



# Complementarity between CSR dimensions and innovation: behaviour, objective or both?

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## ABSTRACT

This research assesses the impact of combining the economic, social and environmental dimensions of the corporate social responsibility (CSR) on firm innovation. In particular, we test whether the three dimensions of CSR (economic, social and environmental) are interrelated (behavioural complementarity), and whether their joined adoption will generate super-additive innovation performance effects (objective complementarity). To that end, we draw on the Community Innovation Survey (CIS) for Spain during the period 2009–2014. The analyses confirm behavioural complementarity among the three dimensions of CSR, as well as differences on objective complementarities depending on the innovation performance measure considered. In particular, the combination of the social dimension with any of the two others (economic and environmental) is the one that gives the best results in terms of radical innovation, whereas both the economic and environmental dimensions of CSR seem to be fundamental to foster incremental innovation. These results have implications for academics and practitioners, since they provide useful guidelines for the design of CSR in order to enhance firm innovation.

## 1. Introduction

The concept of Responsible Social Innovation (RSI) has gained attention over last decades. Practitioners, policy makers and academics claim that innovation and corporate social responsibility (CSR) should advance together for the world sustainable development (Kuzma et al., 2020). In this context, ‘RSI has become a cross-cutting priority in EU’s Horizon 2020 Framework Programme for Research and Innovation (H2020)’ (Nazarko, 2019, p. 129). Nowadays, many firms include innovation as a key element when designing CSR, since a joint management of innovation and CSR could report several advantages to the firm in terms of sustainability. As companies that innovate are more prepared to respond to the new challenges of the competitive environment, innovation is one of the main success factors that ensure the long-term survival of the company (Andronikidis et al., 2020; Cegarra-Navarro et al., 2016; Turner et al., 2020). In this sense, an important research question is whether the CSR models implemented by firms promote innovation.

From the academic sphere, there are several studies dealing with the study of the key elements of both the CSR and the RSI (Bocquet et al., 2013; Cegarra-Navarro et al., 2016; Hadj, 2020; Neumeier, 2017).

Although the majority of previous research within this framework confirms the role of CSR as a driver of firm innovation (e.g. Briones et al., 2018; Le Bas & Poussing, 2017), existing research is scarce and not clear about the nature of that relationship (Martínez-Conesa, Soto-Acosta, & Palacios-Manzano, 2017; Ratajczak & Szutowski, 2016; Surroca, Tribó, & Waddock, 2010; Wagner, 2010). An important limitation of previous empirical papers is that they have used a wide definition of CSR or have paid attention to only one dimension of CSR, measuring it as a homogeneous construct. In this sense, they have not differentiated its three core dimensions (Mithani, 2017), as defined by the ‘Triple Bottom Line’ (TBL) approach (Bohmann et al., 2018; Mühlbacher & Böbel, 2019; Vanelander, 2016). In our analysis of the innovation–CSR relationship, we overcome this limitation by following the TBL approach, which identifies three CSR dimensions, those being the economic, the social and the environment dimensions. In doing so, we respond to recent calls for moving from a unidimensional consideration of CSR to a multidimensional concept (Halme and Laurila, 2009; Martínez-Conesa et al., 2017; Pan et al., 2021; Ratajczak & Szutowski, 2016). This could help to clarify the nature of the relationship between CSR and the innovation performance of firms, avoiding the confusion related to some CSR definitions ‘that may indicate denial of the environmental or the social

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responsibility of business (DesJardins, 1998)' (Halme & Laurila, 2009, p. 336), and contributing to clarify whether the relationship between CSR and innovation exists in the majority of empirical research (Martínez-Conesa et al., 2017; Ratajczak; Ratajczak & Szutowski, 2016).

Based on that recognition of the three core dimensions of CSR, the main objective and contribution of this paper is to analyse their relation with the firm innovation performance by applying the 'Complementarity Approach'. To the best of our knowledge, this paper is the first in applying that approach to the analysis of the CSR–innovation relationship. This approach, has been broadly applied to the study of complementarities in other research contexts (i.e. Lokshin et al. 2009; Ballot et al., 2015; Guisado-González et al., 2017; Serrano-Bedia et al., 2018), but not for this specific issue. It will shed light on the CSR–innovation link (Ennen & Richter, 2010) and will extend our knowledge on the design of CSR practices of firms. In this sense, although previous literature, mainly related to the resource-based view (RBV; Barney, 1991), suggests that there is complementarity between the different dimensions of CSR, this issue has been underexplored in previous empirical research. Previous literature suggests that two types of complementarities can be found: behavioural complementarity, which defines complementarity as a synonym for fit, and objective complementarity, which is related to synergy (Schweiger et al., 2019). Thus, behavioural complementarity refers to the behaviour of the firms in the sense of how they combine different activities, whereas objective complementarity refers to the combination that improves the performance results of the firm. In particular, we expand on previous literature by postulating that the economic, social and environmental CSR practices are interrelated (behavioural complementarity), and that jointly adopted will generate super-additive innovation effects (objective complementarity), which means that performance effect of the joint adoption of different activities is greater than the sum of the performance effects of the adoption of each activity in isolation (Crifo et al., 2016). Building from these arguments, Mithani (2017) suggests that managerial attention to innovation can be undermined by a greater emphasis on CSR, and explains the difficulty that firms face when paying simultaneous attention to innovation and CSR. The analysis of complementarities between the different dimensions of CSR, mostly ignored by previous empirical research, could shed light on our understanding of the link between CSR and innovation and will allow us to determine which combination of CSR practices are more likely to enhance innovation performance.

Moreover, we expand on previous literature by integrating in our analysis both types of complementarities. In contrast to what have been done in previous works, which have usually focus on only one type of complementarity (behavioural complementarity – i.e. Gómez & Vargas, 2009; Carboni & Russu, 2018; García-Piqueres et al., 2020 – or objective complementarity – i.e. Lokshin et al. 2009; Ballot et al., 2015; Guisado-González et al., 2017; Serrano-Bedia et al., 2018), we take a broad approach by focusing on both types of complementarities. To that end, we apply a novel methodological approach by combining in only one paper two different methods depending on the type of complementarity to be tested. Behavioural complementarity is estimated using a 'Correlation' approach (Arora & Gambardella, 1994), whereas Objective complementarity is tested based upon the 'Supermodularity Theory' (Milgrom & Roberts, 1995), which has not been previously applied in the field of the CSR–innovation relationship.

Our dataset for the empirical analysis is built from the Community Innovation Survey (CIS) for Spain from 2009 to 2014 available in the Spanish Technology Innovation Panel (PITEC). We apply a panel data methodology. The results of this study, which confirm the existence of both behavioural and objective complementarity, are of interest for both practitioners and academics, because they provide interesting guidelines to design different combinations of CSR practices that have a positive impact on company innovation.

The paper presents the following structure. The second section presents previous related literature as well as the hypotheses development. In the third section, the methodological issues related to the method

applied, the source of data used and the measurements are compiled. Then, the empirical results are shown. Finally, the last part develops the conclusions, implications and future directions of research.

## 2. Background and hypotheses

The capacity of CSR activities to enhance innovation has been acknowledged in the literature (Magrizos et al. 2020; Belloc 2012, in; Santana & Cobo-Martín, 2020), and a positive impact of CSR on innovation has been empirically confirmed in several studies (i.e. Wagner 2010; Martínez-Conesa et al., 2017; Mahmoud & Hinson, 2012; García-Piqueres & García-Ramos, 2020). For example, Bacinello et al. (2020), based on a sample of Brazilian firms, found that the three CSR dimensions (economic, social and environmental) have a positive influence on the sustainable innovation of firms. Using survey data from Luxembourgish companies, Bocquet et al. (2017) also found a positive effect of CSR on firm innovation. From a survey for Spanish firms of the agribusiness sector, Briones et al. (2018) show the positive influence of CSR on innovation, as well as the mediation effect of cooperation on that relationship. However, other studies find a negative or even mixed relationship between CSR and firm innovation (Pan et al., 2021). For instance, Gallego-Álvarez et al. (2011) found a negative effect of CSR on the innovation performance of a sample of companies listed on the Dow Jones Sustainability Index, and conclude that the effect is dependent on the sector of activity. Costa et al. (2015) and Bocquet et al. (2013) found mixed evidence about the effect of CSR on innovation for a sample of Portuguese and Luxembourgish firms, respectively.

From a theoretical viewpoint, there is a 'lack of sound theoretical background, which hinders the full exploitation of the interactions between CSR and innovation' (Ratajczak & Szutowski, 2016, p. 309) and 'it seems that for the moment, the RBV is the only one that constituted a sound theoretical background for the scientific studies' (Ratajczak & Szutowski, 2016, p. 309). This theoretical approach gives support to the positive effect of CSR on the innovation performance of firms (García-Piqueres & García-Ramos, 2020), mainly based on 'how knowledge sharing and resource investment affect innovation outcomes' (Lin, 2020, p. 2).

The RBV (Barney, 1991; Hart, 1995; Hart & Dowell, 2011; Wernerfelt, 1984) focusses on the 'resources and capabilities that enable a firm to achieve superior performance and a sustainable competitive advantage' (Nair & Bhattacharyya, 2019, p. 106). Along this approach, CSR practices foster a firm's intangible resources, such as reputation, intellectual property and technology, and a firm's personnel-based resources, such as commitment, loyalty, knowledge and accumulation of expertise (Nair & Bhattacharyya, 2019; Taylor et al. 2018), which allow firms to sustain and maintain their advantages in competitive markets (Gallego-Álvarez et al., 2011; Taylor et al. 2018). CSR makes firms to foster their interactions with other agents (Jansen et al., 2006), whose knowledge is often incorporated into social responsible firms' practices (Gras-Gil et al., 2016), increasing the knowledge base of the firm (Luo & Du, 2015). All of this will result in new knowledge (Katila & Ahuja 2002), which is described in the literature as one of the most important resources of a firm (Müller et al., 2020), and which could allow firms to improve their innovation performance. Moreover, voluntary disclosure of CSR practices 'enhances engagement of stakeholders, such as investors and non-investor stakeholders, such as suppliers and employees, thereby improving access to capital (Cheng et al., 2014)' (Taylor et al., 2018, p. 973) and thus allowing firms to improve their innovation activity.

Regarding the CSR concept, although there are several definitions from different authors and entities, there exists an important consensus regarding its multidimensional conceptualization (Cegarra-Navarro et al., 2016; Gallagher et al., 2018; Ratajczak & Szutowski, 2016). In this sense, it is broadly accepted the TBL approach (see Fig. 1; Martínez-Conesa, Soto-Acosta, & Palacios-Manzano, 2017; Mühlbacher & Böbel, 2019; Vanelslander, 2016), from which 'CSR allows firms to show

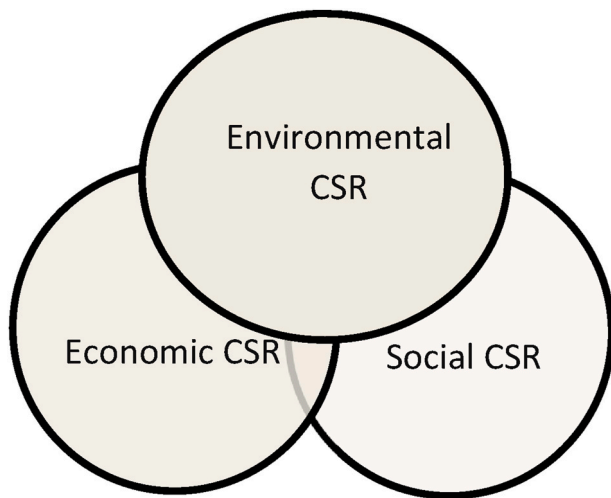


Fig. 1. TBL model  
Source: Own elaboration.

their commitment to economic, social, and environmental development' (García-Piqueres & García-Ramos, 2020; p. 804). In this vein, CSR 'implies that businesses have responsibilities beyond profit-seeking and must to conduct their businesses in a manner that meets also social and environmental standards according to the TBL (Elkington, 1994)' (Sánchez-Hernández et al., 2019; p. 1087).

The consideration of the different dimensions of CSR has been underexplored in previous empirical research analysing the CSR–innovation performance relationship. As Halme and Laurila (2009, p. 326) note, 'the way in which CSR is implemented will in all probability influence its outcomes'. Therefore, it is important to analyse 'not only whether companies practise corporate responsibility or not, but also what kind of responsibility they practise' (Halme & Laurila, 2009, p. 326). As 'firms can do well in some CSR dimensions and poorly on others' (Cavaco and Crifo, 2014, p. 4), all dimensions should be taken into account and should not be considered as a whole.

The economic dimension of CSR can be defined as the 'society expectations that the firm will be profitable in the long term [...] by producing and selling quality goods and services (Alvarado-Herrera et al., 2017; Curras-Pérez et al., 2018)' (in García-Piqueres & García-Ramos, 2020, p. 3). Regarding this dimension of CSR, firms' efficiency and efficacy makes firms to look for new process or products. Thus, innovation can allow firms to improve their competitiveness (Meinel et al., 2020), a core element of the economic dimension (González-Padrón et al., 2008).

The social dimension of CSR is focussed on 'the relationship of the firm with its socio-cultural environment' (Curras-Pérez et al., 2018, p. 735). It pays special attention to matters, such as the reduction of inequalities (Sánchez-Hernández et al., 2019), the avoidance of discrimination, the respect for human rights (Martín-Castejón & Aroca-López, 2016) or the improvement of the living and working conditions of the company employees (García-Piqueres & García-Ramos, 2020). CSR social practices improve firms' image and reputation (Cavazotte & Chang, 2016), increase customer loyalty (Magrizos et al., 2020) and have a positive effect on employees' sentiments (Cegarra-Navarro et al., 2016; García-Piqueres & García-Ramos, 2020). These issues will improve employee recruitment and retention, and will generate the attraction of the most talented and innovative people, and increase the loyalty, commitment and performance of employees (Guerrero-Villegas et al., 2018; Magrizos et al., 2020; McWilliams et al., 2006).

The environmental dimension of CSR 'refers to the impact that companies can have on nature, ecosystems, the Earth, air, and waste (Martín-Castejón & Aroca-López, 2016)' (in García-Piqueres & García-Ramos, 2020, p. 4), and it is focussed on the preservation of a healthy

environment (Sánchez-Hernández et al., 2019). Environmentally friendly processes and products make firms to be more innovative (Bocquet et al., 2013; García-Piqueres & García-Ramos, 2020). For instance, as Branco and Rodrigues (2006) explain, pollution prevention creates opportunities for the firm to innovate using less environmentally harmful materials, recycling, developing new processes, etc. In the same vein, McWilliams et al. (2006) conclude that the adoption of CSR environmental practices encourages R&D investments, thus increasing innovation.

### 2.1. Complementarity between CSR practices

Previous literature has defined complementarity as a synonym for fit and synergy (Schweiger et al., 2019). While fit refers to interrelationships between individual activities, synergy takes into account the possible superior returns from these interrelationships (Ennen & Richter, 2010; Schweiger et al., 2019).

Regarding the former, the existence of interrelationship between different activities implies that they are interrelated and share a 'common core' (Schweiger et al., 2019) that impulse firms to adopt them simultaneously (García-Piqueres et al., 2020). Therefore, the 'adoption of one practice entails the use of another mutual supportive activity' (Ozusaglam et al., 2018, p. 116). This interrelationship has been also called 'relatedness', 'complementarity in use' or 'behavioural complementarity' (Ballot et al., 2015; García-Piqueres et al., 2020; Hullova et al., 2016; Sabidussi et al., 2017).

Regarding the second, synergy refers to the fact that the joint adoption of different activities is associated with super-additive performance effects (Schweiger et al., 2019). What this means is that the performance effect of the joint adoption of different activities is greater than the sum of the performance effects of the adoption of each activity in isolation (Crifo et al., 2016). This effect has also been called 'complementarity in performance' or 'objective complementarity' (Hullova et al., 2019; Sabidussi et al., 2017).

Taking into account both effects, while behavioural complementarity postulates that economic, social and environmental CSR practices are interrelated, the objective complementarity suggests the generation of super-additive effect on innovation performance when different CSR practices are taken together. Whereas behavioural complementarity refers to the behaviour of the firms in the sense of whether they combine different CSR practices, the objective complementarity refers to the combination of CSR practices that gives better performance results to the firm. As previous research (Schweiger et al., 2019), we then delineate between them and assume that the former, behavioural complementarity, is a necessary but not a sufficient condition for the second, objective complementarity, or, in other words, the behavioural complementarity is understood as a prerequisite of objective complementarity (Schweiger et al., 2019).

The potential reasons behind the sources of both behavioural complementarity and objective complementarity between CSR practices are as follows. Regarding behavioural complementarity, it can emerge due to the common core shared by these practices. As has been previously exposed, from the TBL approach CSR refers to three core fields: economic, social and environmental. The European Commission (2011) also acknowledges the multidimensional nature of CSR. In the same vein, the European Commission (2006, p. 136) suggests that 'being socially responsible relates to how firms, beyond to legal requirements, accept to bear the cost of more ethical behaviour by voluntary committing, for instance to improving employment conditions, banning child labour and not working with countries that do not respect human rights, protecting the environment and investing in equipment to reduce their carbon footprint, developing partnerships with NGOs, providing funds to charity, etc.' (Crifo et al., 2016, p. 405). Although there are three different CSR dimensions, economic, social and environmental, they 'are not mutually exclusive' (Pan et al., 2021, p. 216). The economic, social and environmental dimensions of CSR are interconnected



when firms are looking for being ‘more ethical’ in the development of their activity, as they want to implement an effective CSR policy taking a multidimensional approach. Although each ‘CSR dimension may target one aspect of socially responsible action’ (Pan et al., 2021, p. 216), they will interact with each other to positively affect the firm global responsibility (Torugsa et al., 2013). In addition, firms are also expected to fulfil their economic, social and environmental responsibilities simultaneously (Branco & Rodrigues, 2006) and the three CSR dimensions should be integrated in order to achieve the sustainable development of the firm (Bansal, 2005). Then, the common core of these practices makes them to be interrelated, thus determining their joint adoption (Miravete and Pernías, 2010).

From this view, the three CSR dimensions can be considered as a set of interdependent practices, where each practice complements each other. Taking into account these arguments, we proposed the following hypothesis:

**H1.** Economic, social and environmental CSR will be complementary in behaviour.

Following with objective complementarity, it appears if and only if the performance effects of the practices’ combination are higher than the separate performance effects of them (Ballot et al., 2015). In Crifo et al.’s (2016; p. 407) words, ‘adopting more than one CSR practice creates a complementary effect if the magnitude of the performance effect of these management practices altogether is strictly larger than the sum of the marginal effects from adopting only one practice’. Along this line, the RBV can serve as an interesting framework to explain the sources of this superior performance. The RBV argues that joint adoption of different practices allows integrating several activities that mutually reinforce each other (Porter, 1996; Siggelkow, 2001), thus developing resources that generate competitive advantages (Barney, 1991; Hervas-Oliver et al., 2018). Therefore, synergies from the combination of resources and capabilities can be used to explain superior firm performance (i.e.: Song et al., 2005; Tanriverdi & Venkatraman, 2005; Schweiger et al., 2019). Within this view, the adoption and combination of different CSR practices may provide distinctive competencies making firms to outperform other organizations (Damanpour et al., 2009). Along this line, managerial choices can be designed to create performance advantages by synchronizing resources (Schweiger et al., 2019), based upon the synergistic effect that exists when firms adopt different CSR practices together (Crifo et al., 2016). This framework proposes that the construction of strong relations with primary stakeholders (employees, customers, suppliers, or communities) could facilitate the conflict-resolution process by reducing conflicts between various stakeholders, yield long-term competitive advantages (Crifo et al., 2016), help to acquire resources that are critical for the sustainable growth and survival of the firm (Magrizos et al., 2020), and, thus, assure long-term success of organizations (Mithani, 2017). In this same vein, Branco and Rodrigues (2006) explain that the economic dimension of CSR is fundamental for the others CSR dimensions. First, from a social and environmental point of views, the economic responsibility of the firm is of great importance, as it is acknowledged by the sustainable development notion (Branco and Rodrigues, 2006). In addition, shareholders are also stakeholders of the firm and the firm must look for their interest as for the rest of stakeholders (Branco and Rodrigues, 2006). Last, but not the least, the social and the environmental dimensions of CSR will depend on the fulfilment of economic responsibilities ‘in the sense that the survival of the firm and availability of sufficient resources to devote to other responsibilities depends on such fulfilment’ (Branco & Rodrigues, 2006, p. 114).

Taking into account these arguments, we expect that the joint effect of economic, social and environmental CSR practices on firm innovation will be higher than the individual effect of each type of CSR practice. According to this expectation, our hypothesis is stated as follows:

**H2.** Economic, social and environmental CSR will be complementary

in objective.

### 3. Data source, variables and method

#### 3.1. Data source

The empirical part runs on the CIS for Spain between 2009 and 2014, which is available in the Technological Innovation Panel (PITEC), and collected by the Spanish National Statistics Institute (INE). The PITEC data are representative of the Spanish firms’ population. The CIS is an official survey of the European Commission and Eurostat, conducted in several European Union Member States. It develops insights into private organizations’ innovation behaviour. The use of CIS data has a long-standing tradition in innovation economics (Archibugi et al., 2013; Belderbos et al., 2004; Cassiman & Veugelers, 2002; Czarnitzki & Toole, 2011; Hashi & Stojčić, 2013) and innovation management (Andries & Faems, 2013; Faems et al., 2010; Frenz & Ietto-Gillies, 2009; Klingebiel & Rammer, 2014; Laursen & Salter, 2006; Leiponen & Helfat, 2010; Schweitzer et al., 2015)” (Andries et al., 2019; p.283). The CIS survey follows the methodological framework of the *Oslo Manual* (1997; 2005), where CIS questions and methods of the survey are described. Piloting and pre-tests across different European countries ensure the reliability, validity and interpretability of the data survey (Ovuakporie et al., 2021). With the six consecutive waves of the abovementioned survey (2009–2014), we construct an unbalanced panel of firms. After cleaning the data, we have a sample size of 57,008<sup>1</sup> of both manufacturing and services firms.

#### 3.2. Variables and methods

In order to test the hypotheses, several empirical methods have been developed. Our approach is built on a broad perspective about complementarities. In more concrete terms, as we focus on two types of complementarities (behavioural and objective) identified in previous literature (Ballot et al., 2015; Hullova et al., 2019; Ozusaglam et al., 2017), we employ two different types of methods in order to test them.

##### 3.2.1. Behavioural complementarity

Behavioural complementarity (H1) is tested using a ‘correlation’ approach (i.e. Ozusaglam et al., 2018; García-Piqueres et al., 2020). This method tests the conditional correlation between two practices on other factors and is based on the work of Arora and Gambardella (1994). In particular, for testing behavioural complementarity, we follow two steps:

STEP 1:

1. We regress each CSR practice (Economic<sub>it</sub>, Social<sub>it</sub>, Environmental<sub>it</sub>) on a set of explicative variables related to innovation using a probit random effects estimation. Using panel data allows to control for heterogeneity, as well as the non-detectable effects from cross-section or time-series data (Hsiao, 1985, 1986; Klevmarken, 1989; Solon, 1989; Baltagi, 2002). Regarding the use of random effects instead of fixed-effect, it avoids the ‘incidental parameter’ problem<sup>2</sup> (Hsiao, 1986). Our specification is as follows:

$$\text{Probit } (p(\text{Economic}^*_{it})) = \beta_0 + \beta_1 C_{it} + \beta_2 Z_{it} + \epsilon_{it} + \alpha_i \quad (1)$$

$$\text{Probit } (p(\text{Social}^*_{it})) = \beta_0 + \beta_1 C_{it} + \beta_2 Z_{it} + \epsilon_{it} + \alpha_i \quad (2)$$

$$\text{Probit } (p(\text{Environmental}^*_{it})) = \beta_0 + \beta_1 C_{it} + \beta_2 Z_{it} + \epsilon_{it} + \alpha_i \quad (3)$$

<sup>1</sup> Ten thousand seven hundred ninety-six firms in 2009 (18.94 %); 10,380 firms in 2010 (18.21 %); 9977 firms in 2011 (17.50 %); 9612 firms in 2012 (16.86 %); 9172 firms in 2013 (16.09 %) and 7071 firms in 2014 (12.40 %).

<sup>2</sup> In addition, in order to decide between fixed or random effects we run a Hausman test whose results support the use of random effects (Green, 2008).

where  $p(\text{Economic}^*_{it}/\text{Social}^*_{it}/\text{Environmental}^*_{it})$  represents the probability of implementing CSR practices (economic, social or environmental) for firm  $i$  at time  $t$ . Independent variables are captured in the vector,  $C_{it}$  and  $Z_{it}$ , are the controls.

*Dependent variable*

We construct three variables related to CSR, each of them measuring one of the three dimensions of CSR described by the TBL approach: economic, social and environmental. These measures are based upon the combination of the CSRConPerScale developed by Alvarado-Herrera et al. (2017) with other items used by previous literature (i.e. Kim et al., 2012; Chowdhury et al., 2018). In the construction of these variables ‘CSR is treated as policies and activities that go beyond mandatory obligations, such as economic responsibility (being profitable) and legal responsibility (obeying the legislation and adhering to regulation)’ (Halme & Laurila, 2009, p. 327), and we are consistent with the CSR actions type described by Halme and Laurila (2009) as CSR integration<sup>3</sup> and CSR innovation.<sup>4</sup> To test for complementarities, these variables have been coded in 0 and 1, in line with most of the previous relevant and recent research in the innovation complementarity research field (i. e. Cassiman & Veugelers, 2006; Ballot et al., 2015; Guisado-González et al., 2017; Serrano-Bedia et al., 2018):

- *Economic CSR (Economic<sub>it</sub>)*: The CSR economic dimension allows firms to improve their processes (efficiency) or to find new forms of responding customer demands (efficacy) (García-Piqueres & García-Ramos, 2020). Based upon this theoretical basis of the concept, *Economic<sub>it</sub>* is constructed as a dummy variable that takes value 1 if the firm improved the products’ quality (goods and services), and/or increased the production capacity, and/or increased the flexibility of production and/or increased the market share, and 0 in other case.
- *Social CSR (Social<sub>it</sub>)*: The social CSR dimension refers to ‘practices aimed at hiring people in danger of social exclusion, improving employees’ living and working conditions (i.e. reconciling professional and social life, protecting employees’ health, and work safety), involvement with the professional development of employees, maintenance and improving standards of living and supporting social issues, and avoiding discrimination and violations of human rights (Martín-Castejón & Aroca-López, 2016)’ (García-Piqueres & García-Ramos, 2020; p. 4). Taking into account this definition of the concept, and due to the limitations of the data used (Haus-Reve et al., 2019), which only collected information about those social CSR practices related to the employees’ working and living conditions, *Social<sub>it</sub>* is a dummy variable that takes value 1 if the firm has improved the health and safety workplace conditions, and/or maintained employees, and/or increased the employees, and/or created qualified employees, and 0 in other case.
- *Environmental CSR (Environmental<sub>it</sub>)*: Environmental CSR practices are related to ‘making the optimum use of natural resources; improving waste management; minimizing ecological externalities in production processes; promoting eco-friendly products; and/or introducing processes to reduce pollution, resource depletion, and even environmental damage, among others (Choi & Ng, 2011) with the aim of reducing the impact that companies can have on nature, ecosystems, the Earth, air, and waste (Martín-Castejón & Aroca-López, 2016)’ (García-Piqueres & García-Ramos, 2020; p. 4). Based upon this theoretical basis of the concept, *Environmental<sub>it</sub>* is a dummy variable that takes value 1 if the firm has decreased the environmental impact, and/or the materials, and/or the energy consumption, and 0 in other case.

*Independent variables*

Independent variables related to the innovation activities of firms have being constructed based upon previous research (Belderbos et al., 2004; Fontana et al., 2006; García-Piqueres et al., 2020; García-Piqueres & García-Ramos, 2020; Guisado-González et al., 2017; Karlsson & Tavassoli, 2016; Serrano-Bedia et al., 2018):

- *Internal R&D expenditures (Internalrd<sub>it</sub>)*: This is a dummy variable that takes value 1 if the firm  $i$  has engaged in internal R&D expenditures in year  $t$ , and 0 otherwise (García-Piqueres et al., 2020; García-Piqueres & García-Ramos, 2020; Karlsson & Tavassoli, 2016).
- *External R&D expenditures (Externalrd<sub>it</sub>)*: This is a dummy variable that takes value 1 if the firm  $i$  has engaged in external R&D expenditures in year  $t$ , and 0 otherwise (García-Piqueres et al., 2020; García-Piqueres & García-Ramos, 2020; Karlsson & Tavassoli, 2016).
- *Training expenditures (Training<sub>it</sub>)*: This is a dummy variable that takes value 1 if the firm  $i$  has engaged in expenditures for employee training in year  $t$ , and 0 otherwise (García-Piqueres et al., 2020; García-Piqueres & García-Ramos, 2020; Karlsson & Tavassoli, 2016).
- *Machinery acquisition expenditures (Machinery<sub>it</sub>)*: This is a dummy variable that takes value 1 if the firm  $i$  has engaged in expenditures for the acquisition of machinery, equipment or software in year  $t$ , and 0 otherwise (García-Piqueres et al., 2020; García-Piqueres & García-Ramos, 2020; Karlsson & Tavassoli, 2016).
- *Market introduction expenditures (Market<sub>it</sub>)*: This is a dummy variable that takes value 1 if the firm  $i$  has engaged in expenditures for the introduction of innovation in the markets in year  $t$ , and 0 otherwise (García-Piqueres et al., 2020; García-Piqueres & García-Ramos, 2020; Karlsson & Tavassoli, 2016).
- *External knowledge acquisition expenditures (Externalknowledge<sub>it</sub>)*: This is a dummy variable that takes value 1 if the firm  $i$  has engaged in expenditures for external knowledge or have collaborated with other agents in year  $t$ , and 0 otherwise (García-Piqueres et al., 2020; García-Piqueres & García-Ramos, 2020; Karlsson & Tavassoli, 2016).
- *Cooperation (Cooperation<sub>it</sub>)*: This is a dummy variable that takes value 1 if the firm  $i$  has collaborated with other agents in year  $t$ , and 0 in any other case (García-Piqueres et al., 2020; García-Piqueres & García-Ramos, 2020; Karlsson & Tavassoli, 2016).
- *R&D employees (Rdpersonnel<sub>it</sub>)*: This is measured as the proportion of R&D employees over the total number of employees in the year  $t$  as

**Table 1**  
Descriptive statistics.

Variable	Mean	S.D.
Economic <sub>it</sub>	0.691	0.461
Social <sub>it</sub>	0.465	0.498
Environmental <sub>it</sub>	0.510	0.499
Radical <sub>it</sub>	0.074	0.201
Incremental <sub>it</sub>	0.101	0.242
CSR000	0.180	0.384
CSR100	0.108	0.310
CSR010	0.011	0.105
CSR001	0.009	0.099
CSR110	0.032	0.176
CSR101	0.063	0.244
CSR011	0.007	0.085
CSR111	0.265	0.441
Internalrd <sub>it</sub>	0.429	0.495
Externalrd <sub>it</sub>	0.204	0.403
Training <sub>it</sub>	0.106	0.308
Machinery <sub>it</sub>	0.130	0.336
Market <sub>t</sub>	0.161	0.367
Externalknowledge <sub>it</sub>	0.015	0.122
Rdpersonnel <sub>it</sub>	0.103	0.243
Cooperation <sub>it</sub>	0.123	0.328
Openness <sub>it</sub>	24.144	7.564
Exportations <sub>it</sub>	7.594	54.917
Group <sub>it</sub>	0.424	0.494
Size <sub>it</sub>	4.066	1.762

<sup>3</sup> In Halme and Laurila (2009, p. 329) words, ‘CSR Integration: emphasis on conducting existing business operations more responsibly’.

<sup>4</sup> In Halme and Laurila (2009, p. 329) words, ‘CR Innovation: emphasis on developing new business models for solving social and environmental problems’.

**Table 2**  
Pair-wise correlations between independent variables.

	1	2	3	4	5	6	7	8
1. Internalrd <sub>it</sub>								
2. Externalrd <sub>it</sub>	0.450***							
3. Training <sub>it</sub>	0.237***							
4. Machinery <sub>it</sub>	0.134	0.130***	0.310***					
5. Market <sub>it</sub>	0.359***	0.233***	0.266***	0.235***				
6. Externalknowledge <sub>it</sub>	0.058***	0.083***	0.164***	0.148***	0.115***			
7. Rdpersonnel <sub>it</sub>	0.489***	0.260***	0.121***	0.014***	0.145***	0.025***		
8.Cooperation <sub>it</sub>	0.283***	0.253***	0.142***	0.099***	0.125***	0.058***	0.177***	
9. Openness <sub>it</sub>	0.453***	0.331***	0.186***	0.082***	0.212***	0.072***	0.253***	0.242***
10. Exportations <sub>it</sub> <sup>a</sup>	0.112***	0.0555*	0.008	-0.0051	0.037**	0.006	0.068***	0.066***
11. Group <sub>it</sub>	0.083***	0.127***	0.061***	0.089***	0.066***	0.046***	-0.079***	0.121***
12. Size <sub>it</sub> <sup>a</sup>	0.081***	0.126***	0.102***	0.151***	0.097***	0.076***	-0.201***	0.103***
13. CSR000	-0.053***	-0.036***	-0.065***	-0.022***	-0.052***	0.022***	-0.007***	-0.016***
14. CSR100	0.122***	0.039***	0.074***	0.104***	0.066***	0.030***	0.083***	0.039***
15. CSR010	0.071***	0.037***	0.005	-0.0003	0.022***	0.001***	0.069***	0.025***
16. CSR001	0.038***	0.032***	0.014***	0.0334*	0.0143*	0.0035	0.008***	0.014***
17. CSR110	0.111***	0.080***	0.090***	0.060***	0.065***	0.027***	0.080***	0.057***
18. CSR101	0.134***	0.071***	0.045***	0.069***	0.078***	0.027***	0.028***	0.044***
19. CSR011	0.048***	0.036***	0.006	0.018***	0.005	0.006	0.023***	0.022***
20. CSR111	0.438***	0.282***	0.188***	0.155***	0.239***	0.059***	0.186***	0.198***

\*p < 0.05; \*\*p < 0.01; \*\*\*p < 0.001.  
aLogarithmized variables.

in the previous research (Belderbos et al., 2004; Fontana et al., 2006; Serrano-Bedia et al., 2018).

- *Openness* (*Openness<sub>it</sub>*): This is measured based on the items of the survey related to the importance given by firms (on a scale from 1 to 4) to the use of a diversity of external knowledge sources from different partners (providers, clients, competitors, consultants, laboratories, private institutes, universities, public research organizations, technological centres, conferences, meetings, publications and trade shows). For the construction of *Openness<sub>it</sub>*, we subsequently sum the scores about the importance given by firms to the above external knowledge sources, in the same way as in the work of Guisado-González et al. (2017).

**Control variables**

With the aim of controlling for firm-level heterogeneity, control variables are used as in the previous research (i.e.: Karlsson & Tavassoli, 2016; Criscuolo et al., 2017). We control for firm characteristics with the following variables:

- *Export* (*Exportations<sub>it</sub>*): As in the works of Guisado-Gonzalez et al. (2017), Serrano-Bedia et al. (2018), García-Piqueres and García-Ramos (2020) and García-Piqueres et al. (2020), this is measured as the proportion of the total turnover from exports for firm i in year t.
- *Group size* (*Group<sub>it</sub>*): This is measured following previous research (i.e. Catozzella & Vivarelli, 2014; Criscuolo et al., 2017; García-Piqueres & García-Ramos, 2020) as a dummy variable that takes value 1 if the firm i belongs to a group in year t, and 0 in any other case.
- *Firm size* (*Size<sub>it</sub>*): This is the logarithm of the number of firm’s employees in year t, in line with previous research in the innovation field (i.e. Carboni & Russu, 2018; Catozzella & Vivarelli, 2014; Criscuolo et al., 2017; Hervás-Oliver et al., 2017; Karlsson & Tavassoli, 2016). This variable has been logarithmized to minimize kurtosis (Hernandez-Linares et al., 2018).
- *Industry*: Industry (NACE classification) dummy variables are included.
- *Time*: Time-specific dummy variables are included.

**STEP 2:**

2. We test the correlation between the residuals of these previous estimated regressions. This method consists on carrying out pair-

wise correlations between the coefficients obtained from the estimations of the CSR dimensions after controlling for specific variables effects. Positive and significant correlations suggest the existence of behavioural complementarity between economic, social and environmental CSR. Following Wursten (2017) research, we apply a new Stata command (pwcorrff) more appropriate to test for correlation across panel units, that is ‘more convenient/flexible/efficient than existing commands’ (Wursten, 2017), and allows to provide the robust tests.

**3.2.2. Objective complementarity**

The analysis of the objective complementarity (H2) is based upon the supermodularity theory (Milgrom & Roberts, 1995). From this perspective, complementarity is more than the association between practices and occurs if ‘the total economic value added by combining two or more complementary factors – resources – in a production system therefore exceeds the value that would be generated by applying these production factors – resources – in isolation’ (Ennen & Richter, 2010, p. 2008; Ozusaglam et al., 2017). In our case, if objective complementarity exists, the innovation performance derived from using one CSR practice will be higher if the complementary practice is present at the same time than if it is not present. Following Mohnen and Roller (2005), we will test whether the innovation function is supermodular, what will occur if and only if the co-occurrence of two activities provides higher increasing returns on performance than occurrence of the activities in isolation, based upon the following two steps:

**STEP 1:**

1. We test the direct effect of CRS on innovation with a basic regression model, which takes the following form:

$$\text{Radical}^*_{it} = \beta_0 + \beta_1 C_{it} + \beta_2 Z_{it} + \epsilon_{it} + \alpha_i \tag{4}$$

$$\text{Incremental}^*_{it} = \beta_0 + \beta_1 C_{it} + \beta_2 Z_{it} + \epsilon_{it} + \alpha_i \tag{5}$$

Where *Radical\*<sub>it</sub>* and *Incremental\*<sub>it</sub>* represent the proportion of firm’s i turnover due to ‘new to the market’ and ‘new to the firm’ innovations in year t, respectively. Firm CSR is captured by *C<sub>it</sub>* and *Z<sub>it</sub>* includes the control variables.

**Dependent variable**

Innovation performance is taken as a dependent variable. Following previous literature (i.e. Domínguez-Escrig et al., 2019; Haus-Reve et al.,

	9	10	11	12	13	14	15	16	17	18	19
0.044***											
0.079***	0.0008										
0.105***	-0.073***	0.446***									
-0.523***	0.0046	-0.021***	-0.040***								
-0.051***	0.0124*	-0.0080*	-0.008**	-0.163***							
0.035***	0.005	0.005	-0.013***	-0.050***	0.037***						
-0.009*	-0.0013	0.012***	0.015***	-0.047***	-0.034***	-0.010**					
0.077***	0.0063	0.0060	0.014***	-0.085***	-0.063***	-0.019***	-0.018***				
0.059***	-0.005	0.047***	0.050**	-0.122***	-0.090***	-0.027***	-0.026***	-0.047***			
0.021***	0.003***	0.021***	0.014***	-0.040***	-0.029***	-0.009**	-0.006**	-0.015*	-0.022*		
0.431***	0.051***	0.086***	0.094***	-0.282***	-0.209***	-0.064*	-0.060***	-0.109***	-0.156***	-0.051***	

2019; Gimenez-Fernandez et al., 2020; Foucart & Cher Li, 2021; Ovuakpoire et al., 2021), two well established innovation performance measures are used: radical and incremental innovation performance:

- Radical innovation performance (Radical<sub>it</sub>): This is measured as the proportion of the firm’s turnover related to products and services that are new to the market.
- Incremental innovation performance (Incremental<sub>it</sub>): This is measured as the proportion of firm’s turnover related to product and services that are new to the firm, but not new to the market.

Taking these two measures of innovation performance allow us to test whether there exist differences on the CSR–innovation link depending on the degree of novelty involved in innovation (Ovuakpoire et al., 2021). On the one hand, radical innovations are more explorative as they are related to the process of introducing a new products or services to the market for the first time, normally at the beginning of a new technology life cycle (Foucart & Cher Li, 2021; Haus-Reve et al., 2019). On the other hand, incremental innovations are more exploitative, and occur at the technological frontier within a product life cycle (Foucart & Cher Li, 2021).

*Independent variables*

From economic (Economic<sub>it</sub>), social (Social<sub>it</sub>) and environmental (Environmental<sub>it</sub>) CSR, we construct the independent variables for the study of objective complementarities. The independent variables measure these three CSR practices – economic, social and environmental – and all their exclusive combinations. Therefore, eight exclusive CSR practices are empirically analysed:

- CSR000: 1 if the firm did not apply economic, social and environmental CSR dimensions, and 0 in other case.
- CSR100: 1 if the firm only applied economic CSR and 0 in other case.
- CSR010: 1 if the firm only applied social CSR and 0 in other case.
- CSR001: 1 if the firm only applied environmental CSR and 0 in other case.
- CSR110: 1 if the firm applied economic and social CSR, and 0 in other case.
- CSR101: 1 if the firm applied economic and environmental CSR, and 0 in other case.
- CSR011: 1 if the firm applied social and environmental CSR practices, and 0 in other case.
- CSR111: 1 if the firm applied economic, social and environmental CSR, and 0 in other case.

*Control variables*

With the aim of controlling for firm-level heterogeneity, control variables are used as in the previous research (i.e. Karlsson & Tavassoli, 2016; Criscuolo et al., 2017). We first control for those variables related to the innovation activities of firms: internal R&D expenditures (Internalrd<sub>it</sub>), external R&D expenditures (Externalrd<sub>it</sub>), training expenditures (Training<sub>it</sub>), machinery acquisition expenditures (Machinery<sub>it</sub>), market introduction expenditures (Market<sub>it</sub>), external knowledge acquisition expenditures (Externalknowledge<sub>it</sub>) and cooperation (Cooperation<sub>it</sub>), R&D employees (Rdpersonnel<sub>it</sub>), openness (Openness<sub>it</sub>). Second, we control for firm characteristics with the variables of export (Exports<sub>it</sub>), group (Group<sub>it</sub>), size (Size<sub>it</sub>) and industry and time dummies.

STEP 2:

2. We establish an objective function. X<sub>1</sub>, X<sub>2</sub> and X<sub>3</sub> represent the three CSR dimensions, Z represents the exogenous variables and e is the error term:

$$F(X_1, X_2, X_3, Z) = \beta_{000} (1-X_1)(1-X_2)(1-X_3) + \beta_{100} X_1(1-X_2)(1-X_3) + \beta_{010} (1-X_1)X_2(1-X_3) + \beta_{001} (1-X_1)(1-X_2)X_3 + \beta_{110} X_1X_2(1-X_3) + \beta_{101} X_1(1-X_2)X_3 + \beta_{011} (1-X_1)X_2X_3 + \beta_{111} X_1X_2X_3 + \beta_Z Z + e \tag{6}$$

This model has been tested using a Tobit specification, whose basic regression model takes the same form as equations (4) and (5). As previous literature suggests, in no linear models, the effect of interaction variables can be function not only of the coefficient, but also can differ across observations. Then, the best approach to directly test the effect of complementarities is to investigate whether the innovation function is supermodular (Mohnen & Roller, 2005).

We carry out complementarity tests using the coefficients estimated in the previous step (regressions (4) and (5) of the direct effect of CSR on innovation). In doing so, we follow previous research by Ballot et al. (2015), Serrano-Bedia et al. (2018) or Ozusaglam et al. (2018) that tests for conditional complementarity. This procedure consists on carrying out pair-wise complementarity test between two CSR practices conditioned first on the absence of the third CSR practice and second on the presence of the third CSR practice.

More precisely, let ‘f’ be a function of the three alternative CSR dimensions: X<sub>1</sub> (economic), X<sub>2</sub> (social) and X<sub>3</sub> (environmental).

Firms can be involved in each of the three CSR dimensions: (X<sub>j</sub> = 1) or not (X<sub>j</sub> = 0) and j ∈ {1, 2, 3}.

There are 2<sup>3</sup> possible combinations of these three CSR activities: C {X<sub>1</sub>X<sub>2</sub>X<sub>3</sub>} = [{000}, {001}, {010}, {100}, {011}, {110}, {101} and



**Table 3**

Results of random effects probit estimations (marginal effects). Dependent variables: Economic<sub>it</sub>, Social<sub>it</sub> and Environmental<sub>it</sub> CSR.

	Economic <sub>it</sub>	Social <sub>it</sub>	Environmental <sub>it</sub>
Internalrd <sub>it</sub>	0.581 (0.047)***	0.509 (0.047)***	0.504 (0.047)***
Externalrd <sub>it</sub>	-0.068 (0.043)	0.008 (0.039)	-0.049 (0.040)
Rdpersonnel <sub>it</sub>	-0.170 (0.086)*	-0.065 (0.087)	-0.014 (0.086)
Cooperation <sub>it</sub>	-0.084 (0.051)	-0.041 (0.046)	-0.023 (0.048)
Openness <sub>it</sub>	0.145 (0.003)***	0.135 (0.003)***	0.137 (0.003)***
Exportations <sub>it</sub>	0.002 (0.013)	0.007 (0.012)	0.002 (0.012)***
Group <sub>it</sub>	0.036 (0.053)	0.142 (0.051)***	0.196 (0.052)***
Size <sub>it</sub>	0.063 (0.021)***	0.049 (0.021)**	0.117 (0.021)***
Sector dummies	Included	Included	Included
Time dummies	Included	Included	Included
Constant	-4.2963 (0.5688)***	-3.6669 (0.5938)***	-5.4401 (0.6509)***
Σ	1.284 (0.0534)	1.357 (0.032)	1.381 (0.033)
P	0.622 (0.012)	0.648 (0.010)	0.656 (0.011)
Wald chi <sup>2</sup>	2253.62***	2270.97***	2366.13***
Log-likelihood	-7198.642	-8854.4179	-8358.3822

\*\*\*, \*\* and \* refer to the 1%, 5% and 10% significance levels, respectively.

{111}], where {000} refers to non-adoption of any CSR activity and {111} refers to adoption of all the three CSR activities.

The complementarity conditions for complementarity are as follows:

For complementarity between economic and social CSR:

$$\begin{cases} f(110)+f(000) \geq f(100)+f(010) & \text{(in the absence of Environmental CSR)} \\ f(111)+f(001) \geq f(011)+f(101) & \text{(in the presence of Environmental CSR)} \end{cases}$$

For complementarity between economic and environmental CSR:

$$\begin{cases} f(101) + f(000) \geq f(100) + f(001) & \text{(in the absence of Social CSR)} \\ f(111) + f(010) \geq f(110) + f(011) & \text{(in the presence of Social CSR)} \end{cases}$$

And for complementarity between environmental and social CSR:

$$\begin{cases} f(011) + f(000) \geq f(010) + f(001) & \text{(in the absence of Economic CSR)} \\ f(111) + f(100) \geq f(110) + 101 & \text{(in the presence of Economic CSR)} \end{cases}$$

Both Radical\*<sub>it</sub> and Incremental\*<sub>it</sub> are double-censored variables and bounded between 0 and 1. Thus, we use a Tobit model as was featured in the previous research (e.g. Haus-Reve et al., 2019; Ovuakporie et al., 2021). In order to control for possible inconsistent results derived from the assumption of normality of residuals, a robustness check is developed. Following Laursen and Salter (2006) and Ovuakporie et al. (2021), we take log-transformation with a constant added to original values of Radical\*<sub>it</sub> and Incremental\*<sub>it</sub>. Then, we apply the Tobit method to the converted variables.

Finally, and given the potential reverse causality and simultaneity

**Table 4**

Behavioural complementarity: correlations between residuals.

	Economic <sub>it</sub>	Social <sub>it</sub>
Economic <sub>it</sub>		
Social <sub>it</sub>	0.86962051***	
Environmental <sub>it</sub>	0.86738221***	0.95328429***

\*\*\* refers to the 1 % significance level.

between innovation and CSR,<sup>5</sup> and in order to control for the possible endogeneity, we adopt the following strategy based upon the previous research (Haus-Reve et al., 2019; Foucart & Cher Li, 2021; Wu et al., 2021). On one hand, we use a range of control variables that are expected to impact on both innovation and CSR. As shown in Table 1, these variables are Internalrd<sub>it</sub>, Externalrd<sub>it</sub>, Cooperation<sub>it</sub>, Exportations<sub>it</sub>, Group<sub>it</sub> and Size<sub>it</sub>. On the other hand, as in the previous research (e.g. Tavassoli, 2018; Wu et al., 2021), we use lagged independent variables (Hamilton & Nickerson, 2003; Haus-Reve et al., 2019).<sup>6</sup>

Descriptive statistics of all the variables are displayed in Table 1. For all the variables, we have indicated to test which hypotheses (H1 and H2) each variable is included.

Table 2 presents the pair-wise correlations between the independent variables of our study. All correlation coefficients were smaller than the recommended threshold of 0.65 (Tabachnick & Fidell, 2012) and all the variance inflation factors range between 1.03 and 2.71, and all condition indexes are lower than 30 (Myers, 1990). These results allow us to conclude that multicollinearity does not appear to be a serious concern.

## 4. Results and discussion

### 4.1. Behavioural complementarity

Beginning with the analysis of behavioural complementarities, Table 3 shows the regressions of each CSR practice on a set of variables using a probit random effects estimation. The chi<sup>2</sup> confirms the global statistical significance of the model. These results are not the objective of the paper, but since the residual of these regressions are used to test for correlations, they can be briefly summarized as follows. Differences between economic, social and environmental CSR exit, but for the majority of the explicative variables, the effect is similar on either the CSR dimension considered. Beginning with independent variables related to the firm’s innovation activities, both Internalrd<sub>it</sub> and Openness<sub>it</sub> exert a

<sup>5</sup> Although we focus on the CSR–innovation link, the bidirectional relationship between innovation and CSR has been outlined in the previous research (Gallego-Alvarez et al., 2011; Jain & Krishnapriya, 2020). The alternative effect of that studied on our paper, which is the effect of innovation on CSR, has been also empirically approached by previous literature (e.g. Gallego-Alvarez et al., 2011; Jain & Krishnapriya, 2020). The main theoretical arguments behind the effect of innovation on CSR can be found on the RBV that highlights the importance of non-replicable tangible and intangible resources for CSR (Jain & Krishnapriya, 2020). Along this line, different channels for innovation promoting CSR are suggested. On one hand, intangible resources generated by R&D investment can make firms more flexible in technological terms, which will allow the incorporation of customer preferences into the design of goods produced (Gallego-Alvarez et al., 2011). This increases product quality, and then customer satisfaction and firm’s reputation, which is a prerequisite for CSR (Jain & Krishnapriya, 2020; Prior et al., 2009). On the other hand, innovation-driven CSR can be also conducted by the creation of innovation processes that allow firms to be more socially responsible (Gallego-Alvarez et al., 2011).

<sup>6</sup> Although the use of instrumental variables has also been applied in order to control for reverse causality in the previous research, this method has been proved not being suitable for our data. Along this line, using instrumental variable regression has generally ‘proved unsuccessful in research using CIS data (Mohnen & Roller, 2005; Cassiman & Veugelers, 2006), due to the lack of strong exogenous instruments’ (Haus-Reve et al., 2019, p. 1480).



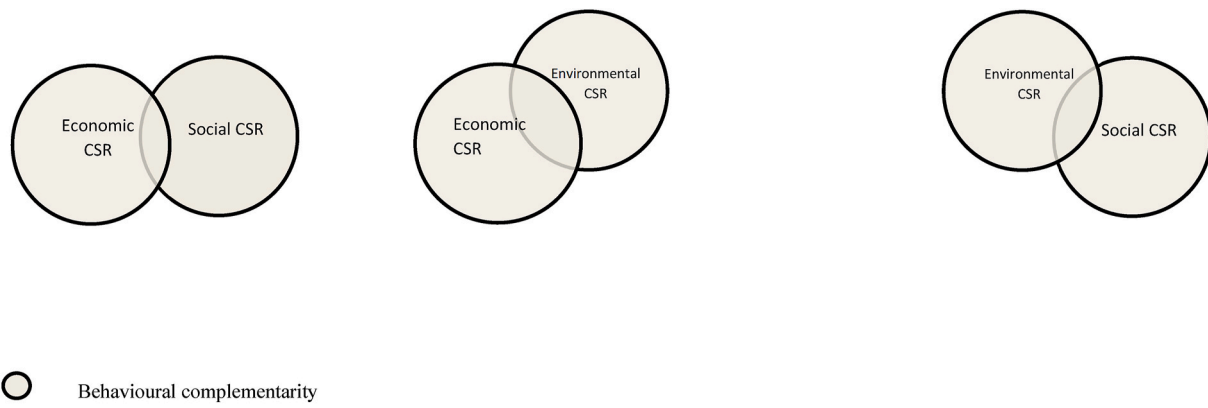


Fig. 2. Behavioural complementarity between the CSR dimensions of the TBL (economic, social and environmental) for each pair-wise correlations between residuals Source: Own elaboration based upon García-Piqueres et al. (2020).

**Table 5**  
Results of Tobit estimations. Dependent variables: for  $Radical_{it}$ , Log transformation of  $Radical_{it}$ ,  $Incremental_{it}$ , Log transformation of  $Incremental_{it}$ .

	(1) $Radical_{it}$	(2) Log transformation of $Radical_{it}$	(3) $Incremental_{it}$	(4) Log transformation of $Incremental_{it}$
$Internalrd_{it}$	0.045 (0.004)***	0.036 (0.003)***	0.033 (0.005)***	0.028 (0.003)***
$Externalrd_{it}$	0.005 (0.003)	0.004 (0.002)	-0.002 (0.004)	-0.0006 (0.003)
$Training_{it}$	0.003 (0.004)	0.004 (0.003)	-0.011 (0.005)**	-0.005 (0.004)
$Machinery_{it}$	-0.002 (0.004)	-0.001 (0.002)	0.007 (0.005)	0.005 (0.0036)
$Market_t$	0.046 (0.003)***	0.036 (0.002)***	0.059 (0.004)***	0.045 (0.003)***
$Externalknowledge_{it}$	0.006 (0.011)	0.005 (0.008)	-0.028 (0.014)**	-0.018 (0.010)*
$Cooperation_{it}$	0.016 (0.004)***	0.013 (0.003)***	0.013 (0.005)**	0.011 (0.003)***
$Exportations_{it}$	0.003 (0.001)***	0.002 (0.0008)***	0.0007 (0.001)	0.0006 (0.0009)
$Group_{it}$	-0.006 (0.004)	-0.004 (0.003)	-0.004 (0.005)	-0.003 (0.003)
$Size_{it}$	-0.0005 (0.001)	-0.0001 (0.001)	0.003 (0.002)**	0.003 (0.001)**
$CSR000_{(i, t-1)}$	0.031 (0.005)***	0.023 (0.003)***	0.068 (0.006)***	0.050 (0.004)***
$CSR100_{(i, t-1)}$	0.038 (0.006)***	0.030 (0.004)***	0.098 (0.008)***	0.073 (0.005)***
$CSR010_{(i, t-1)}$	0.090 (0.013)***	0.067 (0.010)***	0.063 (0.017)***	0.048 (0.012)***
$CSR001_{(i, t-1)}$	0.048 (0.013)***	0.036 (0.009)***	0.092 (0.017)***	0.069(0.012)***
$CSR110_{(i, t-1)}$	0.046 (0.009)***	0.036 (0.006)***	0.076 (0.011)***	0.059 (0.008)***
$CSR101_{(i, t-1)}$	0.048 (0.006)***	0.037 (0.005)***	0.083 (0.008)***	0.062 (0.006)***
$CSR011_{(i, t-1)}$	0.038 (0.015)**	0.030 (0.011)***	0.062 (0.019)***	0.045 (0.013)***
$CSR111_{(i, t-1)}$	0.048 (0.005)***	0.038 (0.004)***	0.102 (0.006)***	0.078 (0.004)***
Sector dummies	Included	Included	Included	Included
Time dummies	Included	Included	Included	Included
$\Sigma$	0.123 (0.001)***	0.092 (0.001)***	0.143 (0.002)***	0.103 (0.001)***
Constant	0.007 (0.018)	0.002 (0.013)	-0.004 (0.022)	0.002 (0.013)
Log-likelihood	4932.013	10870.657	572.651	6992.274
Wald $\chi^2$	1106.77***	1291.98***	1051.90***	1260.70***

\*\*\*, \*\* and \* refer to the 1 %, 5 % and 10 % significance levels, respectively.

positive and significant effect on the three CSR dimensions, whereas there is not a significant effect of the other three variables ( $Externalrd_{it}$ ,  $Rdpersonnel_{it}$  and  $Cooperation_{it}$ ) on any of the three CSR dimensions. Following with the general firm's characteristics, whereas  $Exportations_{it}$  has non-effect on economic and social CSR, its effect on environmental

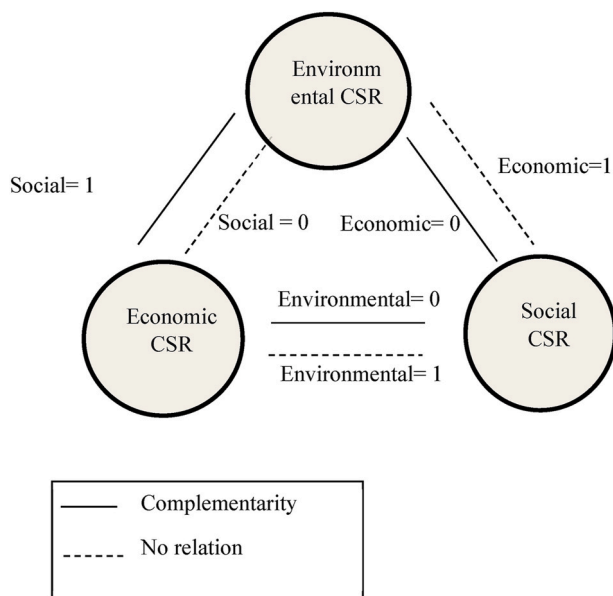
CSR is positive.  $Group_{it}$  has a positive and significant impact on social and environmental CSR. Finally,  $Size_{it}$  positively and significantly affects all the three CSR dimensions (economic, social and environmental).

Table 4 presents the results for correlations between residuals

**Table 6**  
Objective complementarity: Complementarity Tests between CSR practices.

	Radical <sub>it</sub>		Log transformation of Radical <sub>it</sub>		Incremental <sub>it</sub>		Log transformation of Incremental <sub>it</sub>	
	Chi <sup>2</sup>	p-value	Chi <sup>2</sup>	p-value	Chi <sup>2</sup>	p-value	Chi <sup>2</sup>	p-value
<b>Economic–social</b>								
First condition (Environmental = 0): f(110)+f(000)≥f(100)+f(010)	10.15	0.0014*	10.35	0.0013*	0.68	0.4094	0.72	0.3954
Second condition (Environmental = 1): f(111)+f(001)≥f(101)+f(001)	0.28	0.5972	0.24	0.6220	3.65	0.0562*	4.55	0.0330*
<b>Economic–environmental</b>								
First condition (Social = 0): f(101)+f(000)≥f(100)+f(001)	0.27	0.6058	0.30	0.5810	4.44	0.0352*	5.00	0.0253*
Second condition (Social = 1): f(111)+f(010)≥f(110)+f(011)	6.49	0.0108*	6.31	0.0120*	0.96	0.3276	1.25	0.2628
<b>Social–environmental</b>								
First condition (Economic = 0): f(011)+f(000)≥f(010)+f(001)	8.72	0.0032*	8.45	0.0036*	0.67	0.4148	1.05	0.3046
Second condition (Economic = 1): f(111)+f(100)≥f(110)+f(101)	0.60	0.4369	0.49	0.4860	9.57	0.0020*	9.51	0.0020*

\*p < 0.1.



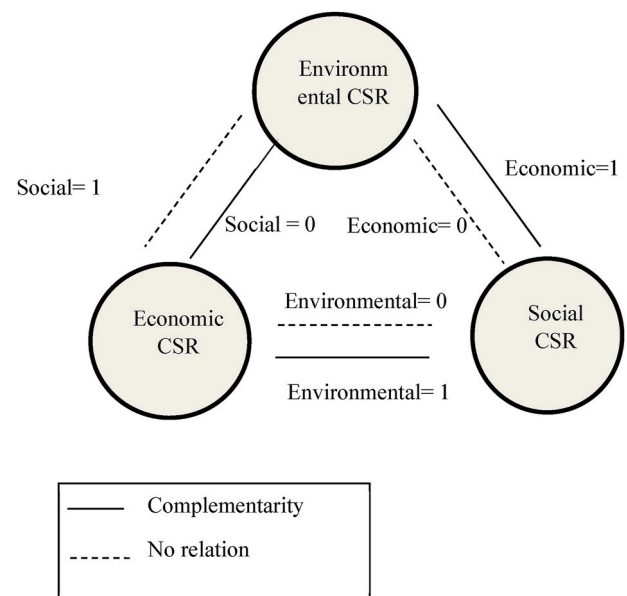
**Fig. 3.** Objective complementarities between the CSR of the TBL (economic, social and environmental) for radical innovations  
Source: Own elaboration based upon Ballot et al. (2015).

estimated in the previous regressions of Table 3. The positive and significant correlations between errors show that the three CSR dimensions are interrelated. These results confirm hypothesis H1 stating that the three CSR dimensions are complementary in behaviour (Fig. 2). According to the estimated correlations, the most intense relation is that between social and environmental CSR, whereas between social and economic CSR, and between economic and environmental CSR, the relation is a little less intense. These results give empirical support to the arguments suggesting that the economic, social and environmental practices are different parts of the multidimensional concept of CSR and that firms perceive that an effective firm’s CSR policy must be multidimensional and take into account environmental, social and business behaviour factors (Crifo et al., 2016).

4.2. Objective complementarity

Table 5 summarizes the results regarding the effect of control variables and exclusive CSR practices on innovation performance.<sup>7</sup> The chi<sup>2</sup> confirms the global statistical significance of the model.

<sup>7</sup> Although we run hierarchical regressions, for reasons of space, only full models are reported. Partial models are available upon request to the authors.



**Fig. 4.** Objective complementarities between the CSR of the TBL (economic, social and environmental) for incremental innovations  
Source: Own elaboration based upon Ballot et al. (2015).

Beginning with control variables, regarding the effect of general firm characteristics, only Exportations<sub>it</sub> and Size<sub>it</sub> have a significant and positive effect on innovation performance, for radical and incremental innovations, respectively. Following with the effect of control variables related to innovation, Internal<sub>it</sub>, Market<sub>it</sub> and Cooperation<sub>it</sub> exert a positive and significant effect on all the innovation performance measures. However, a negative and significant effect is found for the case of Training<sub>it</sub> and Externalknowledge<sub>it</sub> on incremental innovations. Finally, no effect is found for the rest of the control variables.

Following with the CSR variables, all the variables measuring CSR practices have a positive effect on the innovation performance. In more concrete terms, there is a positive and significant effect of all the CSR variables containing the economic dimension (CSR 100<sub>(i, t-1)</sub>, CSR 110<sub>(i, t-1)</sub>, CSR 101<sub>(i, t-1)</sub> and CSR 111<sub>(i, t-1)</sub>). As far as the social dimension, there is also a positive and significant effect of CSR010<sub>(i, t-1)</sub>, CSR110<sub>(i, t-1)</sub>, CSR011<sub>(i, t-1)</sub> and CSR111<sub>(i, t-1)</sub>. And finally, as far as the environmental dimension of CSR, the coefficients of CSR001, CSR101<sub>(i, t-1)</sub>, CSR011<sub>(i, t-1)</sub> and CSR111<sub>(i, t-1)</sub> are also positive and significant. The biggest effect of CSR strategies that combine different dimensions of CSR is for CSR111<sub>(i, t-1)</sub>, which combines economic, social and environmental practices, on incremental innovations. In addition, if we look at the positive and significant impact of all the variables measuring exclusive CSR (CSR100<sub>(i, t-1)</sub>, CSR010<sub>(i, t-1)</sub>, CSR001<sub>(i, t-1)</sub>) practices on innovation

performance, we can see that the biggest effect is for CSR10<sub>(i, t-1)</sub> (only social CSR) in the case of radical innovations, and CSR100<sub>(i, t-1)</sub> (only economic CSR) for incremental innovations.

Table 6 presents the results of the analysis of objective complementarity between CSR dimensions on innovation (Figs. 3 and 4), based on the coefficients of previous estimated regressions (Table 5). As shown in Table 6, the conditions of supermodularity hold when the three CSR dimensions are present (1) or not present (0), where the significance of the  $\chi^2$  indicates that the condition is met. Table 6 shows different results of objective complementarities depending on the innovation performance measure. Beginning with radical innovations, the results confirm the pair-wise objective complementarity between economic and social CSR when the environmental CSR dimension is not present, between the economic and environmental CSR dimensions when the social dimension is present, and between social and environmental CSR when the economic dimension is not present. However, there is no objective complementarity between economic and social CSR when the environmental CSR dimension is present, between the economic and environmental CSR dimensions when the social dimension is not present, and between social and environmental CSR when the economic dimension is present. Results are quite divergent for incremental innovations, for which objective complementarity occurs for other combinations different for those of radical innovation. Thus, the results confirm pair-wise complementarity between economic and social CSR when the environmental CSR dimension is present, between the economic and environmental CSR dimensions when the social dimension is not present, and between social and environmental CSR when the economic dimension is present. Therefore, H2 can be partially confirmed only for these cases.

#### 4.3. Discussion

Beginning with the effect of CSR on innovation, the results of the study confirm its positive effect on innovation in line with previous empirical research (i.e. Wagner 2010; Martínez-Conesa et al., 2017; Mahmoud & Hinson, 2012; García-Piqueres & García-Ramos, 2020) and give support to the theoretical bases of the RBV (Barney, 1991; Hart, 1995; Hart & Dowell, 2011; Wernerfelt, 1984). Therefore, CSR practices seem to foster firm's intangible resources (e.g. reputation, intellectual property, technology) and firm's personnel-based resources (e.g. commitment, loyalty, knowledge, expertise) that constitute a sustainable competitive advantage for the firm and enhance the firm innovation performance (Gallego et al., 2011; Nair & Bhattacharyya, 2019; Taylor et al., 2018). As the theoretical arguments suggest, the empirical study has proved that CSR makes firms to increase the knowledge base of the firm (Luo & Du, 2015), which is one of the most important inputs of innovation processes, and allows firms to improve innovation performance (Müller et al., 2020).

Furthermore, as our analysis takes into account the TBL approach by considering the three CSR dimensions suggested by previous literature (i.e. Bohlmann et al., 2018; Mühlbacher & Böbel, 2019), as well as two different innovation measures, the results allow us to develop the discussion regarding the heterogeneity nature of the effect of CSR on innovation depending on the type of the CSR dimension and the type of innovation measure analysed. Along this line, if we take into account those combinations that comprise a unique CSR practice, we find that the results change depending on the CSR practice and the innovation measure. The CSR practices presenting the biggest effects on radical and incremental innovations, respectively, are social and economic CSR in insolation.

Regarding behavioural complementarities, the correlation analysis results confirming the behavioural complementarity between the economic, social and environmental CSR (Table 2) give support to the arguments found in previous literature and mostly related to the TBL theoretical approach. The obtained results support the idea regarding the existence of a 'common core' between different practices (Schweiger

et al., 2019), as well as how their supportive mutual role (Ozusaglam et al., 2018) impulse firms to adopt them simultaneously (García-Piqueres et al., 2020). Then, firms looking for being 'more ethical' seem to implement an effective multidimensional CSR approach. As literature previously suggested, our results confirm that firms fulfil their economic, social and environmental responsibilities simultaneously (Miravete and Pernías, 2010), on one hand. On the other hand, the combination of social and environmental dimensions presents the most intensive interrelation. This result sounds intuitive, as the social and environmental concerns are more similar regarding their social aims if we compare them with the economic dimension. Therefore, this result would suggest that the 'common core' shared by the social and environmental CSR dimensions is more robust than that the 'common core' that these practices share with the aims of the economic CSR dimension. Finally, this result suggests that, although firms have been traditionally focussed on economic aims, time by time, the social and environmental concerns are gaining attention.

In Table 4, the results from the regression analysis are in the same line. We can see that the majority of the control variables exert a similar effect on either the CSR dimension, thus they share a 'common core' regarding the factors that determine them. This is specially the case for the social and environmental dimensions. First, six variables exert the same effect on both dimensions, and second, they present the more intensive relatedness.

Following with objective complementarities, the results confirm the synergistic effect of different CSR practices in fostering innovation performance (Schweiger et al., 2019). This result gives empirical support to the postulates formulated from the RBV regarding the superior performance that can be achieved when firms are capable of combining successfully different CSR practices, which provide distinctive competencies (Damanpour et al., 2009). Along this line, and as the RBV suggested, the adoption of different CSR practices mutually reinforces each other (Porter, 1996; Siggelkow, 2001). Therefore, the joint adoption of different CSR practices is associated with super-additive performance effects (Schweiger et al., 2019), in line to the RBV and the supermodularity theory. The application of the supermodularity theory (Milgrom & Roberts, 1995) based upon the proposal of Mohnen and Roller (2005) not only confirms this issue (the objective complementarity between CSR dimensions), but also points out to the applicability of the framework into this context.

Additionally, we can also conclude about the differences on objective complementarities depending on the innovation performance measure. Beginning with radical innovations, results indicate that the combination of the social dimension with any of the two others (economic and environmental) is the one that gives the best results in terms of innovation. This finding draws the social dimension as a fundamental axis of the CSR towards innovation of Spanish companies in order to foster their innovation performance in terms of radical innovations. This result reinforces the idea that social CSR practices have a positive effect on employees' sentiments (Cegarra-Navarro et al., 2016; García-Piqueres & García-Ramos, 2020), improving their recruitment and retention, attracting the most talented and innovative people, and increasing then their performance (Guerrero-Villegas et al., 2018; Magrizos et al., 2020; McWilliams et al., 2006), more specifically, their radical innovation performance. A possible reason behind it could be found on that previous explained argument: as social CSR practices seem to be related to the recruitment of the most innovative people, more radical or disruptive innovations can be developed for these kinds of firms.

Contrasting findings are found for incremental innovation, for which the social CSR dimension is not the key element. In this case, the results draw both the economic and environmental dimensions as fundamental axis in order to foster firms' capacity to develop incremental innovations. This result suggests that combining economic and environmental CSR practices allows firms to both improve their competitiveness (Meinel et al., 2020) and their environmentally friendly processes and products (Bocquet et al., 2013; García-Piqueres & García-Ramos, 2020).

As our results suggest, all of this will result in incremental modifications of previous products or processes.

Then, in the light of the empirical results, we can confirm that, depending on the type of innovation the firm wants to be developed, the best combination of CSR practices changes. Along this line, whereas for the case of radical innovations, social CSR emerges as a fundamental axis, and for the case of incremental innovations, it is the combination of economic and environmental CSR. Thus, in addition to the traditional economic CSR dimension, the environmental CSR practices seem to be fundamental for Spanish companies in order to foster their incremental innovation performance. This result is consistent with some previous studies that found a ‘positive effect of environmental regulation on firms’ innovations (e.g. Jaffe & Palmer, 1997; Rennings & Rammer, 2011)’ (Bocquet et al., 2013, p. 643). Furthermore, this result gives support to some arguments found in previous literature regarding the role of the environmental dimension, which suggests the necessity ‘to adopt integrated and more complex green strategies and not only “end of pipe” technologies’ Gilli et al., 2014.

## 5. Conclusions

This paper analyses the existence of complementarity between the three core dimensions of the CSR, as defined by the TBL approach (economic, social and environmental), and their effect on the firm innovation, considering both radical and incremental innovations. In doing so, we focus on two types of complementarities: behavioural and objective. These issues are approached from both theoretical and empirical points of view, using data from the Spanish CIS survey for the period 2009–2014. The results confirm the existence of both types of complementarities giving support to the hypotheses formulated.

In particular, the results obtained confirm the positive effect of CSR on innovation, as well as the existence of differences in that effect depending on both the CSR dimension and the innovation performance measure considered, as had been anecdotally confirmed by the previous research (García-Piqueres & García-Ramos, 2020).

Moreover, this paper adds to previous literature by applying the ‘Complementarity Approach’ to the CSR–innovation relationship issue. To the best of our knowledge, this is the first research in analysing complementarities within the context of the CSR–innovation link. From an academic point of view, it represents an important advance in the research fields of innovation and CSR. In doing so, our findings confirm the applicability of the assumptions suggested by the RBV, as well as the TBL approach, in order to explain the existence of complementarity (behaviour and objective) between different dimensions of CSR and their relationship with innovation performance. In particular, behavioural complementarity refers to the behaviour of the firms in the sense that how they combine different activities, whereas objective complementarity refers to the combination that gives the better performance results to the firm.

The results suggest that CSR practices are interrelated (confirming behavioural complementarity), and that their combination has super-additive effects on innovation (confirming objective complementarity).

The results of this study have also practical implications for practitioners, specifically, if we compare the results obtained in terms of behavioural complementarities with those of objective complementarities. In this sense, although the greatest interrelation occurs between the social and environmental dimensions, the results are different, if we look at the objective complementarity. In this case, the CSR practices that have more complementarities are those related to the social dimension (social with environmental and economic with environmental) for the case of radical innovations, and the combination of economic and environmental CSR practices in the case of incremental innovations. Therefore, from a practical point of view and in terms of a rational objective–performance perspective, it seems reasonable to recommend companies to combine the social CSR dimension with any of the others in order to improve the radical innovation performance of

firms, and the economic and environmental for incremental ones. Thus, this study points to the need to consider the different dimensions of CSR and different innovation types in order to assure a competitive advantage in terms of innovation. Nowadays, it is important that CSR strategies promote socially responsible innovation, allowing the adaptation of new technological models to the new socially responsible era, where innovation must have a clear social orientation. Our results could help practitioners in the decision-making process by serving as a tool to choose the CSR practices to implement according to the innovation to be practiced, incremental and/or radical, since the CSR practices required to develop radical innovation seem to be clearly different from those needed to develop incremental innovation (Domínguez-Escrig et al., 2019). Regarding incremental innovation, in addition to the traditional economic CSR dimension, the environmental CSR dimension seems to be of great importance in order to the bettering of existing products and processes. CSR strategies focussed on the responsibility of firms regarding the effects that their products, processes and services have on the environment in terms of air and water quality, biodiversity, consumption of natural resources, climate change and so on is configured as a tool that promotes incremental innovation, which is essential to ensure the sustainability of the company in the long term (Cegarra-Navarro et al., 2016; Khosravi et al., 2019; Meinel et al., 2020). As far as radical innovation is concerned, it seems that social CSR practices related to the improvement of employees’ working and living conditions are a key successful element to promote this type of innovation that implies a high degree of novelty for the company, the market and the industry (Domínguez-Escrig et al., 2019).

This research presents some limitations that can be addressed in future research. First, as we focus on Spain, more research is needed in order to confirm whether our results are generalizable to other geographical contexts. Second, the kind of data available has conditioned the construction of the CSR variables, limiting them to those aspects collected in the CIS survey.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.emj.2021.07.010>.

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