**Financial resources and business eco-innovation**

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## ABSTRACT

Interest in eco-innovation has been increasing among policy makers, academics, and practitioners, in order to provide a conceptual framework for this type of innovation that is considered to be a relevant instrument in the search for solutions to optimise the use of natural resources in industrial production.

However, despite the growing number of studies on the subject within the theoretical framework of the resources based view (RBV), the internal implementation of eco-innovation and the interrelationships that these investment projects have with the resources and capabilities of the companies in which they are carried out is one of the lines of research that is still open, particularly with regards to the specific financial resources that are necessary to undertake investments.

Therefore, the research objectives in this paper are achieved through the analysis of a sample of Spanish companies in which positive and significant relationships are found between the level of eco-innovation implemented by the companies and the investments in research and development for environmental innovations and for eco-innovation. Additionally, a descriptive analysis is provided of the different financial resources applied to eco-innovation, their typology and specificity.

**1. INTRODUCTION**

In recent years, social science research on innovation processes has increased their focus on the analysis of eco-innovation and aspects linked to environmental sustainability in companies (Coenen and Díaz-López, 2010).

Interest in eco-innovation has been increasing among academics, in order to provide a conceptual framework for this type of innovation that is considered to be a relevant instrument in the interest of sustainability, for practitioners, in search of solutions to optimise the use of natural resources and to reduce the ecological footprint of industrial production (Díaz-García et al., 2015), as well as for policy makers, with the objective of defining appropriate policies for its promotion.

In this sense, society's interest currently seems settled on more sustainable innovation (Mele-Russo and Spena, 2015), and this interest is materialised day after day in stricter environmental legislation and in various promotion measures (Bleischwitz et al., 2009) in Europe as well as in a greater public awareness (Kuik et al., 2006).

Following the introduction of the term eco-efficiency by the World Business Council for Sustainable Development (WBCSD, 1995), we encounter various environmental innovations that reveal the economic and social implications that eco-innovation can have in terms of saving resources (Hellström, 2007), with eco-innovation being defined as any innovation based on and striving for eco-efficiency (Scarpellini et al., 2012).

Nonetheless, despite this growing interest, eco-innovation remains difficult to implement (Díaz-López and Montalvo, 2015) in companies since the economic and environmental benefits of innovation must be aligned in order to implement these investment projects. The difficulty that eco-innovation involves for companies in comparison to conventional innovation resides in its positive effect on the environment, by attempting to make two traditionally opposed goals compatible, such as the improvement of business competitiveness and environmental care (Pereira and Vence, 2012).

In regards to the main fields of research on eco-innovation, we can observe academic work focused on the following areas of analysis:

* external factors such as market pressures, barriers and incentives, collaborative networks, regulations, policies, etc. (Ekins, 2010 Leitner et al., 2010);
* factors internal to the firm such as environmental proactivity, technological competencies, financial resources, size, ownership, export-orientation, sector, or measure (Del Río, 2009, Del Río et al., 2015);
* internal or external determinants of supply and demand such as technological capabilities, cost savings, appropriability conditions, or consumer preferences (Horbach, 2008; Carrillo-Hermosilla et al., 2010)

In short, eco-innovation studies have been conducted at the macro, meso, and micro level for companies. In the micro field specifically (Del Río, 2009), the factors that influence companies' commitment to the environment and to the implementation of more sustainable technologies have been analysed in particular (complexity, compatibility with existing production processes, capital life cycle, the high initial direct costs of investment).

Thus, as a first study phase, the majority of researchers focused their attention on external factors (Demirel and Kesidou, 2011), within the theoretical framework of the institutional theory (Aragón-Correa and Leyva-de la Hiz, 2015; Coenen and Díaz-López, 2010) or the theory of stakeholders (Wagner, 2007, Paraschiv et al., 2012; Henriques and Sadorsky, 1999). In the last decade, internal company factors, such as resources and capabilities related to eco-innovation have been the most frequent object of analysis for their conceptualisation (González-Benito and González-Benito, 2006; Aragón-Correa, Rubio-López 2007; Sharma and Sharma, 2011; Demirel and Kesidou 2011; Del Río et al., 2015), as these are also of interest to practitioners.

Based on the literature analysis, we can assert that there is agreement regarding the consideration that firm resources and capabilities prove to be relevant for the success of investments in eco-innovation (Díaz-García et al., 2015).

However, despite the growing number of studies on the subject in the theoretical framework of the resources based view (RBV), the internal implementation of eco-innovation and the interrelationships that these investment projects have with the resources and capabilities of the companies in which they are carried out have still yet to be extensively investigated. More specifically, the definition and measurement of financial resources and capabilities for eco-innovation is one of the lines of research that is still open (Lee and Min, 2015; Johnson and Lybecker, 2012).

Some of the studies conducted in this framework analyse numerous resources or capabilities jointly or separately (Amit and Schoemaker, 1993; Carrillo-Hermosilla et al., 2010; Kraaijenbrink et al., 2010; Halila and Rundquist, 2011, May, 2012; Díaz-López and Montalvo, 2015; Ramanathan et al., 2016), without offering total clarity about the resources required to finance eco-innovation or how these specific resources complement the capabilities necessary for their application to investments.

Taking into account that investment and financing decisions interact (Jensen and Meckling, 1976), it seems appropriate to investigate the relationship that may exist between the strategy followed by the company and its capital structure (O´Brien, 2003). Therefore, this study’s main research objective is to define, classify, and measure financial resources and capabilities, allowing us to contribute to the knowledge of the impact that these have on business eco-innovation. In summary, we intend to define the resources and capabilities that make eco-innovation investments possible and the impact that they have on a company’s achieved level of eco-innovation.

Examining internal factors requires the active collaboration of companies, since this involves defining and classifying the resources and specific capabilities applied to carrying out investments in eco-innovation.

Therefore, the research objectives in this paper are achieved through the analysis of a sample made up of 2000 Spanish companies that demonstrate a pro-active profile in eco-innovation. These companies actively collaborated in a campaign to promote the collaborative framework of this type of innovation, which is described in the methodology section of this paper. This section follows a review of the literature and of the background below this introduction. Finally, based on the results obtained in this research, the main conclusions and contributions achieved in the framework of the RBV are summarised.

**2. Theoretical background**

We adopt an evolutionary approach to innovation (Freeman, 1992; Kemp and Soete, 1992; Carrillo-Hermosilla et al., 2010; Cecere et al., 2014), like other authors (Pavitt, 1984;), and which, in many cases, can mean a significant expansion in the scope of an organisation’s own competencies (Shrivastava, 1995).

Kemp and Pearson (2008) define eco-innovation 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 resources use (including energy use) compared to relevant alternatives.

In a broad sense, eco-innovations are considered to be innovations aimed towards eco-design (Smith et al., 2010), the development of new technologies aimed at reducing and controlling pollution, as well as technologies of renewable and sustainable processes, the implementation of processes for waste reduction, or sustainable transport technologies (Kemp and Pontoglio de 2011).

Eco-innovations can be incremental or radical (Arundel et al., 2003; Freeman, 1982; Kemp, 1997; Kemp and Pearson, 2008; Rennings et al., 2003), and may be entirely novel at the global level or simply innovative in the environment in which they are adopted by creating new functionalities in existing application fields or by substituting or improving existing technologies (Lang-Koetz et al., 2010).

Eco-innovation, which must strive for or consist of eco-efficiency (Scarpellini et al., 2012) to be considered as such must meet improvement goals in environmental terms, and since it is not relevant whether these are obtained intentionally or not (Cecere et al., 2014; Kemp and Oltra, 2011), various conducted projects can be considered eco-innovative at different stages of the product cycle, including those that may have environmental effects only in the use phase or in the final phase of their life cycle (Sharma and Henriques, 2005).

Furthermore, (Calik and Bardudeen, 2016) introduce social, economic, and environmental aspects in the process of eco-innovative R&D, considering that business models also contemplate these aspects (Boons and Lüdeke-Freund, 2013).

As Carrillo-Hermosilla et al. (2010) indicate, the conceptualisation of eco-innovation draws on the evolutionary perspective of innovation (Dosi et al., 1988; Nelson and Winter, 2002), according to which innovation arises through a systemic process that refers to the interconnectedness and dynamic interaction between different actors and internal and external factors influencing the innovation process.

This study focuses on the internal dimension of eco-innovation within the framework of the theory of resources and capabilities of Penrose (1959), according to which companies need to organise available resources and capabilities to be more competitive. It is therefore of interest to focus our analysis on the resources and capabilities that make possible the adoption of different eco-innovative technologies in companies to combine environmental proactivity with innovation (Coenen and Díaz-López, 2010; Cheon and Urpelainen, 2012; Díaz-López and Montalvo, 2015; Aragon-Correa and Leyva-de la Hiz, 2015; Ketaka, 2015) and to thus optimise their environmental and financial performance (Lee and Min, 2015).

The RBV provides an appropriate theoretical base to analyse the resources and capabilities necessary for eco-innovation (Menguc and Ozanne, 2005; Carrillo-Hermosilla et al., 2010; Dangelico and Pujari, 2010; Lee and Kim, 2011; De Marchi, 2010, Halila and Rundquist, 2011; Segarra-Oña et al., 2011; Cheon and Urpelainen, 2012; Kesidou and Demirel, 2012; Aragón-Correa and Leyva-de la Hiz de 2015; Lee and Min, 2015). The natural resources based view (NRBV) developed by Hart (1995, 2005 Hart, 2005; Hart and Dowell, 2011).) is also of interest, according to which the ability to anticipate the market by introducing more sustainable products and technologies can lead to a company’s competitive advantage.

Both the RBV and the NRBV offer a theoretical basis for the idea that competitive advantage obtained through eco-innovation is achieved through an overlapping of financial resources and capabilities employed in innovative processes that, in this type of innovation, are applied to obtaining an environmental improvement. Furthermore, skills depend on the features of the whole firm (Del Río et al., 2015). One very useful characteristic of the RBV is that it helps to explain why some companies function better than others through the analysis of internal resources and capabilities as sources of sustainable competitive advantage (Kraaijenbrink et al., 2010), as several areas of companies are involved (Ketaka, 2015).

However, the in-depth study of the resources and capabilities that enable the creation of value and competitive advantage (Barney, 1991) continues to be a subject of debate, in particular with regards to financial resources and their application to eco-innovation. Given the high difficulty posed by this analysis, few authors enter into the measurement of specific resources and capabilities (Aragón-Correa and Sharma, 2003), such as for example the dynamic capabilities that facilitate the organisation's alignment with the changes in its environment (Lee and Min, 2015 Helfat et al. 2007 Teece et al. 1997 Cockburn et al., 2000. Aragon-Correa and Leyva-de la Hiz, 2015) for which company environmental proactivity is analysed (Aragón-Correa and Sharma, 2003).

In fact, although there is some consensus among scholars about the relevance that firm resources and capabilities have in systemic processes such as those of eco-innovation, there are currently no univocal studies about how to implement resources to achieve a competitive advantage within a changing external environment (Hart, 1995; De Sarbo et al, 2005). In addition, it is important to note that most of the available studies largely refer to firm internal resources and capabilities that are not specific to eco-innovation.

Various studies have attempted to establish causal relationships between financial structure and innovation, understanding that company financial behaviour affects investment decisions in innovation (Friend and Lang, 1988; O´Brien, 2003; Aghion et al. 2004; Schäfer et al. 2004; Ayyagari, et al. 2007; Magri 2009; Bartolini, 2013). In this sense, accessibility to financing is often identified as a facilitating element of the innovation process at the heart of the business. Specifically, in Ayyagari, et al. (2007), it is indicated that the possibility of increasing financial resources facilitates the introduction of new technologies and products (even more so in companies who work with foreign banks, emphasising a young and large profile), so that the lack of resources would limit the company’s innovative strategy (O´Brien, 2003; Brown et al. 2009).

Company debt and debt structure have been used as explanatory variables of company eco-innovation behaviour (Elsayed and Paton, 2005; Wagner, 2005; Lee and Min, 2015; Przychodzen and Przychodzen, 2015; Scarpellini et.al., 2016) through their relationship with financial performance. In fact, the lack of financial resources has been identified as an element that limits the development of an environmental strategy for SME (Noci and Verganti, 1999).

Wagner (2005) analyses the environmental impact of environmental performance on the financial performance of manufacturing companies in the paper industry in different European countries and no relationship is found between debt level and financial performance.

Lee and Min (2015) analyse investment in Green R&D for eco-innovation on the basis of financial and environmental performance. Based on a sample of Japanese manufacturing companies, a positive relationship is shown between company indebtedness and R&D, and between Green R&D and leverage.

Przychodzen and Przychodzen (2015) assess the relationship between eco-innovation the financial performance of Polish and Hungarian companies, introducing debt as an indicator of financial risk, showing that eco-innovative companies have lower profiles of exposure to financial risk (less debt).

Scarpellini et.al., (2016) analyse the economic-financial interface of 44 successful eco-innovative projects developed in Spanish companies, showing that one of the common characteristics of the companies that develop these projects is a greater debt ratio in their financial structure.

In this sense, it is worth noting that the individual characteristics of the financial system in which businesses carry out their activity can also influence the resources used to finance innovation. In countries such as Spain or Italy, with a high degree of banking intermediation (Cardone et al., 2005; Bartolini, 2013), a greater weight of providers of financial resources can be noted, coming from the banking system in comparison with other external financing alternatives. In this sense, it is also necessary to point out the circumstances surrounding the process of risk assessment to assign resources in these types of channels, who have followed traditional criteria for risk assessment of operations to finance, mainly based on solvency criteria, both of the debtor as well as of the project itself, which can undermine investments in environmental innovation in favour of another type of innovation (Ciozzi et al. 2003).

In particular, it is still complex to define and measure specific financial resources and how these are applied to successfully carry out eco-innovative investments, and authors such as Aragon-Correa and Leyva-de la Hiz (2015) affirm that resources for eco-innovation and those applied to conventional innovation differ in very few aspects, such as in the emphasis provided by companies to managing stakeholder relationships (Rueda-Manzanares et al., 2008), and that in any case, those that can be considered specific to eco-innovation are also applicable to the innovation process. In fact, several authors show a substantial overlap in the two types of innovation (Aragón-Correa and Leyva-de la Hiz, 2015; Ramanathan et al., 2016) and therefore, the detailed classification of firm internal financial resources and capabilities for investments in eco-innovation is an undoubtedly complex task and which cannot do without taking into account corporate strategy and the company's environmental commitment. However, the specific resources and capabilities applied to environmental activity are often not internally differentiated (Lee and Min, 2015).

On this basis, our proposal focuses on differentiating resources and capabilities that are specifically applied to eco-innovation and analysing the relationship between these and the level of eco-innovation carried out by companies. To do this, we make a first theoretical approach of analysis and classification applied to eco-innovative companies or those that have expressed interest in the eco-innovation of firm resources and capabilities (inputs) with their level of eco-innovation.

Therefore, our main research question has the double aspect of, in the first place, differentiating financial resources from capabilities that the companies have available, to subsequently measure the extent to which these financial resources result in eco-innovation.

Based on the literature review summarised in the following sections to make a theoretical approach to firm internal financial resources and capabilities, we make progress in the knowledge of the endogenous factors of eco-innovation in the framework of the RBV.

***2.1 Specific financial resources and capabilities***

The availability of financial resources maintains a close relationship with R&D so that the possible restrictions to which resources might be exposed would especially affect these types of investments (Brown et al. 2009). It also seems accepted that certain resources, such as investment in R&D in the environmental field (Parthasarthy and Hammond, 2002), provide a competitive advantage to companies for eco-innovation (Lee and Min, 2015) and that their analysis can help an industry to develop unique resources and capabilities that may increase its eco-innovative activity, also increasing financial results and environmental performance (Ketata, 2014).

As endogenous resources, the literature has analysed financial resources (Halila and Rundquist, 2011; Paraschiv et al., 2012; Cruz-Cázaresa et al., 2013; Triguero et al 2014; Lee and Min, 2015 Paraschiv et al., 2012), access to capital, either through credit institutions, venture capital, capital increase, or individual funds, the availability of public funds for the company’s environmental improvement (Johnson and Lybecker, 2012) or company size (Segarra-Oña et al., 2011) as a company characteristic that is relevant for innovation from the hypothesis of Schumpeter (1942), according to which market concentration and company size positively affect innovation (Leitner et al., 2010).

The influence of financial structure and its relationship with R&D activities is addressed in Aghion et al. (2004) in industrial companies in the UK, and a positive relationship is shown between the use of external financing (debt) and investment in R&D. However, the intensity of the innovative effort influences the types of resources, so that companies that are more intensive in R&D tend to use issuing shares as a mechanism to obtain financial resources.

Moreover, in García et al. (2013), a positive and significant relationship is shown between the use of external financing, mainly banking, and innovative activity, in comparison with capital increases or other internally generated funds.

Bartoloni (2013) analyses the capital structure of Italian companies and indicates that, although companies that present a higher profitability tend to introduce increased internal funding, the greater the innovative effort of the company, the greater the need for external financing, specifically, the use of debt.

On the contrary, in Magri (2009), a greater weight is observed for internal financial resources, to the detriment of external financing, in more innovative and smaller companies. In this line, the studies by Friend and Lang (1988), Hall (1992, 2010), and O´Brien (2003) show a clear negative correlation between R&D intensity and leverage, so that companies with greater R&D intensity maintain lower debt levels.

From the perspective of risk in the financing of projects, in Schäfer et al. (2004), on German innovative small and medium enterprises (SMEs), the authors demonstrate that an increased risk in the project to be financed implies a greater orientation towards internal financing, given that lenders tend to demand a higher cost and collateral, and these are more difficult to meet in certain profiles.

Aspects such as the company age, its financial characteristics, or those of the financial environment in which it carries out its activity may be determining factors of a company's innovative behaviour (Aghion et al. 2004). Younger companies may have difficulties in having an appropriate ability to generate internal resources and would be forced to rely on outside funding sources, incurring a higher financial cost due to an increased risk of insolvency (Schäfer et al. 2004).

Even a company's financial performance may be related to the profile of its financial resources. In Aghion et al. 2004, it is shown that those with a greater financial performance (profitability) tend to have lower debt levels, by having a greater potential to generate their own resources, distributing a lower volume of dividends, and with a greater presence of debt with short-term maturity (Elkemali and Rejeb, 2005). In fact, access to capital has been considered a major barrier by several authors (Biondi et al., 2002 Fleiter et al. 2012; de Groot et al., 2001; Rohdin et al., 2007; Thollander et al., 2007), who indicate that the availability of funds to undertake the necessary initial investments influences the eco-innovation adoption level in companies, in particular also due to the short-term perspective of company investments that hinder eco-innovation (Biondi et al., 2002) and access to resources (Brío and Junquera, 2003).

Halila and Rundquist, 2011 examine access to capital, proposing different possibilities for investment, such as external financing and venture capital, proposed for the most advanced phase of development in which the company finds itself in the best position for negotiation, or issuing shares. For eco-innovative companies, the challenge is not only to attract sufficient funds, but also to ensure that the associated incentives are appropriate for each stage of the life cycle (Johnson and Lybecker, 2012).

However, the choice of the financial provider to finance eco-innovation activity will be conditioned by the existence of developed, extensive, and transparent financial markets with sufficient liquidity. Above all, these must be appropriate for different enterprise sizes, as well as for the degree of banking intermediation in which each economy is immersed, as is the case of the credit market.

From another approach, R&D activity (Cruz-Cázaresa et al., 2013; Triguero et al., 2014; Ding, 2014; Lee y Min, 2015; Segarra-Oña et al., 2015) that is internally developed in companies ensures its participation in eco-innovation projects (Canielli et al., 2015), which is related to investments in patents (Segarra-Oña et al., 2011; Aragón-Correa and Leyva-de la Hiz, 2015; Segarra-Oña et al., 2015) and to ongoing innovation activity (Doran and Ryan, 2014) and therefore, to an ongoing availability of resources for these activities.

The level of investment in R&D, in fact, has been considered a relevant resource for eco-innovation (Ding, 2014; Ketaka, 2015; Lee and Min, 2015), leaving the field of research open on the specificity of environmental resources devoted to R&D such as eco-innovation rather than contemplating the level of R&D investment in an aggregate manner.

Previous studies have emphasised public aid as an element that facilitates research, development, and innovation activities (Pereiras and Huergo, 2006). At the environmental level, Ghisetti and Rennings (2014) highlight the importance of public financial incentives to adopting eco-innovation in companies, especially in projects that would not be profitable for these companies. Moreover, they highlight the difficulty in distinguishing the effects of each and every one of the incentives; therefore, in the end it is only possible to obtain information on whether the company does or does not receive financial incentives (of any type).

Subsidies or grants available for companies as a resource for environmental investments (Aschoff and Sofka, 2009; De Marchi, 2011; Doran and Ryan, 2012; May et al., 2012; Galia et al., 2015; Ketaka, 2015) have been, however, specifically measured. The existence of public and sustainable incentives facilitates the change from polluting technologies to clean technologies over time (Veugelers, 2012). Moreover, measures related to the reduction of rates and taxes promote the adoption of more sustainable behaviours, such as for example in the field of energy in the automotive sector (Sierzchula et al., 2014).

In the consideration that companies give to aspects that are intrinsic to eco-innovation, we can observe how economic-financial aspects represent a topic that is very relevant to decision making (May et al. 2012), underscoring that the financial resources that influence profitability must be considered in the definition of investments of this type.

In summary, although there are studies that show relationships between environmental performance and financial performance, there is very little evidence about how companies finance eco-innovation (Johnson and Lybecker, 2012) and instruments such as public aid, whether for R&D or production bonuses, can generate problems in regards to costs that have resulted in standard limits of total production in the EU (Eropean Commission 2014).

Furthermore, studies dedicated to financing through production bonuses are very abundant. For example, in the case of renewable energy (Morgan 2005; Li et al. 2017), the few studies published on eco-innovation financing show that, despite public support initiatives for sustainable development and eco-innovation such as those of the EU (Lightfoot & Burchell 2004; Steurer et al. 2010; Hees 2014; European Commission 2010; European Commission 2013), most innovation continues to be funded by private sources, whether these are equity (stocks) or through sources of external financing (loans from financial institutions, venture capital funds, etc.). On the other hand, business interest in eco-innovation is largely driven by the market, which determines innovation funding (Johnson and Lybecker, 2012).

Concerning the capabilities of organisations for eco-innovation, we adopt the definition of Penrose (1959) for analysis, according to which capabilities are unique combinations of organisational processes that group strategic knowledge and thus, not only is the company’s possession of resources relevant, but also the manner in which these resources are used.

In the literature, we can find numerous theoretical perspectives that address the study of company capabilities for eco-innovation, such as technological capabilities (Kemp et al., 1992; Pereira and Vence, 2012 Hoogma et al., 2002; Kemp et al., 1998; Raven, 2005; Van der Laak et al., 2007), those applied to reducing resources for production, recycling, preventing pollution, and product eco-design (Georg et al., 1992; Winn and Roome, 1993; Lall, 1992 in terms of efficient management of energy, water, waste, etc., has been a topic of several research studies (lvarez-Gil et al., 2001; Carmona-Moreno et al., 2004; Holcomb et al., 2007; Kirk, 1995; Molina-Azonrin et al., 2009; Montabon et al., 2007). Furthermore, dynamic capabilities have been analysed (Teece et al., 1997; Eisenhardt and Martin, 2000; Gabler et al., 2015), since they allow an organisation to align itself with the changes in its natural and business environment and that are often related to the proactivity of management towards eco-innovation (Chang and Chen, 2013; Del Río et al., 2015). Therefore, some authors emphasise the key role of responsible leadership (Pless, 2007; Cameron, 2011; La Rocca, 2011), and their experience (Bartlett and Trifilova, 2010).

Collaborative capabilities (Hammar and Löfgren, 2010; Triguero et al., 2014), thanks to which companies actively collaborate with research institutes, agencies, universities, participate in networks or collaborate with all players in the value chain, have been the subject of analysis for several authors (De Marchi, 2010; Cainelli et al., 2011; Cao y Zhang, 2011; Petruzzelli et al., 2011; Ding, 2014; Del Río et al., 2015; Díaz-García et al., 2015) as they are considered to be a very significant advantage for innovation since they enable better organisational learning, knowledge transfer, and the improvement of the absorption capacity (Cohen and Levinthal, 1990; Pereira and Vence, 2012; Vickers and Cordey-Hayes, 1999 Cetindamar and Ulusoy, 2008).

The joint solution of problems, training and information (Mondéjar-Jiménez et al., 2013), as well as external sources of knowledge for innovation (Freel, 2003; McCann and Simonen, 2005; Roper et al., 2008) and links with public entities for eco-innovation (Doran and Ryan, 2012) are considered collaborative capabilities of companies that are very relevant to carrying out this process, which furthermore, in some cases give rise to the acquisition of public funding intended for collaborative activities.

Moreover, organisational capabilities (Horbach, 2008; Kesidou and Demirel, 2012), those applied to monitoring productivity (Florida et al., 2001), the ability to implement environmental management systems (Wagner, 2007; Horbach, 2008; Demirel and Kesidou, 2011), and the ability of an organization to reduce its environmental impact and to increase its operational efficiency have been indicated as relevant to the adoption of eco-innovation.

For the environmental field, we can also emphasise environmental management, considered a relevant company capability (Horbach 2008; Wagner 2008; Demirel, Kesidou 2011; Rave et al. 2011; Horbach et al 2012; Kesidou, Demirel 2012 Díaz-García et al., 2015 Georg et al., 1992; Kemp et al., 1992; Winn and Roome, 1993 Nill and Kemp, 2009), linked in some way with the implementation of certificates such as the ISO 14001 or EMAS (Mazzanti and Zoboli, 2006; Demirel and Kesidou 2011).

Other studies have highlighted organisation characteristics such as age (Richardson, 1972) or experience and know-how (Dosi et al., 2000) that are associated with company "routine" activities (Nelson and Winter, 1982; Grant, 1991; Chandler, 1992; Collis, 1994) that are applied to eco-innovative processes (Chiesa y Frattini, 2009; Schaltegger, 2011), both to those that have been developed internally as well as those that are acquired (Frondel et al., 2007).

In this sense, Muller et al. (2005) notes that the capacity of companies to combine several process innovations (production efficiency) or several products, is important in developing and adopting eco-innovations (Oltra and Saint Jean, 2005). In addition, the ability of a company to anticipate regulatory changes is considered important for the successful implementation of environmental technologies (Taylor et al., 2005).

Environmental capabilities or eco-capabilities (Ramanathan et al. (2016 Gabler et al., 2015) are employed by companies to comply with the commitment of corporate social responsibility (CSR) (Jimenez and Lorente, 2001 Ramanathan et al., 2016), to improve their performance through investments Alvarez-Gil et al., 2001 Angell and Klassen, 1999 Jimenez and Lorente, 2001), and to improve their reputation in environmental terms (Judge and Douglas, 1998; Klassen and McLaughlin, 1996 Angell and Klassen, 1999. These capabilities are focused on the interaction of environmental proactivity and the innovative character of the company (Gabler et al., 2015) and confirms the findings made by Rivera-Torres et al. (2016).

However, the causality between these firm capabilities and eco-innovation is still a subject of debate and unclear (Ziegler, 2009 Nill and Kemp, 2009 Díaz-García et al., 2015 Cainelli et al. (2011 Cuerva et al. 2014 Petruzzelli et al. (2011).). The definition of a possible specific capability that is inherent in the optimum use of financial resources for eco-innovation also remains unaddressed since the possible lack of funding has been indicated as a reason for why specific capabilities for eco-innovation in companies have not been extensively developed (Kammerer 2009 Del Río et al., 2015).

***2.2 Measuring eco-innovation in companies***

After the determination of financial resources and related capabilities for eco-innovative investments, it is proposed to analyse the relationship between these and the level of eco-innovation in companies. Thus, determinants of investment projects in eco-innovation are also studied, as these are a topic that is the object of analysis for the literature on the subject (Scarpellini et al., 2016), such as company characteristics, age (Cainelli et al., 2011; Santolaria et al., 2011) Pereira and Vence, 2012, size (Dong et al. 2014 Segarra-Blasco et al., 2008; Segarra-Oña and Peiró-Signes, 2013; Biondi et al. 2002; Berkhout; 2005; Scarpellini et al., 2016 Pereira and Vence, 2012) or sector Antonioli et al. (2013) Cecere et al., 2014; Doran and Ryan, 2014 Triguero et al (2014) Pereira and Vence, 2012) and others, such as the importance that green organisation identity has in the development of these types of innovations (Chang and Chen, 2013).

To understand the relationship between the applied financial resources and eco-innovation performed in companies, it is necessary to define different levels of eco-innovative activities and to thus analyse the typology and amount of financial resources that allow us to obtain greater results in eco-innovation through these specific capabilities. The relevant contribution that is pursued here is linked both to the typology of resources as well as their measurement in order to understand the way in which these are applied in the most eco-innovative companies.

Company performance in eco-innovation has been analysed by some authors as a combined indicator of economic performance, competitiveness, and environmental sustainability (Orlitzky et al., 2003; Margolis and Walsh, 2003; Boons and Wagner, 2009 Dong et al. 2014) and requires the understanding of the mechanisms that companies apply in order to obtain it (Sandström and Tingström, 2008).

Indicators that measure financial results related to eco-innovation projects include the investment cycle, rate of return on investment (ROI), and the net present value, and are usually measured through cost-benefit analysis, including cash flow and dynamic profitability (Kemp and Horbach, 2007).

In general, environmental performance includes the efficient use of resources, the reduction of waste and energy consumption, and the reduction of environmental risks and carbon emissions (Aragón-Correa et al., 2008; Smith et al., 2010).

Often, studies performed using surveys to gather data about environmental R&D activity do not ask about investment volume (Horbach, 2008) and focus on whether or not the company invests without being able to provide more information about the invested amounts and their origin.

Nonetheless, some authors have incorporated environmental R&D costs as an indicator of eco-innovation (Kesidou and Demirel, 2012; Aragón-Correa et al., 2008) to measure the level of a company's investment in eco-innovation in a more specific and accurate manner in comparison with the majority of eco-innovation indicators present in the literature. Therefore, this study specifically incorporates this measurement as a relevant resource for analysis, although it is employed here as a variable of the resources applied by companies rather than adopting the eco-innovative result as a measurement.

An interesting method that illustrates the eco-innovative processes is the qualitative model proposed by Kanerva et al. (2009), which analyses the relationships between inputs (R&D, patents, investment) and the results in terms of eco-innovation. This has also been used to determine the potential of eco-innovations in the related fields of energy, the economy, and the environment (Kijek & Kasztelan 2013).

In general, a company’s level of eco-innovation can be defined by measuring the improvements achieved in environmental terms or by the goals pursued by the company through the eco-innovative l innovative process (Carrillo-Hermosilla, Del Río, & Könnölä, 2010 Díaz-García et al., 2015). Thus, we can observe the results, whether this is financial profitability or competitiveness (Sarkar, 2013; Segarra-Oña et al., 2011). The drivers of the process and the different levels of investment, results, or proactivity of the company towards eco-innovation can also be defined, which provide evidence about the process, R&D (Machiba, 2010), and the management of development or marketing Díaz-García et al., 2015).

We can therefore note that the variables to measure the economic-financial results of eco-innovation projects (Kemp and Horbach, 2007; Fleiter et al. 2012; Scarpellini et al., 2016) have been infrequently employed in previous studies since they require access to information on the investments made by companies and confidential data. On this basis, the research questions proposed here are:

Does the availability of different funding sources influence a company’s decisions to eco-innovate and the level of investments made for eco-innovation?

Are there different levels of quality and diversification in financial resources that companies apply to eco-innovation? Do these levels influence the performance of eco-innovation in companies?

Which financial resources most influence the level of eco-innovation adopted by companies? Are these resources specific to this type of innovation?

To answer these questions, we chose to use a qualitative methodology that allows us to understand the relationship between different levels of eco-innovation and financial resources and capabilities applied by companies to obtain eco-innovative results.

Based on a quantitative methodology, a response to the proposed questions is provided as described in the following sections.

**3. Methodology and sample description**

***3.1 Selection of the methodological approach***

There is no doubt that, through the numerous studies that have applied methodologies of quantitative and econometric analysis, interesting results have been reached to determine the most relevant resources and capabilities for eco-innovation in companies. However, if we briefly summarise the main results achieved in this field of research, we can observe that the definition and measurement of this set of financial resources and capabilities applied to investments in eco-innovation has not been comprehensively addressed.

Quantitative studies provide empirical evidence of great utility on some of the resources or capabilities or part of the process and of the results. Ketaka (2015) provides empirical evidence about the drivers of eco-innovation from 1,100 German companies, while Kesidou and Demirel (2012) do this through a dataset of 1566 companies in the United Kingdom. Cheng and Shiu (2012) apply regression analysis to a sample of managers from 245 Chinese businesses to analyse the determinants of eco-innovation, while Lee and Min (2015) analyse data from Japanese manufacturing companies between 2001 and 2010 to analyse the impact of R&D activity for eco-innovation in their results.

In turn, the behaviour of European entrepreneurs with respect to eco-innovation has been studied by Triguero et al. (2014) and, for similar purposes, Segarra-Oña and Peiró-Signes (2013) analyse data from 3,013 Spanish service companies using multivariate analysis. Likewise, Santolaria et al. (2011) analyse how 1,256 Spanish companies oriented to innovation apply eco-design and, at the sector level, Segarra-Oña et al. (2015) analysed, among other studies, companies of the construction sector at a national level to demonstrate that the environmental orientation of companies affects their behaviour in the innovation process.

Doran and Ryan (2012), using innovation survey data from 2,181 companies, investigate the main economic drivers of eco-innovation in Ireland and whether this results in additional benefits (cost reduction) and also offer a classification of key activities for eco-innovation that are summarised in the decrease in intensity of raw materials, water, energy in products, reduction of the carbon footprint in production, the replacement of polluting materials with other non-polluting materials, the reduction in environmental pollution and waste as well as the use of recycled materials. As another interesting result in the matter, Lee and Min (2015) assert that eco-innovation contributes to better environmental behaviour (reduction in carbon emissions) and to the improvement of financial results (Tobin's Q) at the same time.

On the other hand, a series of empirical studies on innovation have shown that the implementation of environmental management systems has a positive impact on eco-innovation (Horbach, 2008; Wagner, 2007), and by empirically analysing green and non-green patents (Aragón-Correa and Leyva-de la Hiz, 2015), a positive relationship is predicted between a company’s number of patented eco-innovations and conventional innovations, since both are subject to the influence of similar factors.

Based on the review of quantitative studies, the main variables have been defined that have already been analysed in-depth, thus detecting variables that are little explored in the literature, such as those of financial resources. Some limitations can be observed in regard to sources of information that are often based on data collected through surveys that are not specifically designed for eco-innovation, and more specifically, that refer to aspects linked to the environmental orientation of the companies in innovation (Santolaria et al., 2011; Kesidou and Demirel, 2012; Segarra-Oña and Peiró-Signes, 2013 Segarra-Oña et al., 2015; Ketaka, 2015; Lee and Min, 2015).

In the analysis carried out using data more directly linked to the eco-innovation process (Wagner, 2007; Horbach, 2008; Doran and Ryan, 2012; Aragón-Correa and Leyva-de la Hiz, 2015), there exist data of great interest that, however, specifically analyse some firm resources or capabilities and do not reveal their application to results of eco-innovation projects in detail regarding those of a financial nature.

***3.2 Sample and data collection***

To achieve the objective proposed in this research study, the analysis is performed through surveys designed for this purpose and proposed to channel active cooperation in this investigation of eco-innovative companies that express interest in eco-innovation by participating in a collaborative campaign that promotes eco-innovation in North-eastern Spain, in line with the idea that the dissemination of environmental information among the relevant actors can help promote products, processes, new forms of organisation, and new businesses that are environmentally friendly and economically viable (Pereira and Vence, 2012).

Below, the analysed sample is presented, the target variables of this research study are detailed and an account is given of the methodology used.

In this analysis, the population was structured based on the data extracted from the SABI database[[2]](#footnote-2), and corresponds to the last full year available at the time of preparing the population (2013). The companies were selected in order to have a sample of eco-innovative companies or companies with high interest rates in eco-innovation to launch a collaborative campaign to promote R&D for eco-innovation in the Spanish autonomous communities of Aragon, Catalonia, Navarre, and the Basque Country, to which the companies adhered. This meant selecting companies with 50 or more workers, considering that size increases the possibilities of carrying out eco-innovation (Dong et al. 2014; Segarra-Blasco et al., 2008; Triguero et al. 2014; Roda-Llorca et al., 2015; Rehfeld et al. 2007; Wagner 2007), that operate in the sectors of greater potential for eco-innovation, such as those related to technologies referred to in the documents known as “BREFs” of the "Best Available Techniques"[[3]](#footnote-3), and specifically the industrial, transport and logistics, and waste sectors, whose NACE 09 codes correspond to that of extractive industry (05-09), manufacturing industry (10-33), electricity, gas, steam, and air conditioning supply (35), water supply, sewerage, waste management, and remediation activities (36-39), and transporting and storage (49-53). Although some eco-innovative companies may be excluded, it is considered that the vast majority of firms are represented with this selection criterion that are the object of study in line with Ding (2014).

Finally, a population of 2000 companies was obtained of which contact information was made available for half of the companies that were contacted by e-mail and to which the survey was sent on their eco-innovation activity in order to adhere to the collaborative campaign. 90 responses from the companies that make up the sample were obtained through this means. Despite not being a large number of observations, it should be noted that the companies are identified with their tax ID number and that these are not anonymous surveys, ensuring the commitment of companies to this research and the quality of the answers provided. Moreover, the identification of the companies in the sample allows us to integrate study variables with economic-financial data of the companies and their main characteristics.

The companies of the sample are distributed as is shown in Table 1.

***Table 1***

***3.2 Measurement***

Using a series of indicators that measure the level of eco-innovation achieved by the surveyed companies throughout the last three years, a set of variables was designed that synthesises resources and capabilities available in these companies and that they apply to eco-innovation activities. For the selection of these variables, those used in other studies in the literature were taken as a starting point, as well as evaluations provided by the expert panel. Specifically, a set of 10 variables was used (Table 2) to measure eco-innovation, the financial resources applied, including the amount and typology, environmental management capabilities, as well as others such as control variables, organisation age, and size. Based on the opinion of the company survey respondent, these variables allow us to quantify the level of investments and of eco-innovative activities performed by the companies. Thus, scales are defined of percentages of improvements implemented in the companies in recent years in terms of savings of emissions and resources, replacement of raw materials and components as well as investments made to decrease the environmental impact of products and companies. To gather the perception of those surveyed about the extent to which activities performed in eco-innovation or innovation responded or were related to different resources, capabilities or other factors, a Likert scale of 0 to 10 was applied, where 0 indicates "to no extent" and 10 "to a great extent". The economic-financial variables obtained from the SABI database through the CIF of companies were added to the other variables collected through the survey designed for this purpose.

The variables selected to measure company debt structure and leverage (LRV) (Lee and Min, 2015, ROE Halila and Rundquist, 2011; Triguero et al., 2014; Scarpellini et.al., 2016) or liquidity (Dong et al., 2014) are among the more strictly financial variables for the measurement of the company's resources. It is important to note that these types of resources have been scarcely analysed due to the need for company financial data for their analysis, which cannot be conducted through studies carried out using anonymous surveys. In our study, they can be considered due to the availability of a large panel of eco-innovative companies or companies that have expressed interest in eco-innovation.

To measure the levels of eco-innovation implemented in companies, environmental improvement indicators are commonly used (Jasch, 2000; Chen, 2008; Lin and Ho, 2008, CIS, 2009; Bartlett and Trifilova, 2010; Klewitz et. al., 2012; Doran and Ryan, 2014; Shuaib et al. 2014; Galia et al., 2015 Fiksel et al.,1998; Herva et al., 2011) Jasch (2000).). Thus, variables for the replacement of a component or of raw materials are applied in this study (Cole et al., 2005; Nogareda, 2007; Bartlett and Trifilova, 2010; Ding, 2014; Dong et al. 2014; Doran and Ryan, 2014) as well as the decrease in the use of raw materials or energy resources (Cole et al., 2005; Doonan et al., 2005; Seroa da Motta, 2006; Hellström, 2007; Chen, 2008; Lin and Ho, 2008; CIS, 2009; Bartlett and Trifilova, 2010; De Marchi, 2012; Dong et al., 2014; Klewitz et. al., 2012; Doran and Ryan, 2014; Li, 2014; Shuaib et al., 2014; Ketata et al., 2015; Galia et al., 2015; Issa, et al., 2015).

The size of investments in R&D (Segarra-Oña and Peiró-Signes, 2013) and, in particular, in R&D in the environmental field, is also the subject of this study (Horbach, 2008), concerning company environmental capabilities (Georg et al., 1992; Kemp et al., 1992; Winn and Roome, 1993).

Therefore, it is at first of interest to describe the percentage of investments in environmental R&D, eco-design, or similar projects that are financed with internal funding, how much is financed by public financial incentives (subsidies, tax deductions, bonuses, etc.) and what percentage of R&D investments are financed through funds originating from foreign sources.

***Insert Table 2***

Based on these first statistical-descriptive results, we proceed to analyse the percentage of total income invested in Research & Development (internal or acquired R&D) in the environmental field to make products or services more innovative and, therefore, in eco-innovation, and moreover, the percentage of total income invested in new equipment/appliances/machinery to decrease the company's impact on the environment as a whole. The results are summarised in the following Table.

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**4. PRINCIPAL RESULTS AND DISCUSSION**

Based on the information relating to eco-innovation and to the applied financial resources, we proceed to visualise the obtained results through descriptive tables.

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**5. CONCLUSIONS**

As the main research objective, this study has examined the internal implementation of eco-innovation and the interrelationships that these investment projects have in the framework of the resources based view (RBW), providing a contribution regarding the definition and application of the specific financial resources that are necessary to carry out investments in eco-innovation.

Through the analysis of the financial resources applied to eco-innovation in a sample of companies, we were able to show the positive and significant relationships that exist between the level of eco-innovation implemented by companies and investments in research and development for environmental innovations and eco-innovation.

This research study is not free of limitations, more specifically related to the size and the geographical location of the company sample analysed. However, these issues have been mitigated through the use of longitudinal data of the economic-financial variables obtained, and by the specificity of the variables provided by the companies about financial resources applied to eco-innovation in a specific way.

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**7. Annexes**

Variables analysed

* C1.- Percentage of total income invested in Research and Development (internal or acquired R&D) in the environmental field to make products or services more innovative (eco-innovation)
* C3.- Percentage of total income invested in new equipment/appliances/machinery to reduce the company's impact on the environment as a whole (environmental investments)
* C10.- Percentage of environmental R&D investments (eco-innovation), eco-design or similar projects financed with internal funds.
* C11.- Percentage of environmental R&D investments (eco-innovation), eco-design or similar projects financed through public financial incentives (subsidies, tax deductions, bonuses, etc.
* C12.- Percentage of environmental R&D investments (eco-innovation) financed through funds originating from foreign sources.
* A1.- Measure in which the products or services of the company offer clear possibilities of innovative environmental improvements or changes.
* A6.- Improvement in company competitiveness obtained through ground-breaking innovation in design for the reduction in the environmental impact, even if they were not necessary.
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E-mail: sabina@unizar.es [↑](#footnote-ref-1)
2. Iberian Balance Sheets Analysis System (SABI) [online database]. 2014. Madrid [↑](#footnote-ref-2)
3. See <http://www.prtr-es.es/documentos/documentos-mejores-tecnicas-disponibles>. (accessed June 2015). [↑](#footnote-ref-3)