The Role of Social Capital on Innovation with Environmental Benefits: The European Case

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1 Introduction

The new millennium has been marked by a process of profound questioning of the capitalist economic system since the mid-1970s with the first oil crises. The 4th industrial revolution, characterized by virtual space, brought us the liberating greatness of a globalized and borderless life, very promising in terms of economic growth. However, the ambivalent aspects of growth continue to be felt. The first warnings of depletion of environmental resources appeared in 1972 by the United Nations Environment Program (UNEP), which seeks to promote planet sustainability. As stakeholders of the new societal project, companies integrate environmental concerns in the innovation agenda. For instance, in 1996, ISO launched its

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environmental management system standard, ISO 14001, which helps firms and organizations to identify and control their environmental impact. Nowadays, the United Nations considers, in its 2030 Agenda for Sustainable Development, the importance of innovation on employment and growth (Goal 9) and the need for climate action in order to provide a more sustainable planet for future generations (Goal 13). Innovations with environmental benefits are relevant to achieve these goals.

Innovations with environmental impacts were first heard, at European level, in 2014, in a business inquiry instrument that we intend to analyze in this article. This is the most recent and only information made available by EUROSTAT for a scientific approach to innovation with environmental benefits. This article aims to analyze the importance of these innovations relating them to social capital. The main objective is to understand how, in the new paradigm of the networked company, belonging to a social relations network can be decisive for innovation with environmental benefits.

The article is organized as follows: in Sect. 2, the heuristic potential of the concept of social capital is discussed and its relationship with business approaches, namely environmental innovation is demonstrated; in Sect. 3, the data and methodological choices are discussed, as well as the proxies used to assess the influence of social capital on innovation with environmental benefits; in Sect. 4, the main results are presented, distinguishing the role of social capital in the various types of innovation with environmental impact. The article ends with a discussion of the limitations of the study and suggestions for future research.

2 Social Capital and Innovation

2.1 Networked Company and Social Capital: Theoretical Tool for the Analysis of Innovation

The business world has undergone profound changes over the course of different industrial revolutions and their technical–economic paradigms. The networked company and the corresponding cooperation paradigm is one major organizational transformation that justifies the use of the concept of social capital in the business world (Bowey and Easton 2007).

According to Castells (2010), a network (or net) is a "set of interconnected nodes" (p. 501) and the type of node depends on the network, the latter being an open, highly dynamic and innovative structure that is able to expand without limits. However, the author points out that communication in and between networks is only possible if the same codes, such as values or performance forms are used (Castells 2010).

Also referring to the emergence of a new economy as a result of the globalization process, the author points out that the network is "organized around global

networks of capital, management, and information, whose access to technological know-how is at the roots of productivity and competitiveness" (Castells 2010, p. 502). Thus, the work process is increasingly "reintegrated through a multiplicity of interconnected tasks in different sites, ushering in a new division of labor based on the attributes/capacities of each worker" (Castells 2010, p. 502).

Interconnection strategies bring flexibility to the system and the company itself works internally as a network. According to the author, this is the model of the "horizontal corporation" that gains from the decentralization and autonomy of its units, even allowing their internal competition within the scope of a common general strategy (Castells 1996, p. 193). This network transformation of companies takes on different internationalization strategies. The most basic one is investment in the international market and the most advanced one is participation in transnational networks. At the higher internationalization level, companies relate to different markets and exchange information on them, and foreign direct investment gives place to "a set of relationships between companies located in different institutional contexts" (Castells 1996, p. 193). According to Castells, this transnational structure allows small and medium-sized companies to link up to larger companies, forming networks capable of innovating and adapting. The operating units are now the business projects and the information circulates and is processed between companies due to the experience acquired in each field. The challenge of the horizontal company is coordination and flexibility in a context of rapid change.

Taking into account the paradigm of cooperation and coordination of the networked company, we seek to relate the ability of companies to innovate from an environmental point of view to the concept of social capital.

The notion of social capital implies the recognition of the importance of social relations as a mediator of collective achievements.

We will begin by the classic approach to social capital whose forerunner is Coleman (1988). This author sees this form of capital as an available resource to be mobilized by actors in their actions. He identifies three different forms of social capital: obligations and expectations, information channels, and social norms. The analytical reference is that of rational action in which the actor plays with the means and ends, social capital being a part of action resources. Social capital is raised through its function of mediation between subject and structure: it facilitates action taking the environment into account. Coleman considers that relationships of proximity and trust allow objectives to be more effectively achieved by facilitating action and cooperation with a view to mutual benefit. It is the mediation of social capital that explains cooperation between individuals, each one of them trying to reach his/her own private interests. Social capital would be a special type of public good since it is actualized in an intersubjective way and enhances relationships of trust and reciprocity.

Bourdieu (1980) defines social capital as the "actual or potential set of resources related to the ownership of a durable network of more or less institutionalized relations of inter-knowledge and recognition" (p. 2). The social capital that an individual has and mobilizes depends directly on the networks s/he is part of.

Although for Bourdieu (1989) social capital is economic at its root, it is expressed through symbolic power and has an intangible character. Social capital consists of resources derived from the individual's association to social groups. The amount of social capital accessible to a private agent varies according to the extent of his/her social relations network and the capital flow within the group. The gains derived from belonging to a group sustain relationships of reciprocity within it. In this sense, we can see social capital as an important business asset.

For Granovetter (1985), the question is to know how economic behavior and institutions are affected by their involving social relations. Economic behavior is usually considered to be based on social relationships in traditional societies and as autonomous in modern societies. In other words, in the traditional model, the market is ruled by social relations while in the modern model, the market coordinates social relations. Granovetter stands out from these visions and sees the rooting of economic practices as a historical constant that evolves *pari passu* with the dynamics of social relations. The search for well-reputed economic partners in the market shows that it is networks that validate exchanges between social actors. The key point is that trust relationships can reduce uncertainties regarding reciprocal behavior and this favors the construction of stable relationships, which is promising to several business components, namely the one that concerns us here—environmental innovation.

In short, social capital refers to a network of social relationships in which social agents can obtain benefits that would otherwise be inaccessible (Vale et al. 2006).

> As Teramoto and Jurčys (2017) point out in a crucial article, "Accumulation of trust between members of a society (a kind of social capital) significantly contributes to sharing of ideas and enhances cooperation.[...] In designing a trust-based innovation ecosystem, it is first of all important to identify the relevant stakeholders and their main interests. […] Higher level of trust between various stakeholders of ecosystem contributes to sharing, collaboration, dissemination of information and innovation" (Teramoto and Jurčys 2017, p.129).

2.2 Social Capital, Innovation and Environment

We conducted a bibliometric analysis on the relationship between social capital, innovation and environment. It includes, for the time period 2000–2021, (i) 2310 publications containing the terms *social capital* and *innovation* and (ii) 278 publications containing the terms *social capital* and *innovation* and *environment.*[1]

[1] This search at the Web of Knowledge (BETA version, available at https://www.webofscience.com/wos/woscc/basic-search) was carried out in March 2021. It included all types of publication between January 2000 and March 2021 that included these concepts at least in one of all possible fields (title, abstract, keywords, text, etc.). Quotation marks were used before and after each concept to narrow down the number of publications that specifically correspond to the subject.

In the beginning of the 21st Century, the theoretical emphasis was placed on the network theory (Castells 1996). It demonstrated the importance of social capital in business contexts (e.g. MacLeod 2000), namely for fostering innovation (e.g. Senge et al. 2001), creating and developing personal and formal networks, clusters and business communities (e.g. Ashton 2001; Carayannis et al. 2000; Mao et al. 2002), but also for internal skills in terms of human resources (e.g. Yli-Renko et al. 2001; Lee et al. 2001).

More recently, studies regarding *social capital* and *innovation* focus on diverse and current topics such as artificial intelligence (e.g. Tubadji et al. 2021), the sustainable local or regional development of communities, and cooperation (e.g. Salla and Caesar 2021; Schuch et al. 2021), immigration, gender studies (e.g. Fatemi et al. 2021), etc. Nevertheless, some publications began to focus also on environmental matters—be it the implementation of environmental solutions in communities or in the market and industries—and on the importance of social capital for managerial competences (Mehta and Ali 2021), business contexts (Khan et al. 2020), green innovation (e.g. Zhao et al. 2021), or societal future trends (e.g. Kashima et al. 2021).

Considering the concept of *environment*, it is possible to identify the emergence of some publications focusing on the relationship between social capital and environment. They either reflect on the impacts of social capital when environment is considered, or on how social capital (translated into resources or networks) affects environmental innovation (Chen and Luo 2011; Halme and Korpela 2014; Liao 2018).

This analysis led us to consider the interrelation between *social capital* and *innovation*, as well as its interdependence with competitive regions and competitive performances not only at the economic, but also social level (Xi et al. 2017).

It is also possible to understand the growing importance ascribed to climate and environmental actions in business and innovation contexts when considering social capital as a resource. As early as 2001, Senge et al. (2001) suggested that, in the next industrial revolution, an integrated vision of systems—combining social and environmental principles—would be necessary for innovative organizations since it would allow them to reach long-term profitability and financial sustainability. Later on, Liao (2018) analyzed the relationship between social capital (divided into structural, relational and cognitive capitals) and environmental innovation in the manufacturing industry, concluding that the structural and relational social capitals had a positive effect on environmental innovation. Halme and Korpela (2014) suggest that environmentally and socially responsible innovations by small and medium enterprises (SMEs) need a resource combination that "comprises equity, research and development cooperation, networks, industry knowledge and reputation" and that "Environmental technology innovations call for more abundant resource combinations" (p. 547).

3 Data and Methods

The Community Innovation Survey (CIS) is a survey which is part of the European Union [EU] science and technology statistics and includes firm level data on innovation activities by EU members. Surveys are voluntarily implemented in several EU member countries every two years. Given that EU member countries compile the information in CIS on a voluntary basis, each CIS wave may include different countries. In a given year (or wave), companies are questioned about their innovation activities: whether they have introduced an innovation in the period under analysis, the type of innovation, whether they have had access to public funding, among other variables. The CIS also includes variables that provide a general characterization of the company, such as economic sector, turnover and percentage of employees with a tertiary degree (Eurostat 2020a).

In this study, we use the CIS to analyze the impact of social capital on innovation with environmental benefits. We start from the following hypothesis: companies that co-operate with other companies or organizations, regardless of the purpose, build relationships of proximity and trust that benefit them both in terms of information and knowledge sharing, and the challenges they face, responding to these more positively than isolated companies. We consider that these companies are more likely to dedicate themselves to innovations, namely innovations with environmental benefits. These refer to a relatively secondary intervention area for companies (as illustrated in the bibliometric analysis, they are mentioned only in 278 out of a total of 2310 publications). Within the latter, belonging to a social relations network can be decisive for considering this area of innovation, including its importance for businesses bearing in mind the excesses of capitalism over the environment. These are influencing factors that can be associated with what Coleman (1988) calls the closure of a social network as a "self-help system" in which dense groups are more able to mobilize resources among themselves to achieve their goals.

The last available CIS wave corresponds to surveys implemented in 2014 [CIS2014]. In addition to variables regarding innovation in general, CIS2014 also gathers information regarding innovations with environmental benefits. Thus, our database includes information for 2014 from companies of 13 countries: Bulgaria, Cyprus, Czech Republic, Germany, Estonia, Greece, Croatia, Hungary, Lithuania, Latvia, Portugal, Romania and Slovakia.[2] Each company corresponds to one observation, with a total of 26,509 observations.[3] Considering the statistical classification of economic activities in the European Community (NACE Rev. 2), each company is included in one of the following 9 sectors (Eurostat 2020b): manufacturing and other industry; construction; wholesale and retail trade, transportation and storage, accommodation and food level service activities; information and communication; financial and insurance activities; real estate activities; professional, scientific,

[2] CIS2014 also includes data for Spain and Norway, but these countries were dropped out from our study as data regarding innovations with environmental benefits is missing.

[3] See Table 5 in the annex for a list of the number of observations per country.

technical, administration and support service activities; public administration, defense, education, human health and social work activities; other services.

The database gathers information on the companies' innovations with environmental benefits, recording whether the firm has introduced such an innovation and distinguishing it by type—product, process, organizational or marketing innovation—and occurrence—during production (e.g., reduction in material or water use per unit of output; reduction in CO_2 production or pollution; replacement of materials or fossil energy by less polluting substitutes or renewable energy sources; recycling of waste, water, or materials) or during product/ service consumption by the final user (e.g., reduction in energy use or CO_2 'footprint'; reduction in pollution or easement of product recycling after use; extension of product life through longer-lasting, more durable products), as stated in Eurostat (2020a). As such, we consider in our analysis 7 (binary) dependent variables: the introduction of an innovation with environmental benefits (variable *Innovation*); the introduction of an innovation with environmental benefits within the company (variable *Within*); the introduction of an innovation with environmental benefits during the consumption or use of a good or service by the end user (variable *End_user*); the introduction of a product innovation with environmental benefits (variable *Product*); the introduction of a process innovation with environmental benefits (variable *Process*); the introduction of an organizational innovation with environmental benefits (variable *Organizational*); and the introduction of a marketing innovation with environmental benefits (variable *Marketing*).

As for independent variables, we use two alternative proxies to evaluate the role of social capital: company engagement in external knowledge, as the company may acquire other organizations' knowledge and use it as an input to introduce an innovation (variable *Engagement*); whether the company cooperated on any innovation activity with suppliers, clients, or competitors (variable *Cooperation*). Several other variables are considered in our study to characterize the company: whether it is part of a business group (variable *Group*); whether it sold goods/ services in international markets (variable *International*); its size proxied by the company's turnover (variable *Turnover*); the employees' level of education measured by a binary variable for the percentage of employees with a tertiary degree equal to or greater than 25% (variable *Education*); whether it benefitted from any public funding for innovation activities (variable *Funding*). Table 1 describes the variables and presents some descriptive statistics.

The analysis of Table 1 allows us to conclude that 69.2% of the firms in our sample introduced an innovation with environmental benefits during the period under analysis. While 43.3% of them introduced an innovation with environmental benefits within the company, only 30.7% of the companies introduced an innovation with environmental benefits during the consumption or use of a good or service by the end user. Interestingly, the percentage of companies that engaged in process innovation (43.2%) is higher than the corresponding percentage for product (33.8%), organizational (25.7%) or marketing (11.9%) innovations.

As for social capital, 19.9% of the companies acquired knowledge from other organizations for the introduction of an innovation, although a more significant

Table 1 Variables and descriptive statistics

	Variable	Description	Mean	Std. dev	Min	Max
Indicators of innovation with environmental benefits	Innovation	Binary variable equal to 1 if the company introduced an innovation with environmental benefits between 2012 and 2014; 0 otherwise	0.692	0.462	0	1
Dependent variables	Within	Binary variable equal to 1 if the company introduced an innovation with environmental benefits within the company between 2012 and 2014; 0 otherwise	0.433	0.495	0	1
	End user	Binary variable equal to 1 if the company has introduced an innovation with environmental benefits during the consumption or use of a good or service by the end user between 2012 and 2014; 0 otherwise	0.307	0.461	0	1
	Product	Binary variable equal to 1 if the company introduced a product innovation with environmental benefits between 2012 and 2014; 0 otherwise	0.338	0.473	0	1
	Process	Binary variable equal to 1 if the company introduced a process innovation with environmental benefits between 2012 and 2014; 0 otherwise	0.432	0.495	0	1
	Organizational	Binary variable equal to 1 if the company introduced an organizational innovation with environmental benefits between 2012 and 2014; 0 otherwise	0.257	0.437	0	1
	Marketing	Binary variable equal to 1 if the company introduced a marketing innovation with environmental benefits between 2012 and 2014; 0 otherwise	0.119	0.324	0	1

(continued)

Table 1 (continued)

	Variable	Description	Mean	Std. dev	Min	Max
Social capital indicators	Engagement	Binary variable equal to 1 if the company acquired knowledge from other companies or organizations for the introduction of an innovation between 2012 and 2014; zero otherwise	0.199	0.399	0	1
Explanatory variables	Cooperation	Binary variable equal to 1 if the company cooperated on any innovation activity with suppliers, clients or competitors between 2012 and 2014; 0 otherwise	0.935	0.246	0	1
Characterization indicators of companies	Group	Binary variable equal to 1 if the company was part of a business group in 2014; 0 otherwise	0.379	0.485	0	1
Contextual variables	International	Binary variable equal to 1 if the company sold goods and/or services in international markets between 2012 and 2014; 0 otherwise	0.653	0.476	0	1
	Turnover	Natural log of the company total turnover (thousands of euros) for 2014	13.752	4.666	0	23.101
	Education	Binary variable equal to 1 if the percentage of the company's employees with a tertiary degree in 2014 was equal to or greater than 25%; 0 otherwise	0.450	0.498	0	1
	Funding	Binary variable equal to 1 if the company received any public funding for innovation activities between 2012 and 2014; 0 otherwise	0.324	0.468	0	1

share of them (93.5%) cooperated on any innovation activity with suppliers, clients or competitors. The descriptive statistics for control variables suggest that there is some heterogeneity among companies in our sample as 37.9% of them were part of a business group and 65.3% sold their products in foreign markets. There is also some variability in company turnover, showing that the database includes companies with different sizes. Table 1 also reveals that 45% of the companies in the sample had a percentage of employees with a tertiary degree equal to or greater than 25 and that 32.4% of them received public funding for innovation activities.

We want to analyze the role of social capital on innovations with environmental benefits. Given the available data and the variables put forward, we resort to a regression analysis taking into account the nature of the data, i.e., the fact that we have survey data. As all dependent variables are binary, assuming only the values of zero and one, we rule out the possibility of adopting Ordinary Least Squares [OLS] as an estimation method, given that the latter assumes that the dependent variable is continuous and not truncated or restricted to a given set of values (Gujarati and Porter 2008). Instead, we use the probit model for survey data (see, e.g., Wooldridge 2010), which explicitly assumes survey data and that the dependent variable is binary. The probit model assumes that since the dependent variable can be equal to one or zero, the probability of it being equal to one depends on a function of the independent variables as follows:

$$Probability(Y_i = 1) = F(\alpha + \beta X_i),$$

where Y_i is the dependent variable of the model (each one of the 7 dependent variables in Table 1), X_i is the vector of independent and control variables included in the model (see Table 1), α is the constant coefficient of the model, β the vector of coefficients associated to each independent and control variable, and $F(.)$ is the cumulative distribution function for the normal distribution. We estimate separate regressions for each one of the 7 dependent variables presented in Table 1 and include in all regressions sector and country fixed effects, as well as robust standard errors for heteroskedasticity.

4 Results and Discussion

With data from 26,509 companies of 13 European countries in 2014, we estimate the probit model separately for each dependent variable presented in the previous section. As we consider two alternative proxies for social capital—variables Engagement and Cooperation—we present results using each proxy in order to check the robustness of the results.

Table 2 displays our estimates using Engagement as a proxy for social capital. Our outcomes show that social capital has a positive impact on innovations with environmental benefits as the associated coefficient is positive and statistically significant at the usual significance levels. It is worth mentioning that this result holds regardless of the type of innovation considered in the analysis—product, process, organizational or marketing innovation—or its occurrence—within the company or during consumption by the end user.

We also found that belonging to a business group has a positive impact on innovations with environmental benefits within the company—though there is no significant effect on the other dependent variables—which may be related to intra-group knowledge that flows from one company to another, as well as to

Table 2 Estimation results with Engagement

	Innovation	Within	End user	Product	Process	Organizational	Marketing
Engagement	0.196*** (0.071)	0.365*** (0.047)	0.376*** (0.045)	0.346*** (0.060)	0.233*** (0.059)	0.323*** (0.061)	0.327*** (0.072)
Group	0.062 (0.065)	0.097** (0.044)	0.060 (0.044)	0.077 (0.060)	0.024 (0.060)	–0.002 (0.061)	-0.005 (0.075)
International	–0.060 (0.069)	–0.030 (0.043)	0.026 (0.044)	0.061 (0.064)	–0.054 (0.061)	0.029 (0.066)	-0.034 (0.077)
Turnover	0.058*** (0.019)	0.054*** (0.013)	0.032** (0.013)	–0.005 (0.017)	0.089*** (0.016)	0.066*** (0.016)	-0.007 (0.025)
Education	0.165** (0.079)	0.007 (0.048)	0.039 (0.048)	0.253*** (0.068)	–0.051 (0.065)	0.034 (0.068)	0.073 (0.078)
Funding	0.187*** (0.058)	0.255*** (0.038)	0.155*** (0.037)	0.150*** (0.051)	0.182*** (0.050)	0.085 (0.054)	0.000 (0.062)
Constant	–0.167 (0.303)	–1.438*** (0.180)	–1.422*** (0.178)	–0.066 (0.245)	–1.128*** (0.231)	–1.494*** (0.234)	-0.969*** (0.362)
Observations	8900	17,640	17,622	9997	9999	10,000	9,998

Notes *** (**) [*] statistically significant at 1% (5%) [10%]. Robust standard errors in parentheses

pressure or guidelines from the group that create an incentive for innovation (Dunning and Lundan 2008).

Interestingly, selling in international markets has no statistical effect on innovation when compared to companies operating only in the domestic market. This result may be due to market globalization since companies have both domestic and foreign competitors and, therefore, even those selling their products exclusively in national markets are motivated to innovate in order to survive in the long run. In fact, globalization allows for technology diffusion around the globe and fosters innovation in domestic companies (Feng et al. 2019).

As expected, company size (proxied by variable Turnover) has a positive effect on innovation (the exceptions being product and marketing innovations). Larger companies have more human and financial resources that can be channeled to innovation activities, bear higher sunk costs of innovation, and benefit from economies of scale and scope in innovation development (Symeonidis 1996).

Regarding Education, our findings suggest that companies with educated employees are more capable of developing product innovations with environmental benefits, which is in line with research on the link between human capital and company innovation (e.g., Organisation for Economic Co-operation and Development [OECD] 2011). However, there is no significant influence of Education on process, organizational or marketing innovations. While this is somewhat surprising, the dataset does not include additional information to examine this relationship in detail.

As for public funding, Table 2 reveals its positive and statistically significant effect on innovation with environmental benefits (except for organizational and marketing innovations). Public funding may have an additional effect on private investment—allowing companies to get hold of financial resources required by innovation—and stimulates private research and development expenditures, boosting innovation outcomes (Ebersberger 2005; Bai et al. 2019).

Table 3 presents our findings using Cooperation as a proxy for social capital, which corroborates the results presented above for variable Engagement: social capital has a positive and statistically significant influence on innovations with environmental benefits no matter the type of innovation considered (product, process, organizational or marketing innovation) or its occurrence (within the company or during product consumption by the end user). Comparing the estimates displayed in Tables 2 and 3, which consider different proxies for social capital, there is evidence of the positive role of social capital on innovation with environmental benefits.

As for the other variables, conclusions are similar to those drawn from the inclusion of variable Engagement: all variables that were significant in each regression in Table 2 remain significant except for Funding, which no longer has a significant impact on variables Innovation and End user.

Since we estimated parameters of non-linear regressions, estimates in Tables 2 and 3 allow us to analyze the significance—and to distinguish the positive or negative effect—of each variable, but not its marginal effect, i.e., the variation of the conditional mean of the dependent variable due to a unitary change in the independent variable. Thus, we present, in Table 4, the marginal effects for both proxies of social capital, variables Engagement and Cooperation.

Table 3 Estimation results with Cooperation

	Innovation	Within	End user	Product	Process	Organizational	Marketing
Cooperation	0.282** (0.140)	0.342*** (0.121)	0.260** (0.117)	0.214* (0.115)	0.336*** (0.129)	0.254** (0.126)	0.470*** (0.177)
Group	–0.024 (0.111)	0.144* (0.078)	–0.039 (0.074)	0.103 (0.096)	–0.003 (0.101)	–0.017 (0.090)	0.069 (0.104)
International	–0.167 (0.115)	–0.038 (0.083)	0.071 (0.082)	0.092 (0.104)	–0.079 (0.105)	0.022 (0.102)	0.013 (0.114)
Turnover	0.054* (0.028)	0.059** (0.026)	0.048** (0.025)	–0.015 (0.027)	0.083*** (0.027)	0.082*** (0.022)	-0.038 (0.042)
Education	0.302** (0.122)	0.049 (0.085)	0.131 (0.081)	0.270*** (0.102)	–0.042 (0.105)	0.005 (0.100)	0.115 (0.114)
Funding	0.038 (0.086)	0.146** (0.066)	0.092 (0.063)	0.140* (0.075)	0.134* (0.078)	0.107 (0.080)	0.052 (0.090)
Constant	–0.098 (0.484)	–1.342*** (0.387)	–1.458*** (0.372)	0.092 (0.425)	–1.079*** (0.416)	–1.873*** (0.372)	-0.904 (0.662)
Observations	5465	8027	8017	5811	5811	5811	5,771

Notes *** (**) [*] statistically significant at 1% (5%) [10%]. Robust standard errors in parentheses

Table 4 Marginal effects for Engagement and Cooperation

	Innovation	Within	End user	Product	Process	Organizational	Marketing
Engagement	0.065*** (0.023)	0.134*** (0.017)	0.135*** (0.016)	0.118*** (0.020)	0.089*** (0.022)	0.093*** (0.017)	0.060*** (0.013)
Cooperation	0.072** (0.036)	0.121*** (0.043)	0.098** (0.044)	0.075* (0.040)	0.124*** (0.047)	0.074** (0.037)	0.100*** (0.038)

Notes *** (**) [*] statistically significant at 1% (5%) [10%]. Robust standard errors in parentheses

According to the computed marginal effects, social capital increases the probability of a company introducing an innovation with environmental benefits by approximately 7 percentage points (pp), as Table 4 reports an impact of 6.5 pp if we consider the Engagement proxy and 7.2 pp using the Cooperation proxy. As for the other innovation variables, the effect of social capital is somewhat different for both proxies: social capital increments the probability of the company developing an innovation with environmental benefits internally by around 13 pp (12 pp with variable Cooperation) and during consumption or use of a product by the end user by almost 14 pp (10 pp with variable Cooperation).

While the probability of developing a product innovation is boosted by around 12 pp (8 pp with variable Cooperation), social capital expands the corresponding value for process innovation by 9 pp (12 pp with variable Cooperation). Also, social capital raises the probability of generating an organizational innovation by about 9 pp (7 pp with variable Cooperation) with a corresponding value for marketing innovation around 6 pp (10 pp with variable Cooperation).

Thus, this discussion allows us to affirm that social capital has a positive and significant impact on innovations with environmental benefits, boosting the probability of introducing such innovations by between 6 and 14 pp depending on innovation type and occurrence, as well as the proxy for social capital under consideration.

5 Conclusion

In this paper, we used the concept of social capital to analyze its relevance in promoting innovations with environmental benefits. We use data from the European Community Innovation Survey of 13 European countries for 2014 and resort to two alternative proxies of social capital to explore its role on innovations with environmental benefits. Our results suggest that social capital—measured by variables Engagement and Cooperation—has a significant and positive influence on innovations with environmental benefits, boosting the probability of introducing these innovations by between 6 and 14 pp regardless of innovation type (product, process, organizational or marketing) and occurrence (within the company or during the consumption or use of the product by the end user).

This positive relationship between social capital and innovations with environmental benefits may be particularly relevant nowadays, given that the former may be a way to boost the latter. This is crucial to meet the UN 2030 Agenda for Sustainable Development, as it underlines the importance of innovation on employment and growth (Goal 9) and the need for climate action in order to ensure a sustainable future for the next generations and the planet (Goal 13).

Since the literature on social capital and environment is relatively new and only a small number of studies has considered this issue, this article contributes to the analysis of the European case. However, it has some limitations. Our database only includes 13 European countries, leaving aside relevant nations such as France or

Italy, among others; on the other hand, we only have information for one year (2014) and include two proxies for social capital in our analysis.

For future research, it would be interesting to have richer data on a larger set of countries and periods of time, allowing for comparisons among regions and across time. The inclusion of more variables to proxy social capital would further consolidate the study.

Annex

See Table 5.

Table 5 Number of observations per country

Country code	Country name	Observations	Percentage
BG	Bulgaria	3725	14.05
CY	Cyprus	1346	5.08
CZ	Czech Republic	2364	8.92
DE	Germany	4818	18.17
EE	Estonia	1627	6.14
EL	Greece	1456	5.49
HR	Croatia	1332	5.02
HU	Hungary	2012	7.59
LT	Lithuania	1297	4.89
LV	Latvia	505	1.91
PT	Portugal	4167	15.72
RO	Romania	1114	4.20
SK	Slovakia	746	2.81

Note Total number of observations in the dataset = 26,509

References

Ashton P (2001) Social capital for design innovation and integration. In: Lloyd P, Christiaans H (eds) Designing in context. Delft University Press, pp 331–344

Bai Y, Song S, Jiao J, Yang R (2019) The impacts of government R&D subsidies on green innovation: evidence from Chinese energy-intensive firms. J Clean Prod 233:819–829

Bourdieu P (1980) Le capital social [The social capital]. Actes De La Recherche En Sciences Sociales 31:2–3

Bourdieu P (1989) O poder simbólico [Symbolic Power]. Editora Difel

Bowey J, Easton G (2007) Entrepreneurial social capital unplugged: an activity-based analysis. Int Small Bus J 25(3):273–306

Carayannis EG, Alexander J, Ioannidis A (2000) Leveraging knowledge, learning, and innovation in forming strategic government-university-industry (GUI) R&D partnerships in the US, Germany, and France. Technovation 20(9):477–488
Castells M (1996) La sociedad red [The rise of network society]. Alianza Editorial
Castells M (2010) The rise of the network society. Willey-Blackwel
Chen JY, Luo YK (2011) Structural growth characteristics and sustainable development of technological innovation capability: research on the agricultural science and technology enterprises. In: Jie XW, Xu EM, Zahra SA (eds) Environment, low-carbon and strategy. Sichuan University Press, pp 465–472
Coleman JS (1988) Social capital in the creation of human capital. Am J Sociol 94:95–120
Dunning J, Lundan S (2008) Multinational enterprises and the global economy. Edward Elgar
Ebersberger B (2005) The impact of public R&D funding. VTT Publications 588
Eurostat (2020a) Community innovation survey (CIS). https://ec.europa.eu/eurostat/web/microdata/community-innovation-survey
Eurostat (2020b) NACE Rev. 2—Statistical classification of economic activities. European Commission, Luxembourg
Fatemi SZ, Sadeghian S, Ganji SFG, Johnson LW (2021) Do different genders' knowledge sharing behaviors drive different innovative behavior? The moderating effect of social capital. Eur J Innov Manage. Advanced online publication. https://doi.org/10.1108/EJIM-07-2020-0305
Feng G-F, Zheng M, Wen J, Chang C-P, Chen YE (2019) The assessment of globalization on innovation in Chinese manufacturing firms. Struct Chang Econ Dyn 50:190–202
Granovetter M (1985) Economic action and social structure: the problem of embeddedness. Am J Sociol 91:481–510
Gujarati DN, Porter DC (2008) Basic econometrics. McGraw-Hill Professional
Halme M, Korpela M (2014) Responsible innovation toward sustainable development in small and medium-sized enterprises: a resource perspective. Bus Strateg Environ 23(8):547–566
Kashima Y, O'Brien L, McNeill I, Ambrose M, Bruce G, Critchley CR, Dudgeon P, Newton P, Robins G (2021) Low carbon readiness in social context: introducing the social context of environmental identity model. Asian J Soc Psychol. Advanced online publication. https://doi.org/10.1111/ajsp.12454
Khan SH, Majid A, Yasir M, Javed A (2020) Social capital and business model innovation in SMEs: do organizational learning capabilities and entrepreneurial orientation really matter? Eur J Innov Manag 24(1):191–212
Lee C, Lee K, Pennings JM (2001) Internal capabilities, external networks, and performance: a study on technology-based ventures. Strateg Manag J 22(6–7):615–640
Liao ZJ (2018) Social capital and firms' environmental innovations: the moderating role of environmental scanning. Bus Strateg Environ 27(8):1493–1501
MacLeod G (2000) The learning region in an age of austerity: capitalizing on knowledge, entrepreneurialism, and reflexive capitalism. Geoforum 31(2):219–236
Mao KJ, Liu JJ, Xu QR (2002) In: Xu QR, Wu X, Chen J (eds) Management of technology and innovation in the 21st centuries, pp 127–132. Zhejiang University Press
Mehta AM, Ali SA (2021) Dynamic managerial capabilities and sustainable market competencies: role of organisational climate. Int J Ethics Syst. Advanced online publication. https://doi.org/10.1108/IJOES-07-2020-0121
Organisation for Economic Co-operation and Development (2011) Skills for Innovation and Research. OECD Publishing
Putnam R (2003) Better together: restoring the American community. Simon & Schuster
Sallah CA, Caesar LD (2021) Performance of Ghanaian women businesses community: the moderating role of social competence. J Enterprising Commun People Places Glob Econ. Advanced online publication. https://doi.org/10.1108/JEC-12-2020-0209
Schuch E, Dirks S, Nhim T, Richter A (2021) Cooperation under social and strategic uncertainty—the role of risk and social capital in rural Cambodia. J Behav Exp Econ 90:1–9
Senge P, Cardest G, Porter P (2001) Innovating our way to the next industrial revolution. MIT Sloan Manag Rev 42(2):24–38

Symeonidis G (1996) Innovation, firm size and market structure: Schumpeterian hypotheses and some new themes (OECD Economics Department Working Paper Nº161). Organisation for Economic Co-operation and Development. https://www.oecd-ilibrary.org/economics/innovation-firm-size-and-market-structure_603802238336

Teramoto, S., & Jurčys, P. (2017). Intermediaries and mutual trust: The role of social capital in facilitating innovation and creativity. *Perspectives in Law, Business and Innovation,* 129–150.

Tubadji A, Denney T, Webber DJ (2021) Cultural relativity in consumers' rates of adoption of artificial intelligence. Economic Inquiry. Advanced online publication. https://doi.org/10.1111/ecin.12978

Vale GM, Amancio R, Lauria M (2006) Capital social e suas implicações para o estudo das organizações. Organizações & Sociedade 13(36):45–63

Wooldridge JM (2010) Econometric analysis of cross section and panel data. MIT Press

Xi YY, Cui SJ, Xu EM (2017) Does the social capital drive innovation ecosystem knowledge transfer: a view from big data landscape. In: Xiaowen J, Erming X, Woodside A (eds) New thinking for strategy: green, innovation and sharing. Sichuan University Press, pp 3–11

Yli-Renko H, Aution E, Sapienza HK (2001) Social capital, knowledge acquisition, and knowledge exploitation in young technology-based firms. Strateg Manag J 22(6–7):587–613

Zhao Y, Zhang X, Jiang W, Feng T (2021) Does second-order social capital matter to green innovation? The moderating role of governance ambidexterity. Sustain Prod Consumption 25:271–284