Knirsch, 2005), and firm size (Aboelmaged, 2018; Bocken et al., 2014; Segarra-Oña et al., 2011; Triguero et al., 2015; Zhang & Walton, 2017) are some of the economic–financial characteristics of firms that have also been mentioned as possible factors in improvements related to eco-innovation processes.

From a different perspective, it is also accepted that firm-internal R&D activity guarantees the firm's participation in eco-innovative processes (Cainelli et al., 2015; Cruz-Cázares, Bayona-Sáez, & García-Marco, 2013; Ding, 2014; Lee & Min, 2015; Segarra-Oña, Peiró-Signes, & Cervelló-Royo, 2015; Triguero et al., 2014), which is related to investment in patents (Aragón-Correa & Leyva-de la Hiz, 2016; Segarra-Oña et al., 2011, 2015; Triguero et al., 2016) and to

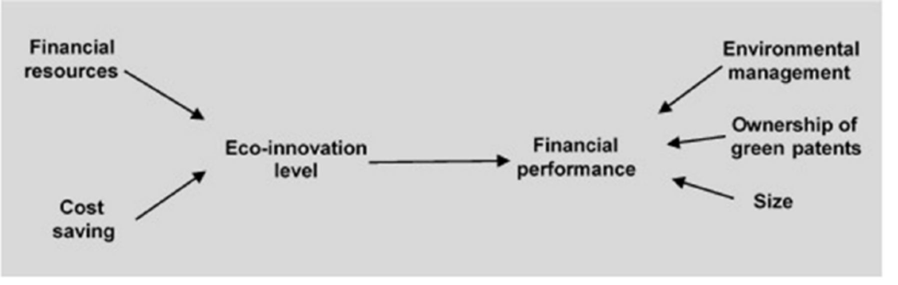

Figure 1. Model for analysis.

continued engagement in innovation, which leads to the regular allocation of resources to these activities (Doran & Ryan, 2014).

Oltra et al. (2010) demonstrated that the patent holder is in a position to set a higher-than-competitive price for the corresponding good or service, which allows recovery of innovation costs. Moreover, the number of patents is one of the indicators frequently used to measure the results of R&D activity and knowledge transference (Hall, 2010; Hall & Ziedonis, 2001; Konar & Cohen, 2001) as well as the protection of industrial property (van Dongen, Winnink, & Tijssen, 2014).

Some authors have challenged the use of green patents as reliable indicators of eco-innovation, pointing out that they cannot accurately reflect the output of innovation processes (Rennings, Ziegler, Ankele, & Hoffmann, 2006). This is because not all innovations can lead to a patent, and many firms use other methods to protect their industrial property, such as industrial secrecy (Archibugi & Pianta, 1996). In fact, the reasons for registering a green patent can vary widely among companies, and it can be stated that the acquisition of green patents is not necessarily a privilege of those companies that invest in eco-innovation.

For this reason, this study aims to understand whether firms interested in protecting their environmental innovations through green patents exhibit different behaviour in terms of eco-innovation and its relationship with performance. This means answering an initial research question about the differences between the intensity in investments for eco-innovation and the ownership of green patents.

A model for analysis is therefore proposed (Figure 1) to study the financial performance from a two-fold perspective in relation to cost saving and financial resources allocated to eco-innovation from one side, and in relation to green patents and other related capabilities of firms from another side, such as the environmental management and the size, considered as relevant for eco-innovation in the previous literature focused on RBV.

The basic cause–effect relations between financial variables and eco-innovation are summarised in Figure 1. They have been repeatedly tested in the literature (Aragón-Correa, Hurtado-Torres, Sharma, & García-Morales, 2008; Coad et al., 2016; Epstein et al., 2010; Lee & Min, 2015; Montabon, Sroufe, & Narasimhan, 2007; Segarra-Oña et al., 2011; Wagner, 2007), and they are a basis for the definition of the first hypothesis presented here:

> **Hypothesis 1:** There is a positive relationship between the level of eco-innovation and financial performance.

The effects of green patents in the competitive advantage of firms have been already pointed out in the literature, offering the basis for the second hypothesis tested in this study (Aragón-Correa & Leyva-de la Hiz, 2016; Higgins, 2003; Oltra et al., 2010).

Hypothesis 2: There is a positive relationship between the ownership of green patents and financial performance.

The model assumes that the benefits of eco-innovation (in terms of lower costs) and the amount of financial resources allocated to eco-innovation activities are determinants of the firm's eco-innovation profile. The model also reflects other relations among green patents, the implication of managers in the eco-innovation activities, and size in financial performance. Thus, jointly analysing both the determinants of eco-innovation and the ownership of green patents yields a deeper knowledge about those internal resources and capabilities allocated to eco-innovation by firms and their relationship with financial performance.

Method

Sample and Data Collection

The population for this study consists of companies in north-eastern Spain that operate in sectors with great potential for eco-innovation, such as those related to technologies referred to in the documents known as "BREFs" (European Commission, 2003) of the "Best Available Techniques".[1] Specifically, we look at the industrial, transport and logistics, and waste sectors, whose NACE 09 codes correspond to those of the extractive industry (05-09), the manufacturing industry (10-33), electricity, gas, steam, and air-conditioning supply (35), water-supply, sewerage, waste-management, and remediation activities (36-39), and transportation and storage (49-53). Although some eco-innovative companies may be excluded, following Ding (2014), it is believed that with this selection criterion, the vast majority of firms that are the aim of study have been selected. Other characteristics that aim to give the sample the necessary homogeneity are the following: (1) firms are active and (2) a minimum of 50 employees work at the firm, considering that size increases the possibilities of undertaking eco-innovation (Dong et al., 2014; Rehfeld, Rennings, & Ziegler, 2007; Roda-Llorca, Segarra-Oña, & Peiró-Signes, 2015; Triguero et al., 2015; Wagner, 2007).

To achieve the objectives proposed in this research study, the data were obtained through surveys designed for this purpose (see the appendix) in order to channel active cooperation for private companies in this research by participating in a collaborative campaign that promotes eco-innovation in north-eastern Spain. The surveys were sent to the managers of companies who were directly involved in eco-innovation investments and to environmental managers of companies. The sample was obtained through refining a list of 2,232 companies elaborated from the SABI database.[2] A total of 996 surveys were e-mailed during 2015 to these companies with detailed contact information. Finally, 110 questionnaires were obtained, and 87 of them were considered valid observations, representing a final sample of 8.8% of the 996 surveyed firms. Although the response rate is low, the number of questionnaires obtained in absolute value is adequate compared with other empirical studies in the environmental field carried out with a similar rate of respondents (Jabbour, Jugend, De Sousa Jabbour, Gunasekaran, & Latan, 2015).

It should be highlighted that the main objective of this study required the collection of data from eco-innovative businesses or from companies that expressed an interest in environmental R&D to obtain information regarding the internal resources and capabilities of business. Despite the fact that the sample does not consist of a large number of companies, the companies are fully identified with their VAT code,[3] and these are not anonymous surveys. The collaboration with identified firms for the empirical analysis means a smaller number of valid observations, but the identification of the companies in the sample allows us to integrate the economic–financial data of the companies with their position regarding eco-innovation investments and the specific resources allocated.

Table 1. Description of the Sample.

Variable	Description	Population n	Population %	Sample n	Sample %
Size: Number of employees	From 50 to 250 employees	1,566	70.19	58	66.67
	From 250 to 450 employees	386	17.30	13	14.94
	More than 450 employees	279	12.51	16	18.39
		2,231	100	87	100
Sector	Mining	13	0.58	1	1.15
	Manufacturing	1,041	46.64	34	39.08
	Energy	601	26.93	23	26.44
	Water supply	64	2.87	8	9.20
	Transport and storage	513	22.98	21	24.14
		2,232	100	87	100
Return on equity (ROE)		*n* (2,224)	Mean (0.13)	*n* (87)	Mean (0.18)

The companies included in the sample ($n = 87$) operate in five different sectors identified with CNAE 09 codes that correspond to the manufacturing industry (39.08%); the supply of electricity, gas, steam and air conditioning (26.44%); transport and storage (24.14%); water supply, waste management and decontamination (9.20%); and mining (1.15%). Moreover, they can be divided into three size categories based on the number of employees, as shown in Table 1. These distributions are not substantially different from those of the population of firms in the SABI database. If we compare the percentage distributions between the sample and the population (see Table 1), there is little representation in the sample of the water supply, sanitation, waste management and decontamination sector category, although this bias is reduced if two company categories ("manufacturing industry" and "supply of electricity, gas, steam and air conditioning") are considered together and compared with the set of the other three categories ("transport and storage," "water supply," and "mining").

The results obtained in the chi-square test show that there are no significant differences between the distribution in the sample and in the population if the two sectorial company categories are considered together, $\chi^2(1) = 2.72$, $p = .10$. Regarding the employee distribution in the sample, there is no significant bias when the two distributions are compared. The results obtained in the chi-square test show that there are no significant differences between the employee distribution in the sample and in the population, $\chi^2(2) = 2.70$, $p = .26$. Moreover, a *t* test was performed comparing the mean values of the return on equity (ROE) in the population and in the sample. The results obtained in the *t* test ($p = .98$) show that there are no statistically significant ROE differences in the comparison of the population with the sample.

Furthermore, to check for possible non-response bias, chi-square tests for two independent samples were undertaken by testing respondents and non-respondents. Sectorial and employee categories were compared for a sub-sample of respondents with non-respondents. The results obtained in the chi-square test show that there are no significant differences at 5% level of significance between the employee distribution in the respondent and non-respondent sub-samples, $\chi^2(2) = 2.96$, $p = .23$. Moreover, there are no statistically significant differences in the subsamples if "manufacturing industry" and "supply of electricity, gas, steam and air conditioning" are considered together and compared with the set of other three categories ("transport and storage," "water supply," and "mining"), $\chi^2(1) = 3.01$, $p = .09$. On the other hand, a *t* test was performed comparing the mean values of the ROE in the respondents (0.18) and non-respondents (0.13). The results obtained in the *t* test ($p = .99$) show that there are no statistically significant ROE differences in the comparison of respondents with the non-respondents. Together, these results indicate no significant concern for non-response bias.

Taking into account the object of the study, the metrics were developed from the more general approach of the RBV because the different dimensions of the static resources and the dynamic capabilities indicated by Aragón-Correa and Sharma (2003) could not be specifically captured in this analysis. Thus, a series of indicators that measure the level of eco-innovation achieved by the surveyed companies over the past 3 years and a set of variables that synthesise the resources and capabilities available in these companies were selected to be included in the questionnaires in order to answer to the research question and to test the hypothesis in the framework of the more general RBV. Specifically, a set of variables were designed to measure the eco-innovation investments carried out by companies, the amount and typology of the financial resources allocated by firms, the number of green patents, and the environmental management capabilities (Delgado-Verde, Amores-Salvado, Martin-de Castro, & Navas López, 2014). Thus, the eco-innovative activities performed by the companies in the last few years were measured in terms of savings in emissions and resources, the replacement of raw materials and components, and the investments made to decrease the environmental impact of products and the company. The questionnaire also provides information about the managers' perception of the main purpose of investing in eco-innovation (cost saving or environmental protection) or about the level of involvement of managers in eco-innovation activity. Further economic–financial variables of companies were obtained from the SABI database to define the firm size in terms of assets, income, and employees.

Statistical Analysis

To achieve the objectives of the research and test the working hypotheses, a sequential process was followed. In the first phase, a sequential cluster analysis and discriminant analysis were used to identify and characterise different groups of companies based on their activity regarding environmental R&D for eco-innovation ("Eco-Innovation Intensity" section). This gave rise to two groups independent, on which we then conducted Mann–Whitney tests to compare them with different variables. In the second phase, Mann–Whitney tests, with two subsamples of companies (companies with green patents and those without), were performed to test whether there are any different behaviours in any of the variables that are characteristic of companies with a high level of investments in environmental R&D for eco-innovation ("The Intensity of Investment in Environmental R&D for Eco-Innovation and the Ownership of Green Patents" section). The results of these analyses allow us to understand how a company that invests intensively in eco-innovation could, however, not have green patents to protect its environmental innovations. If this is so then it is interesting to analyse the influence on the financial result of both independent variables, the eco-innovation and the ownership of green patents. In the third phase, to test the theoretical model's hypotheses, a PLS-SEM was used ("Eco-Innovation and Financial Performance" section). SmartPLS 3.0 software was chosen for this end, as it is less sensitive to the violation of assumptions of data normality (Chin, 1998; Ram, Corkindale, & Wu, 2014).

With regard to the statistical procedure used, the data available in this research are sufficient to perform the analyses suggested and to perform PLS properly. PLS establishes minimum requirements on the scales of measurement, sample size, and data distributions (Fornell & Bookstein, 1982). According to Henseler, Hubona, and Ray (2016) PLS path modelling requires metric data for the dependent variables, but this one is not the requirement for the independent variables. However, given that our study's green patents variable (GP) is a binary coded variable, two PLS models have been assessed, defined by the presence or not of GP. Then we can show how that the presence of this variable in the PLS model (added to the metric variables) does not change the results of the analysis and we can make an easier interpretation of the results.

Table 2. Equality of Means Test of the Groups.

Variables		Wilks's λ	*F*	Significance
R1	Total revenue that has been invested in environmental R&D (internal or external) for eco-innovating	.922	7.147	.009
R2	Total revenues invested in innovative equipment/equipment/ machinery to reduce the environmental impact of the company	.841	16.117	.000
R3	Investments in environmental R&D, eco-design, or similar that are financed with own funds	.265	235.877	.000

Results

The first analyses were carried out to answer to the research question about the differences between the intensity in investments for eco-innovation and the ownership of green patents ("Eco-Innovation Intensity" and "The Intensity of Investment in Environmental R&D for Eco-Innovation and the Ownership of Green Patents" sections). After checking that the intensity of investments in environmental R&D for eco-innovation could be a factor independent of the ownership of green patents, we analysed whether there are any cause–effect relationships between the variables of the theoretical model ("Eco-Innovation and Financial Performance" section).

Eco-Innovation Intensity

To identify the different groups of companies according to their investment intensity in environmental R&D for eco-innovation, we use three variables, named R1, R2, and R3 (Table 2). We applied a sequential cluster analysis, followed by a discriminant analysis to classify and reassign the solution. First, a hierarchical cluster analysis was applied to define each object to be classified (i.e., the companies) according to the three previous variables.

As a proximity measure, we used the squared Euclidean distance, and as a classifying algorithm, we used Ward's method. The result of this analysis is a dendrogram that allows us to establish the existence of two clusters and centroids in order to apply the K-means method.

Moreover, to reinforce these results, we use the elbow diagram. The results of elbow method return very consistent values and adjust to the expected results. The optimal number of clusters to select is two clusters, as seen in the elbow diagram (Figure 2).

In the second phase, the results of the discriminant analysis allow us to verify that the division of the groups made with the cluster analysis is correct. The homogeneity of the groups is tested with a test of equality of the mean values. The *F* statistic is the same statistic that would be calculated in an ANOVA analysis. The results of the equality test of mean values (*F*) demonstrate the existence of inequality of mean values between the two groups analysed for all variables included in groups (see Table 2). Next, we performed the Box's M test to compare with what extent the matrices of variances and covariances for each of the two reference groups (Groups 1 and 2 from the cluster analysis) come or not from the same population. Box's M test revealed an *F* statistic of 47.863, with a significance level of .000, allowing us to reject the null hypothesis of this test, accordingly, we accept that there are significant statistical differences between the cited matrices for the two groups of companies.

The information on the discriminant functions is summarized in Table 3. We moreover observed low Wilks's λ values and significant chi-square values associated with Wilks's λ. This one means that we can accept that there are differences in the ratings given to the independent variables between the two established groups of companies. Finally, the confusion matrix showed that 100% of the original group of cases had been classified correctly. All of the above confirmed that the clusters obtained were different and properly identified. Having confirmed the

Figure 2. Elbow diagram.

Table 3. Wilks's λ.

Contrast function	Wilks's λ	χ^2	Degrees of freedom	Significance
1	0.250	115.623	3	.000

sustainability of the statistical instrument, we will now proceed to discuss the results. We assigned names to the two clusters obtained according to their characteristics.

Group 1. Lower level of investment in environmental R&D for eco-innovation (Lower IIR&D): This group includes companies whose investment in environmental R&D (internal or external) for eco-innovating averaged between 1% and 5%. Regarding the investment in innovative equipment/equipment/machinery to reduce the environmental impact of the company, the levels were also between 1% and 5%. Investment in eco-innovation, eco-design, or similar that was financed with firms' own funds averaged from 6% to 10%.

Group 2. Increased level of investment in environmental R&D for eco-innovation (Increased IIR&D): The companies in this group are characterised by an average level of investment in environmental R&D (internal or external) for eco-innovating, from 6% to 10%. Regarding the investments in innovative equipment/equipment/machinery to reduce the environmental impact of the company, the average levels are between 6% and 10%. The investments in eco-innovation, eco-design, or similar that are financed with firms' own funds have an average score ranging between 21% and 30%.

Once Group 1 (Lower IIR&D) and Group 2 (Increased IIR&D) were identified and defined on the basis of the level of investment intensity in environmental R&D for eco-innovation, we attempted to detect significant differences in behaviour concerning the level of investments in environmental R&D, eco-design or similar (IE), technological characteristics (TC1, TC2), financial performance determinants (FPD), the cost of external financing (C), proactivity (P), business size (S1, S2, and S3), age (A), and financial performance (FP1, FP2).

The relationship between each of the variables listed above and the intensity of investment in eco-innovation (IIR&D) was tested by means of a Mann–Whitney test. The results (summarised in Table 4) indicate significant differences in the average value of different variables, that is, the level of investments in environmental R&D, eco-design or similar, technological characteristics, performance determinants, the cost of external financing, and the proactivity of companies—between Groups 1 and 2. Firms in Group 2 invest more in environmental R&D, eco-design, and similar concepts than firms in Group 1. Specifically, firms in Group 2 score between 6% and 10%, while firms in Group 1 score between 1% and 5%. These results are in line with those obtained by cluster analysis, which indicated that firms characterised by "Increased IIR&D" invest a higher proportion of their own resources in environmental innovations and eco-innovative activities. They also demonstrate greater investment in environmental R&D, eco-design, and similar concepts. These firms are also characterised by a higher technological profile, higher performance-determinant values, a more proactive strategy, and less costly external financing. No statistically significant differences exist between the two groups concerning the average value of the remaining variables under analysis.

The Intensity of Investment in Environmental R&D for Eco-Innovation and the Ownership of Green Patents

To answer to the research question about the differences between the intensity in investments for eco-innovation and the ownership of green patents, a Mann–Whitney test was performed. Companies that own green patents and those that do not were compared in some behaviours concerning the level of investments in environmental R&D for eco-innovation and in the level of certain internal resources and business capabilities.

Table 4 summarises the results of the Mann–Whitney test. These results reveal that there are no significant differences among the mean values for size, age, and performance determinant between the two groups of companies defined according to the green patent (GP) variable. Companies that own green patents are larger, older, and present higher performance determinant scores. These results suggest that the GP variable and IIR&D can be isolated analytically. As the next step, we define whether ownership of green patents is an exclusive feature of firms characterised by "Increased IIR&D." As illustrated in Table 5, this group is formed by 22 firms, while the group characterised by "Lower IIR&D" is formed by 65 firms. The statistics presented in the table indicate that the ownership of green patents is not limited to the first group. A significant percentage (20%) of the firms characterised by "Lower IIR&D" own green patents. Also, 81.82% of firms characterised by "Increased IIR&D" do not own green patents. Therefore, the results presented in Tables 4 and 5 cannot be used to demonstrate the relationship of the research question about green patents. As illustrated in Table 5, the intensity of investment in environmental R&D for eco-innovation is unrelated to the ownership of green patents, as 20% of the firms characterised by "Lower IIR&D" own green patents and 81.82% of the firms characterised by "Increased IIR&D" do not. In addition, the Pearson correlation analysis suggests a very low correlation index (0.02) between the GP and IIR&D variables.

Eco-Innovation and Financial Performance

A sequential process was followed to test the research Hypotheses 1 and 2. First, the constructs measured through multiple items were tested by means of exploratory factor analysis. Second, the measurement model was assessed by testing the reliability and validity of the measurement scales. Last, PLS-SEM was used to test whether there are cause-and-effect relationships between profit in terms of cost and the financial resources used, along with the level of eco-innovation and the associated financial performance.

Table 4. Results of the Mann–Whitney Tests for Variables: IIR&D and GP.

Variable code	Variable description	Lower IIR&D	Increased IIR&D	Mann–Whitney (p Value)	Non-GP	GP	Mann–Whitney (p Value)
IE	Level of investment in environmental R&D, eco-design, or similar	1.21	2.49	$.002^{***}$	1.38	1.85	$.352^{ns}$
TC1	Possibilities for eco-innovation for the company's products/services	3.08	3.91	$.008^{***}$	3.25	3.59	$.384^{ns}$
TC2	Radical innovation in the design for the reduction of the company's environmental impact, even without being necessary, which means the company competes better in the market	2.76	3.50	$.047^{**}$	2.97	3.40	$.178^{ns}$
FPD	How much environmentally friendly change is necessary to increase the competitiveness of the firm	3.06	3.82	$.035^{**}$	3.18	3.95	$.017^{**}$
C	What is the relationship between the cost of financial resources invested in eco-innovation and those generated by other costs?	1.86	1.21	$.049^{**}$	1.64	1.79	$.818^{ns}$
P	Disposition to take part in a video about eco-innovation processes and eco-design	0.32	0.68	$.003^{***}$	0.42	0.35	$.572^{ns}$
S1	Total assets (million euros)	1226.237	35.394	$.208^{ns}$	53.199	4385.108	$.000^{***}$
S2	Total turnover (million euros)	462.649	44.240	$.283^{ns}$	51977.96	1529.167	$.002^{***}$
S3	Number of employees	628.52	172.36	$.682^{ns}$	168.3	1796.47	$.001^{***}$
A	Age	36.28	34.82	$.834^{ns}$	32.36	51.95	$.002^{***}$
FP1	Return on assets (ROA)	0.042	0.038	$.860^{ns}$	0.042	0.038	$.923^{ns}$
FP2	Return on equity (ROE)	0.068	0.020	$.160^{ns}$	0.27	−0.016	$.294^{ns}$

Note. IIR&D = intensity of investment in environmental R&D for eco-innovation; GP = green patents.
$^{**}p < .05$. $^{***}p < .01$. *ns* = not significant.

Table 5. Relationship Between the GP Variable and the IIR&D Variable.

	Increased IIR&D		Lower IIR&D	
	Firms	%	Firms	%
Green patents (GP = 1)	4	18.18	13	20.00
No green patents (GP = 0)	18	81.82	52	80.00
Total	22	100	65	100

Note. IIR&D = intensity of investment in environmental R&D for eco-innovation; GP = green patents.

Table 6. Description of Variables.

Construct/items	Construct/items description	*M*	*SD*
Construct: ECOi	Eco-innovation level		
ECO1	Components of the product or service that have been replaced by innovative ones to comply with environmental regulations	1.65	1.24
ECO2	Raw materials necessary for the manufacture of products or provision of services that have been replaced by recycled materials	1.32	1.15
Construct: FR	Financial resources		
FR1	Total revenue that has been invested in environmental R&D (internal or external) for eco-innovating	1.20	0.71
FR2	Total revenue invested in innovative equipment/ equipment/machinery to reduce the environmental impact of the company	1.55	1.00
FR3	Investment in environmental R&D, eco-design or similar that are financed with own funds	2.12	1.59
Construct: S	Firm size		
S1	Total Assets (thousand euros)	925104.25	5600435.44
S2	Total turnover (thousand euros)	356844.45	1289440.54
S3	Employees (number of employees)	513.17	1542.914
Variable	Variable description	*M*	*SD*
Variable: M	Environmental management		
M	Personal linkage of the managers with the eco-innovation activity implementation	3.37	1.33
Variable: R	Cost saving		
R	To what extent cost saving is the driver to implement eco-innovations?	2.98	1.52
Variable: FP	Financial performance		
FP	Return on equity (ROE)	0.18	0.64
Variable: GP	Ownership of green patents		—
GP	Yes/No (GP = 1/0)	mode=0	—

To understand the relationship between the allocated financial resources and the eco-innovation performed in companies, it is necessary to define different levels of eco-innovative activities and thus analyse the amount of financial resources that allows us to obtain greater results in eco-innovation. Based on the accepted definition of eco-innovation, this study aims to measure eco-innovation practices in firms by looking at product or service components that have been replaced by innovative ones as well as to measure specifically environmental R&D and eco-design investment (Table 6).

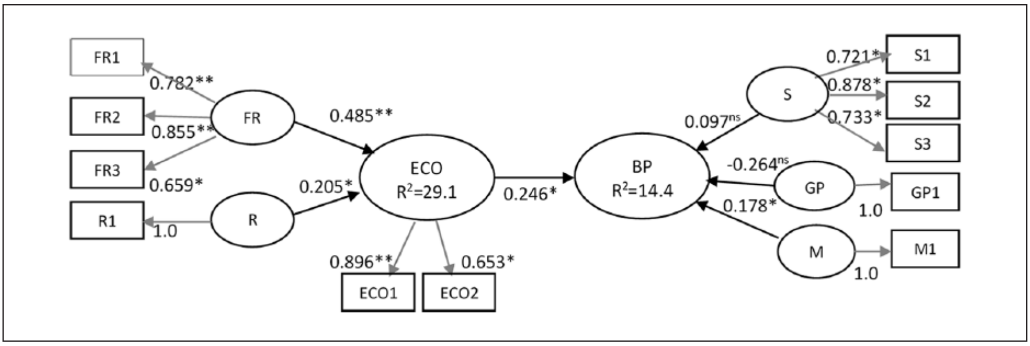

Figure 3. Structural model results.
Note. *$p < .05$. **$p < .01$. *ns* = not significant.

The measurement of the most complex concepts, the eco-innovation level (ECO), the level of financial resources allocated to the eco-innovative activity (FR), and others, such as the size of firms, was carried out through multi-item scales (Table 6). The use of these scales, instead of one-item scales, increases the reliability of the measurements, as it reduces the possibility of misinterpreting individual items (M. Smith, 2003). The selection of the different items was based on the published data. Also, taking into consideration that the usefulness of the scale is closely related to the context in which it is used, the reliability and validity of the data were tested. Table 6 illustrates the multi-item scales proposed for the measurement of the variables and the values assigned to each by the interviewees on a 6-point Likert-type scale (0 = 0%, 1 = 1%-5%, 2 = 6%-10%, 3 = 11%-20%, 4 = 21%-30%, 5 = more than 30%).[4] Table 6 also reflects the average value assigned by interviewees to the following variables: profit, in terms of cost saving, as a motivation for the undertaking of eco-innovative activities (R) and involvement of the managers in the eco-innovation processes (M). These variables used to quantify the extent to which the activities referenced were carried out were measured on 6-point Likert-type scales (0 = *not at all* to 5 = *frequently*). Table 6 also shows the mean value of the variables that define the size of the company (S) and its financial performance (FP). Thus, three items were used to measure the size of the company: the number of assets, the income, and the number of employees that correspond to the last year available at the time the data analysis was carried out. The financial performance variable (FP) was quantified based on the ROE variable, which is the difference between the financial year's results and the firm's own financial resources for 2014. Financial performance, as a variable related to innovative behaviour, was measured on the basis of financial profitability, following Wagner (2005a, 2005b) and Przychodzen and Przychodzen (2015).

In the first stage, an exploratory factor analysis was carried out to verify the factors formed by the variables (the measurement scales). The results for the eco-innovation (ECOi), financial resources (FR), and size (S) scales were formed, in all cases, by a single factor with high explained variance: ECOi = 72.79% (Kaiser–Meyer-Olkin [KMO] = 0.5), FR = 54.55% (KMO = 0.621), and S = 63.2% (KMO = 0.5). Bartlett's sphericity tests reflect a significance level of less than .001 for all the aforementioned scales.

In the second stage, we assessed the structural model. To ensure the adequacy of the selected indicators, we examined the standardised loadings of the variables. For all of the variables, the standardised loadings were greater than 0.7, or very close to that value, and were significant (see Figure 3). All constructs also exhibited very high composite reliability values—in all cases higher than .7 (Table 7). Convergent validity was tested by calculating the average variance extracted (*AVE*), which determines whether the construct variance can be explained by the indicators

Table 7. Construct Reliability, Convergent Validity, and Discriminant Validity.

	ECO	GP	FR	M	R	FP	S	Composite reliability	*AVE*
ECO	*0.727*							0.710	0.528
GP	0.167	*1.000*						1.000	1.000
FR	0.499	0.039	*0.719*					0.752	0.518
M	0.088	0.123	0.239	1.000				1.000	1.000
R	0.239	0.065	0.070	0.029	1.000			1.000	1.000
FP	0.254	0.158	0.035	0.174	−0.025	1.000		1.000	1.000
S	0.374	0.447	0.013	0.073	0.058	0.084	0.071	0.780	0.595

Note. AVE = average variance extracted; ECO = eco-innovation; GP, green patent; FR = financial resources; M, involvement of the managers in the eco-innovation processes; R, profit, in terms of cost saving, as a motivation for the undertaking of eco-innovative activities; FP, financial performance; S = size. Diagonal elements (in italics) are the square root of the *AVE* and other elements are the correlations between the constructs.

Table 8. Outer Model Loadings and Cross-Loadings.

	ECO	FR	R	S	M	GP	FP
ECO1	0.996	0.509	0.232	0.353	0.100	0.147	0.257
ECO2	0.653	0.005	0.135	0.304	−0.106	0.259	0.028
FR1	0.385	0.782	0.133	0.073	0.256	0.108	−0.030
FR2	0.457	0.855	−0.001	−0.044	0.164	−0.148	0.101
FR3	0.084	0.659	0.005	−0.208	0.013	−0.030	−0.115
R	0.239	0.070	1.000	0.058	0.029	0.065	−0.025
S1	0.142	−0.063	−0.013	0.209	0.171	0.306	−0.012
S2	0.326	−0.019	0.020	0.939	0.122	0.451	0.085
S3	0.391	−0.014	0.095	0.927	0.026	0.412	0.064
M	0.088	0.239	0.029	0.073	1.000	0.123	0.174
GP	0.167	−0.039	0.065	0.447	0.123	1.000	−0.158
FP	0.254	0.035	−0.025	0.084	0.174	−0.158	1.000

Note. ECO = eco-innovation; GP, green patent; FR = financial resources; M, involvement of the managers in the eco-innovation processes; R, profit, in terms of cost saving, as a motivation for the undertaking of eco-innovative activities; FP, financial performance; S = size.

selected. The minimum value recommended is 0.5 (Bagozzi & Yi, 1988), which means that over 50% of the construct variance is due to its indicators. The last column in Table 7 displays the values obtained, which satisfied the criterion for all constructs.

Discriminant validity means that each construct must be significantly different from the remaining constructs to which it is unrelated, according to the theory. The discriminant validity criterion was also met: (1) the square root of the *AVE* was larger than the correlations among the constructs (see Table 7) and (2) the model loadings were larger than the cross-loadings (see Table 8).

Bootstrapping with 5,000 resamples was used to assess the significance of the path coefficients (Hair, Ringle, & Sarstedt, 2011). In order to analyse the effects of the green patent variable (GP) on financial performance two models have been assessed, defined by the presence, or not presence, of GP variable in the model—Model 1 (without the GP variable) and Model 2 (with GP variable). Table 9 shows that in the two models, the construct we have termed eco-innovation is positively related to the allocation of financial resources and cost optimisation

Table 9. Structural Model Results.

Relations	Path coefficients	*t* Value	Percentile bootstrap 95% confidence level	
			Lower	Upper
Model 1				
ECO ⇒ FP	0.248**	1.978	0.023	0.536
FR ⇒ ECO	0.485***	5.209	0.370	0.707
M ⇒ FP	0.154**	2.142	0.012	0.273
R ⇒ ECO	0.205**	2.339	0.029	0.369
S ⇒ FP	−0.020^{ns}	0.128	−0.266	0.359
Variances explained R^2	R^2_{ECO} = 29.1%, R^2_{FP} = 10.1%			
Stone–Geisser's Q^2	Q^2_{ECO} = 0.087, Q^2_{FP} = 0.034			
Model 2				
ECO ⇒ FP	0.246**	2.050	0.041	0.508
GP ⇒ FP	−0.264 ^{ns}	1.860	−0.534	−0.003
FR ⇒ ECO	0.485***	4.940	0.281	0.629
M ⇒ FP	0.178**	2.385	0.034	0.320
R ⇒ ECO	0.205**	2.586	0.028	0.345
S ⇒ FP	0.097^{ns}	0.510	−0.229	0.530
Variances explained R^2	R^2_{ECO} = 27.3%, R^2_{FP} = 14.4%			
Stone–Geisser's Q^2	Q^2_{ECO} = 0.123 Q^2_{FP} = 0.150			

Note. Based on a one-tailed *t* (4,999 distribution).
$^{**}p < .05$. $^{***}p < .01$. *ns* = not significant.

(the path coefficients are positive and highly significant). Likewise, there is a positive relationship between the level of eco-innovation and the financial performance. These results suggest empirical support for Hypothesis 1. Figure 3 shows the overall Model 2 results, namely, the R2 in the dependent variables and the path coefficients. The results show empirical support for four of the six cause–effect relations on the theoretical model (Figure 3 and Table 9).

Empirical support is not found for Hypothesis 2 because the relationship between green patents and financial performance is non-significant at the 5% level of significance, and the 95% confidence interval includes zero (Model 2 in Table 9). These results do not challenge the support for Hypothesis 1, which establishes the relationship between the level of eco-innovation and financial performance. This means that the positive effect of eco-innovation on financial performance could be due to structural variables that characterise the eco-innovative activity in firms and is not dependent in this case on having or not having green patents.

Moreover, there is a positive relationship between involvement of the managers in the eco-innovation processes and financial performance, where the path coefficient is positive and highly significant. This result increases our knowledge concerning the capabilities that have an effect on firms' environmental management.

The explanatory power of the proposed Model 2 was acceptable because the variances explained (R^2) were 27.3% and 14.4% for the level of eco-innovation and financial performance, respectively (see Figure 3 and Table 9). Stone–Geisser's cross-validated redundancy was $Q^2 = 0.123$ for the level of eco-innovation, $Q^2 = 0.03$ for the ownership of green patents, and $Q^2 = 0.15$ for the financial performance. These results confirm the model's predictive relevance ($Q^2 > 0$). Thus, the model was highly predictive of the eco-innovation level and the financial performance. Similar and acceptable results are shown for Model 1 (Table 9).

Discussion and Conclusions

Based on the results, it can be stated that investments in environmental R&D give some firms a competitive advantage over others in terms of eco-innovation, as previously suggested by Lee and Min (2015) and Parthasarthy and Hammond (2002). In summary, the results contribute to the literature on eco-innovation in different ways. First, eco-innovation is positively related to the amount of financial resources allocated to the eco-innovative activity, as shown in the statistical significance of the path coefficient in line with other authors as (Ghisetti et al., 2017) demonstrating the relevance of financial resources in the eco-innovation activities. In the same way, the positive relationship between the cost saving obtained through eco-investments and the eco-innovation level in firms is also demonstrated, in line with results previously achieved by Christmann (2000) and Maxwell et al. (2000). These results provide also some support for Porter and van der Linde's (1995) theory by confirming the relevance of cost saving in the eco-innovation process to generate offsets which benefit the firm.

Second, results suggest that there is a positive relation between the level of eco-innovation performed by companies and their financial performance, which is an empirical contribution regarding the debate about the specific impact of eco-innovation in line with Doran and Ryan (2012) when they find that eco-innovation, unlike innovation, has a positive and significant impact on firm performance.

The results obtained by Przychodzen and Przychodzen (2015) are confirmed in this study demonstrating that companies with higher level of eco-innovation are more profitable.

In this regard, our results suggest the relevance of specific financial resources for eco-innovation and the associated results in order to reveal a deeper knowledge about the decision-making processes involving eco-innovation and other characteristics of eco-innovative companies as the ownership of green patents. However, the contribution of green patents to performance lacks empirical support. It could be argued that innovation and eco-innovation somewhat overlap in their effects, as the characteristics of firms that are intensively engaged in R&D for eco-innovation are similar to those of innovative firms, regardless of whether they hold green patents. This result partially supports the overlap suggested by Aragón-Correa and Leyva-de la Hiz (2016) and Ramanathan et al. (2016), because firms that hold green patents are not substantially different, except for their age, size, and their commitment to environmental impact minimisation due to its positive effects in terms of market competitiveness.

This study is not exempt from some limitations. The first is related to the lateral nature of the causal analysis: Parallel vertical analyses could reinforce the conclusions. The second limitation concerns the selection (and rejection) of variables. Variables that have not been taken into account include other financial resources invested in eco-innovation; the promotion of these practices through public financial incentives such as grants, tax exemptions, bonuses, or external funding sources; and other environmental management capacities that can have an effect on the eco-innovative activity and the improvement of the associated financial performance. Future studies could focus on these issues.

Taking into account the limitations related to the size, as well as the sectorial and geographical limitations of the sample, it would be desirable to implement similar research programmes that include larger samples and other sectorial and regional frameworks. Other limitation of this study could derive from the partially static nature of the RBV that points out a complementary research approach through the application of dynamic capabilities for this field of study.

Despite these limitations, the article contributes to the academic knowledge about eco-innovation in firms, its measurement, and decision-making processes. Finally, the main contributions for practitioners are related to the modelling of the firms' internal operations, as well as the relationship between eco-innovation and other variables related to the improvement of financial performance.

Appendix

Survey Questions

Initiatives for the Eco-Innovation. Indicate the extent to which your company has carried out the following initiatives for the eco-innovation over the past three years (1 = *between 1% and 5%*, 2 = *between 6% and 10%*, 3 = *between 11% and 20%*, 4 = *between 21% and 30%*, and 5 = *more than 30%*):

R1 Total revenue that has been invested in environmental R&D (internal or external) for eco-innovating
R2 Total revenues invested in innovative equipment/equipment/machinery to reduce the environmental impact of the company
R3 Investments in environmental R&D, eco-design, or similar that are financed with own funds
IE Level of investment in environmental R&D, eco-design, or similar
ECO1 Components of the product or service that have been replaced by innovative ones to comply with environmental regulations
ECO2 Raw materials necessary for the manufacture of products or provision of services that have been replaced by recycled materials.

Reasons for the Eco-Innovation. Indicate the extent to which your company has the following reasons (role) for the eco-innovation over the past three years (1 = *not at all*; 5 = *to a great extent*):

TC1 Possibilities for eco-innovation for the company's products/services
TC2 Radical innovation in the design for the reduction of the company's environmental impact, even without being necessary, which means the company competes better in the market
PD How much environmentally friendly change is necessary to increase the competitiveness of the firm
C What is the relationship between the cost of financial resources invested in eco-innovation and those generated by other costs?
M Personal linkage of the managers with the eco-innovation activity implementation
R To what extent cost saving is the driver behind the implementation of eco-innovations?

Green Patents

Indicate if your company registered green patents in the last three years (1 = *yes*; 0 = *not register*)

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Notes

1. See http://www.prtr-es.es/documentos/documentos-mejores-tecnicas-disponibles (accessed June 2015).
2. Balance Sheet Analysis System (SABI) [online database]. 2014. Madrid.
3. Value added tax (VAT) identification for the Spanish Administration.
4. Although the respondents evaluated the level of the different investments and activities of eco-innovation type using percent scales, these were transformed into 6-point Likert-type scales to permit us carry out the statistical analysis.

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