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Corporate sustainability: The pivotal role of corporate scientists and gender diversity

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Abstract: At a time when sustainable practices are becoming increasingly important in many economies, we need a thorough understanding of the determinants of corporate sustainability. Research on the influence of human resources in this context focuses mainly on executive roles such as CEO and board member. This emphasis tends to deny the potential contribution made by other employees to fostering corporate sustainability. This is the setting for our study of the part played by corporate scientists. Their rigorous academic training and specialized research expertise endows corporate scientists with distinct attributes which could encourage more sustainable business activities. We show that the role of the corporate scientist goes beyond enhancement of the firm's inventive capacity and find a causal effect of scientist presence on companies' prioritization of environmental objectives. We also find that the presence of women scientists has a particularly pronounced effect. Our results have implications for policy and recruitment strategies in terms of their emphasis on sustainability and gender inclusivity.

Subjects: Gender & Development; Sustainable Development; Environmental Economics; Business, Management and Accounting; Industry & Industrial Studies

Keywords: corporate scientists; gender diversity; environmental objectives; Research & Development (R&D); sustainability in corporate strategy

JEL Classification: J16; O32; Q55; L60; M14

ABOUT THE AUTHORS

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Maria F. Muñoz-Doyague, an associate professor at the University of León, has published works on diverse topics such as employee human resources practices, social network analysis, and the determinants of individual performance. Currently, her research interests include the study of well-being, social and psychological capital, and other behavioral measures.

1. Introduction

Business environmental strategies aim to respond to both the ethical effects of corporate activities (Becker, 2012) and the expectations of pivotal stakeholders such as shareholders and consumers (Longoni et al., 2018). In the contemporary aggressive business milieu, a strategic emphasis on environmental considerations provides differentiation and a competitive edge (Chuang & Huang, 2015; Kwarteng et al., 2016; Singh et al., 2019). These aspects underscore the importance of environmental strategies and technological innovations, which enable transformative solutions and practices that increase sustainability (Adams et al., 2016; Khan et al., 2023, 2023).

Technological innovation is increasingly recognized as essential for corporate sustainability by allowing more efficient use of resources, green practices, and sustainable product designs which link corporate performance to environmental responsibility. The interconnection between innovation and sustainability is evident in R&D activities where innovation is not just a measure of corporate progress but is core to the firm's trajectory and environmental impact (Baumann et al., 2002). The responsibilities of R&D departments include among others, decisions related to the adoption of diverse technologies, the redesign of processes, and the creation of new products. The choices made among the range of alternatives have unique environmental impacts. This underlines the imperative to scrutinize the vital role and influence of decision-makers in R&D departments.

The focus of this paper is on the human capital in R&D units, and the role of corporate scientists. The literature mostly investigates human resources (HR) practices but overlooks the diversity in employee attributes. Understanding the dynamics and influence of specific employee types is crucial for the formulation and implementation of HR practices that enhance environmental awareness. The limited stream of research in this domain focuses primarily on the part played by the CEO and the firm's board members in shaping environmental strategies (Peng & Liu, 2016; Rahman et al., 2020) and generally ignores the distinctive contribution of corporate scientists.

The specialized training and deep understanding of technologies, processes, and environmental implications equip corporate scientists with the capabilities to shape the firm's strategic direction (Herrera, 2020). In addition, their greater awareness of environmental considerations means that they can increase the firms' ecological awareness and reduce its environmental footprint (Hansmann et al., 2020; Meyer, 2015; Tianyu & Meng, 2020). However, this aspect of their activities and influence is mostly intuited and has not been quantified.

The present study provides empirical evidence on the impact of corporate scientists on environmental R&D objectives. Our analysis includes more than 6,000 Spanish companies; we examine whether the proportion of the scientists in the firm's R&D department with a doctoral degree affects the emphasis on environmental R&D objectives. Since it has been shown that the presence of women scientists promotes socially responsible and environmental goals (Chan et al., 2019; Martínez et al., 2019; Xie et al., 2020), we investigate whether R&D departments with higher proportions of women scientists attribute greater importance to environmental objectives.

Differentiating between men and women scientists in this context matters not only in terms of challenging gender stereotypes in science (Carli et al., 2016) but also in terms of fostering diversity and women's representation. Women scientists face unique challenges including gender discrimination (Settles et al., 2006), and accounting for these issues is likely to encourage a more inclusive scientific environment. Moreover, acknowledgement of the intersectionality of gender reveals the additional barriers encountered by women scientists from diverse backgrounds. By studying the influence of women scientists separately, we provide a better perception of their specific contribution to the firm's environmental goals and a richer understanding of the scientist's role in environmental sustainability.

Our findings question the belief that the scientist's role in shaping environmentally responsible R&D objectives is self-evident. We demonstrate quantitatively that the presence of scientists and particularly women scientists, markedly increases the firm's propensity to pursue these objectives. Our research makes three main contributions. First, it challenges the conventional CEO and board member-centric perspective and demonstrates the influence of scientists in shaping the firm's environmental strategies. Second, it provides strong empirical evidence of the causal relationship between the presence of corporate scientists and the pursuit of environmental objectives; we employ an instrumental variable approach to address concerns over endogeneity. Third, we identify gender differences related to the importance of environmental issues which extends the body of work on gender and environmental standards.

The rest of the paper is organized as follows: section 2 reviews the relevant literature and discusses the theoretical framework guiding our study; section 3 presents the research methodology, data sources, sample, variable descriptions, and the empirical model; sections 5 and 5 report our findings, discuss some implications of our analysis, and suggest directions for future research.

2. Literature review

The multifaceted influence of HR on the pursuit of environmental objectives has been examined in some depth (Dwivedi et al., 2023; Stefano et al., 2018). The HR frameworks of environmentally and ethically responsible organizations include the alignment between sustainability and ethical aspects. Consideration for the environment must extend to more than administrative tasks. The inclusion of sustainability in the HR framework can provide tangible benefits such as enhanced employer branding (Yasin et al., 2023).

Sustainable HR management which involves a sustainability ethos in traditional HR practice is a significant driver of corporate sustainability. It has been shown that more effective corporate governance and greater efforts to achieve sustainability are linked intrinsically to the seamless integration of HR practices. This highlights the importance of valuing and nurturing employee talent and emphasizes that HR is fundamental to sustainability initiatives (Çolak & Elegel, 2020).

However, the practical achievement of an HR-driven sustainable future is more complex than the theory would suggest. We need empirical research to identify the mechanisms through which human capital influences corporate sustainability. Although the importance of HR practices is highlighted in the literature, the influence of the diversity of HR has received less attention. Diversity promotes innovation, enhances decision-making processes, and improves organizational performance (Pellegrini et al., 2018).

As a result, a wide range of HR attributes combined with inclusive HR practices can have a profound impact on corporate sustainability. The literature that studies the influence of CEOs and board members does not consider the contribution made by other employee types and does not take account of employee gender. Our analysis delves into the role of corporate scientists and their gender diversity.

2.1. Scientists and corporate environmental objectives

Traditionally, the role of scientists in firms has been linked to the generation and absorption of knowledge although some studies show that they can play different roles in corporate innovation processes (Deeds et al., 2000; Ding, 2011; McMillan & Thomas, 2005). Their advanced education and training, and experience of undertaking scientific and technological research endow them with tacit knowledge which by definition, is not easily imitated by others (Deeds et al., 2000; Subramaniam & Youndt, 2005; Wit-de et al., 2019).

As a result, for firms in science-driven industries, the scientific workforce is seen as a source of competitive advantage and as allowing access to up-to-date knowledge developed and accumulated in universities and research centers (Guido & Heinisch, 2020). Corporate scientists are firm employees with higher education (e.g., doctoral degree) who participate actively in the firm's research activities and generate publications and patents (Herrera, 2020).

Prior studies have measured the contribution made by corporate scientists to the firm's innovation process and research output measured by patents (Herrera, 2020). The presence in the firm of scientists increases the chances of patent applications (Herstad et al., 2015; Singh & Agrawal, 2011; Tzabbar, 2009) and the quantity (Gans et al., 2017; Luo et al., 2009) and quality of the firm's patents (Walsh et al., 2016). Their presence is also linked to the number of products developed and sold by the firm (Huo et al., 2021; Rao et al., 2008). Although there are some differences among these studies, their findings support a relationship between the presence of corporate scientists and an increase in the firm's inventive capacity.

However, analyses identifying the contribution of corporate scientists to the firm's strategy are scarce. There is some evidence suggesting that their level of education, role in the firm, and importance of the tasks they perform makes corporate scientists critical for various firm strategies. Some studies show that corporate scientists are useful for the forging of alliances with other agents (Subramaniam & Youndt, 2005) or attracting partners (Luo et al., 2009). However, more research is needed to understand the influence of the scientific workforce on broader aspects of firms' strategic behavior, and particularly firms' environmental strategies. Investigating the impact of corporate scientists on corporate sustainability is particularly significant in terms of scientists' vocational responsibility, centrality in R&D activities, and potential influence on other employees.

2.1.1. Educational foundations: the vocational responsibility of corporate scientists

First, unlike other types of employees, scientists have "vocational responsibility" which derives from their education and research training and affects the firm's decision-making. The notion of vocational responsibility is a theme that runs through their research training and is reinforced by experience in environments with high ethical standards. Glerup et al. (2017) discuss the idea of vocational responsibility in some depth; they point out that scientists are taught to critically scrutinize both their own work and the work of colleagues, and be meticulous about how they generate knowledge in order to meet their professional standards. Scientific work is shaped also by codes of conduct, codes of practice, and ethical principles which strengthen the scientist's prolonged visibility (prestige) within the practitioner community. The labor market for scientists is regulated by signaling, reputation, and scientific networks.

Stern's (2004) study suggests that the impact of profession-specific ethical codes on the careers of employees engaged in research should not be ignored since the researcher's identity is embedded in the scientific community's values and reward system in the context of pursuit of commercial objectives (Gittelman & Kogut, 2003). Furthermore, Ding (2011) shows that scientists draw on their technical background and experience to inform their business vision and demonstrates the effect of experience in this context. Ding suggests that the presence of entrepreneurial scientists increases adoption of open science methods, influences the organizational strategy choice, counterbalances the effects of the organizational environment, and reduces the deterrent effect of high-risk environments.

Note also that there seems to be a causal relationship between education level and concern for the environment (Meyer, 2015; Tianyu & Meng, 2020). The literature highlights the relationship between these aspects (De Silva & Pownall, 2014), and suggests that it is reinforced by the higher levels of education embodied in scientists and professors (Hansmann et al., 2020). It is reasonable to believe that recruitment of scientists with a doctoral degree will strengthen the firm's innovation activity, work ethic, and concern for environmental matters.

2.1.2. Steering sustainability: the central role of corporate scientists in R&D

Second, corporate scientists can influence environmental practices and objectives. Their activities include decisions about the execution and legitimation of R&D activities. Some studies show that scientists develop a better understanding of cutting-edge scientific knowledge development in universities and research centers (Ding, 2011) which can influence the firm's decision to adopt emerging technologies (Tegarden et al., 2012). Scientists in gate-keeping and boundary-spanning roles that allow the firm to collect, assimilate, and apply external knowledge (Herrera & Nieto, 2015; Rothaermel & Hess, 2007). Their in-depth knowledge of technology also can enhance the firm's ability to choose a technological structure which contributes to sustainability and sustainable practices. Corporate scientists are cognizant of the potential risks of adopting new technologies, and they allow firms to participate in networks and communities engaged in active debate of their use.

Scientists are responsible for the firm's R&D activities and they can exploit their tacit knowledge to create innovations (Agrawal, 2006; Stuart et al., 2007). The scientist's unique knowledge about an invention allows the firm to overcome the barriers to commercialization, and investigate new applications and their implications (Herrera & Nieto, 2015). The scientist must ensure that the exploitation of new knowledge is aligned to the firm's ethical and socially responsible practices. Scientists can exert a disproportionate influence on the application of ethical practices and codes during the use of a new technology to ensure its successful and responsible exploitation (Scarpellini et al., 2017).

The role of the corporate scientist has also been associated with legitimization of R&D activities. Convincing external evaluators and stakeholders of the legitimacy of these activities is achieved by signaling (Luo et al., 2009) which matters particularly in technology-intensive industries and in the context of the firm's links to universities and research centers which provide access to up-to-date scientific knowledge. Several studies suggest that hiring scientists provides the firm with the legitimacy required needed to convince stakeholders that it has the requisite technological capabilities for successful operations in the industry (Luo et al., 2009; McMillan & Thomas, 2005; Rao et al., 2008). Rao et al. (2008) suggest that corporate scientists are able to signal technical credibility, access to external knowledge, and capacity to absorb and utilize new knowledge. In science-based industries, scientific legitimacy has been shown to boost firms' market value (McMillan & Thomas, 2005). Consequently, the presence of scientists in the firm signals to its stakeholders that it has personnel with the expertise required to address the problems related to the discovery process and the capabilities for socially responsible use of scientific knowledge.

2.1.3. Leading by influence: corporate scientists shaping environmental perspectives

The third reason for the focus on corporate scientists is their influence on the behavior and perceptions of other employees (Barge-Gil et al., 2021; Herrera, 2020). This might stem from their hierarchical position in the firm (Ding, 2011), or their high level of productivity in terms of patents and publications (Baba et al., 2009; Kehoe & Tzabbar, 2015). Some study findings show that scientists can boost the productivity of other employees (Furukawa & Goto, 2006) through their interactions with the firm's staff (Almeida et al., 2011; Herrmann & Peine, 2011). These interactions can motivate the non-scientist employees to exploit new knowledge in new ways that respect the firm's ethics and foster sustainability.

Given their vocational responsibility and heightened environmental awareness, through their R&D activities corporate scientists can influence the behavior of others in the firm. We suggest that the presence of highly educated scientists in R&D units is likely to increase the firm's emphasis on environmental objectives.

2.2. Integrating a gender lens: understanding the role of women corporate scientists

In the context of the broader influence of corporate scientists on environmental objectives, an investigation of gender dynamics and the unique contributions of and challenges faced by women scientists in the corporate landscape is critical. Very little research analyzes the influence of women scientists working in corporate contexts (Herrera, 2020), and their influence on the firm's pursuit of sustainability in its R&D activities is generally ignored. This research gap may be attributed to the limited participation of women in the science, technology, engineering, and mathematics (STEM) fields (Piva & Rovelli, 2022) but even when women scientists are employed inequalities in scientific labor force participation, salaries, and responsibilities persist (Whittington, 2018).

The influence of women on firms' environmental behavior is analyzed in work examining the relationship between board gender diversity and corporate sustainability performance. Several studies show that board gender diversity is associated with a higher likelihood of the firm's engagement in sustainable practices, and gender diversity has been linked to environmental practices such as enhanced environmental disclosure (Liao et al., 2015; Alodat et al., 2023) and proactive environmental strategies (Xie et al., 2020).

This stream of work shows that firms with women directors have higher sustainability standards (McGuinness et al., 2017). The empirical evidence indicates that women's involvement in decision-making and the corporate board is often associated with stronger environmental commitment (Amorelli & García-Sánchez, 2020; Byron & Post, 2016). This is because the attitude to risk of women involved in decision-making is distinctive and reduces group polarization while offering new perspectives (Jeong & Harrison, 2017). Several studies find a modest but positive and persistent association between a stronger pro-environmental attitude among women compared to men and heightened concern over sustainability (Franzen & Vogl, 2013; Xiao & McCright, 2015; Zelezny et al., 2000). Women tend to engage more in sustainable behaviors such as recycling and energy conservation (Diamantopoulos et al., 2003).

While this strand of research suggests a positive influence of gender on corporate sustainability, the evidence is not conclusive. This is the motivation for the present examination of women scientists' contribution to environmental objectives. The relationship seems to be context-dependent (Chan et al., 2019; Franzen & Vogl, 2013; Hawcroft & Milfont, 2010). Our analysis focuses on women scientists in Spanish firms.

We investigate whether the presence of women scientists in the R&D unit is likely to enhance the firm's perception of the importance of environmental objectives.

3. Materials and methods

3.1. Sample selection and data source

The data come from the Spanish Technological Innovation Panel (PITEC), compiled by the Spanish Statistics Institute (INE). PITEC is aligned to the European Community Innovation Surveys (CIS) which investigate firm innovation. PITEC provides extensive data on firms' innovation strategies, outputs, objectives, and HR engaged in R&D activities. It provides insights into firms' perceptions about the importance of environmental aspects and its emphasis in their R&D activities. The PITEC website provides more details on the survey.[1]

PITEC provides annual data for over 460 variables; sustainable objectives are measured at three-year intervals which do not allow longitudinal analysis. For instance, the questions in the 2016 survey on environmental objectives refer to the 2014–2016 period. We use 2016 data which are the most recent available to analyze 6,003 firms. Almost 15% of these firms emphasized the importance of sustainability in the context of their innovation activities, and 9.12% of R&D departments included doctoral graduates. The sample includes both manufacturing and service firms to avoid a sole focus on high-tech sectors.

Table 1 presents the distribution of the firms in the sample, based on the inclusion of PhD researchers in the R&D department and research emphasis on environmental objectives.

We can see that 66.55% of firm R&D departments do not include a researcher with a doctoral degree, which suggests that the presence of a doctoral graduate is not a prerequisite for prioritizing environmental objectives.

Table 1. Sample distribution

	Firms not prioritizing R&D environmental objectives	Firms prioritizing R&D environmental objectives
Firms with no PhD graduates in the R&D department	90.88%	66.55%
Firms with PhD graduates in the R&D department	9.12%	33.34%

3.2. Variable measurement

3.2.1. Dependent variable

We are interested in the factors that influence firms' perceptions of the importance of environmental goals in the context of their R&D activities. The survey asked firms to rank the importance of sustainability-related objectives from 1 (high importance) to 4 (no importance). Importance of sustainability was described as "the quest to minimize environmental impact (obj_environmental)". We constructed a binary variable which takes the value 1 if the firm reported high importance and 0 otherwise. Despite lack of specific details (such as which environmental measures to adopt, which environmental laws to comply with), we consider these variables to be representative of firms' perceptions of the significance of sustainability goals in R&D departments.

3.2.2. Explanatory variables

The main explanatory variable measures the proportion of R&D staff with a doctoral degree, log-transformed due to its skewed distribution. PITEC asks about the proportion of women doctoral graduates in the R&D department which allows us to estimate the influence of women scientists.

3.2.3. Control variables

Potential differences in the characteristics of firms with R&D departments that prioritize environmental objectives are measured using a set of covariates including firm size (logarithm of number of employees), firm age (logarithm of number of years since firm establishment up to 2016), firm ownership (a binary variable which takes the value 1 for a private firm with no foreign capital), and exports as the percentage of foreign sales in total sales.

Since our dependent variable measures the firm's perceptions of R&D objectives, we included three binary variables for innovation activities: belonging to a high-technology or medium-technology sector, or a high-technology service sector (based on Eurostat's NACE Rev. 2 classification). Given the concentration of R&D activities in specific regions and locations, we include a binary variable which takes the value 1 if the firm is located in a science and technology park. We also included a binary variable which takes the value 1 if the firm receives public funding and 0 otherwise, and to minimize the risk of reverse causality we include a continuous variable measuring the percentage of internal R&D expenditure in the previous period (t-1).

3.3. Method

Prior work on the influence of corporate scientists on firms' innovation activities underscores the need to account for potential endogeneity. Essentially, a positive correlation between presence of scientists in the firm and changes to the firm's innovation strategies or objectives does not necessarily indicate a causal relationship (Nicola et al., 2004).

It should be noted also that some studies argue that the employment of scientists could be endogenous if correlated with unobservable variables influencing change such as unobserved firm competencies or R&D project characteristics (Herrera, 2020). To address possible endogeneity, we employ an instrumental variable (IV) probit approach. An IV approach establishes whether there is a causal relationship between presence of PhD researchers and particularly strong emphasis on environmental objectives. Our IV is regional supply of doctoral graduates in the firm's location. This is likely to influence recruitment of PhD graduates but should be uncorrelated with firm's perception of the importance of environmental objectives in R&D activities. It is reasonable to assume that regions with more PhD graduates will be more likely to employ doctoral graduate R&D scientists. In other words, our instrument (supply of doctoral graduates) has a significant impact on our variable of interest—corporate scientists—but influences only our dependent variable—importance assigned to environmental R&D objectives—through our variable of interest.

We employed Spanish science and technology statistics to construct an indicator for supply of doctoral graduates, based on number of PhD graduates in 2016 in the firm's region. Several studies of scientist recruitment rely on the supply of PhD graduates (Kim & Marschke, 2005; Nicola et al., 2004; Swift, 2018). We employed the Wald test of exogeneity for the IV and in all cases were able to reject the null hypothesis of no endogeneity. This suggests that a regular probit regression would not be suitable.

We implemented augmented inverse probability weighting (AIPW) to estimate the average treatment effect (ATE). AIPW has advantages in the context of the present study since it accounts for potential non-random treatment assignment while also accounting for binary treatment. By modeling both outcomes and treatment probability it provides doubly robust estimates (Glynn & Quinn, 2010) based on inverse probability weighting (IPW) for the parameters and regression adjustment to estimate the ATE. This results in robust estimates if either conditional mean or propensity score are correctly specified (Heckman & Vytlacil, 2007).

In summary, we employ IV and AIPW to establish the causality of the effect of scientists on the importance attributed to sustainable R&D objectives.

4. Main findings

Table 2 presents the model results. Column (2) presents the probit estimation from the IV, which identifies the factors influencing the firm's propensity to assign high importance to environmental objectives in its R&D activities. We see that the variable measuring share of R&D staff with a doctoral degree has a significant and positive influence on the propensity to prioritize environmental aspects. Specifically, a 1% increase in the share of PhD researchers is correlated with a 0.83[2] points increase in this propensity. The other estimations provide similar results. Column (4) presents the results of the IV probit for R&D departments employing women scientists and shows that the propensity increases to 1.352 points. This means that firms with women scientists among their R&D employees are more likely to assign high importance to sustainability. It supports the findings from other studies that women tend to be more environmentally conscious than men (McCright, 2010; Xiao & McCright, 2015).

The results for the control variables are also consistent with previous findings. Across various estimations, firm size, firm age, and belonging to a medium-technological-intensive manufacturing sector (including chemical manufacturing and automotive, naval, and aircraft industries) significantly increase the likelihood that the firm considers environmental R&D objectives as highly important. This is in line with studies that suggest that innovative, large, and older firms are more able to allocate resources to both R&D activities and sustainable practices and are more aware of the importance of communicating their environmental performance to stakeholders (Rehfeld et al., 2007; Zubeltzu-Jaka et al., 2018). Companies in medium-technology manufacturing sectors have higher average reputation and show higher rates of disclosure to investors about sustainability research. Sustainability activities are defined as R&D to address environmental concerns, climate change, and development of affordable clean energy and responsible consumption and production (Hernandez et al., 2020). Another factor that is positively associated with sustainable innovation is the amount of R&D investment in the previous year.

Table 2. Factors influencing firms' propensity to prioritize reduced environmental impact

	Impact of total number of scientists		Impact of total number of *women* scientists	
Method	**Probit**	**IV Probit**	**Probit**	**IV Probit**
All PhD graduates	0.138***	0.832***		
Women PhD graduates			0.135***	1.352***
Firm size	0.067***	0.051***	0.064***	0.025**
Firm age	0.089**	0.070**	0.085**	0.031
Ownership	−0.224***	−0.088*	−0.229***	−0.039
Exports	0.000	−0.001	0.000	−0.000
High-tech manufacturing sector	0.194*	−0.196**	0.214**	−0.286***
Med-tech manufacturing sector	0.213***	0.142***	0.213***	0.102**
High-tech service sector	−0.102	−0.589***	−0.073	−0.764***
Firm location in a science and technological park	−0.073	−0.197**	−0.064	−0.221***
Public funding	0.200***	−0.073	0.216***	−0.088
Internal R&D expenditures (*t*-1)	0.007***	0.002*	0.008***	0.002*
Constant	−1.899***	−1.518***	−1.851***	−1.066***
Number of observations	6,003	6,003	6,003	6,003
Wald test (Prob > chi2)		34.52***		38.26***

***$p < 0.001$, **$p < 0.05$ and *$p < 0.10$.

We can see that "high technology manufacturing firms" put less importance on environmental innovation (Eurostat's NACE classification includes manufacture of basic pharmaceutical products and preparations, and computer, electronics, and optical products as high technology) (Eurostat, n. d..). Although this result might seem surprising it is line with the literature. Belkhir and Elmeligi (2019) show that although less studied the pharmaceutical sector is significantly more emissions-intensive than the automotive industry. Despite the water contamination resulting from pharmaceutical manufacturing (Urbina et al., 2020), few studies investigate these firms' focus on the environment (Min et al., 2017).

The findings for the environmental impact of computer, electronics, and optical manufacturing firms are in line with previous research (Huang et al., 2009). The NACE high tech industry classification includes semiconductor manufacturing which produces significant chemical waste (Lin et al., 2019; Shen et al., 2018). Wen-Min et al. (2013) argue that while the broader implementation of sustainability standards in the semiconductor industry could provide long-term competitive advantage, it could also lead to poorer short term corporate performance due to increased costs and stricter accountability. These negative effects reduce the incentive to implement reforms without compulsory regulation. In the computer manufacturing industry, where managers have a high degree of industry-level discretion (IDL) or "*latitude of action*" this is particularly relevant and could be used as justification to abandon sustainable practices (Won-Yong et al., 2016).

A similar negative result is observed for firms located in science and technology park which tend to be high-technology firms (Cheng et al., 2014). It would seem that certain ownership structures are associated with a lower probability of attributing importance to environmentally responsible innovation. The literature points to the impact of different types of ownership structure on both innovation and environmental objectives (Wang et al., 2019; Wen-Min et al., 2013). The variables public funding and exporter seem not significant in our context.

Our use of AIPW allows us to claim a causal relationship between the presence of PhD graduates in the R&D department and prioritization of environmental objectives (see Table 3). The ATE is 0.217 which is the average importance attributed to environmental objectives were all companies to employ PhD graduates. This is significantly higher than the estimate for the potential-outcome mean of 0.164 which captures the importance attributed to these objectives if none of the companies were to employ scientists (i.e., the importance in the absence of treatment).

5. Conclusions

The value of corporate scientists has traditionally been assessed based on their contributions to a firm's inventive capacity and patent output. However, given their specialized training, central roles, enhanced environmental awareness, and esteemed standing, scientists are uniquely positioned to influence facets of the firm beyond their primary scientific contributions.

We set out to quantify the impact of scientists in the firm by studying their contribution to the company's environmental R&D strategy. IV estimations allow us to claim a causal relationship between these variables and evaluate the causal effect of the presence of women scientists in the R&D department. Our empirical investigation was conducted in the Spanish context and provides two main findings.

First, our estimates show that a higher proportion of scientists in the firm increases the environmental consciousness of research groups and the emphasis on sustainable innovation objectives. Second, our findings indicate that research teams with a higher proportion of women scientists are more likely to prioritize environmental objectives. Consistent with previous research, we found that high-technology manufacturing sectors typically assign less importance to environmental objectives whereas company age and size are positively correlated to prioritization of sustainable R&D objectives.

Our study adds to our theoretical understanding of corporate sustainability. It underlines the need to extend scrutiny of the influence of human capital on corporate sustainability beyond the positions of CEO and board member. We suggested that corporate scientists are particularly important. By highlighting that a high concentration of scientists enhances the firm's environmental awareness, we provide a more nuanced understanding of what promotes sustainable innovations.

Table 3. Treatment effects estimation using AIPW

Augmented IPW	
Treatment model: probit	
	Number of observations: 6,003
ATE	Coef. (Std. Err)
PhD graduates (1 vs 0)	0.217 (0.032)***
ATE	
PhD graduates (0)	0.164 (0.006)***

***$p < 0.001$, **$p < 0.05$ and *$p < 0.10$.

Additionally, we investigated the gender dynamics within research teams and identified a greater emphasis on environmental objectives among research teams that included women scientists. This adds to work on the role of gender in promoting corporate sustainability. In line with the resource-based view of the firm, we found that workforce diversity and the accompanying broad range of skills and insights, enhance the firm's capacity for innovation and adaptability. Our findings support this view and have relevance for related fields including corporate social responsibility strategies, innovation management, and green HR management practices.

Our findings have implications for organizations by suggesting the need to change the direction of their human capital strategies. Since the presence of corporate scientists seems to significantly shape the firm's sustainability activities firms should make deliberate efforts to recruit, retain, and develop their scientific talent. Our findings suggest also that firms in high tech sectors in particular should make special efforts to increase gender diversity and inclusivity in the innovation and research functions. They should also provide specialized training initiatives designed specifically to enhance sustainable innovation activities among corporate scientists. Our findings support the idea that talent is pivotal for companies striving for sustainability.

Our study has some limitations, which could be addressed in future research. Firstly, our sample is specific to the Spanish context. Although it includes more than 6,000 companies which give it internal validity, external validity is limited. Future research should replicate the analysis in other country contexts. Secondly, large companies may be over-represented at the expense of small and medium-sized businesses. Nevertheless, it contributes by estimating the impact of corporate scientists on environmental R&D objectives in the Spanish context. Lastly, previous studies have identified certain preconditions for positive outcomes from team diversity. These include a critical mass of women in the team (Amorelli & García-Sánchez, 2020), a supportive corporate environment, and regulation to ensure inclusiveness (Halliday et al., 2021). We need more research to understand the interactions among and potential limiting effects of these factors in the context of gender diversity in R&D departments.

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Notes
1. https://www.ine.es/dyngs/INEbase/en/operacion.htm?c=Estadistica_C&cid=1254736176755&menu=metodologia&idp=1254735576669
2. B*log(1.01).

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