Does foreign ownership promote environmental protection? Evidence from firm-level data

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Abstract This paper examines the role played by foreign ownership as a determinant of the environmental behaviour of Spanish manufacturing firms. Unlike previous studies, our analysis distinguishes between current expenditure on and investment in environmental protection as a way of examining potential differences in the firms' short- and long-term strategies. The results show how foreign capital boosts expenditure and especially investment. We also highlight the relevance of accounting for heterogeneity at the firm level by focusing on certain structural characteristics that are key in the manufacturing sector, namely, the size of the firm and the sector of activity where it operates. Our results show that size has a positive effect on firms' decisions about environmental protection. The empirical results also reveal that the beneficial impact of foreign investment is mainly channelled through small firms and it is most evident in industries which are subject to less environmental regulation. Our findings may have pertinent implications regarding the determinants of firms' environmental behaviour and about the effectiveness of foreign participation as a mechanism for overcoming potential barriers in the adoption of environmental protection measures by small firms.

Plain English Summary Macro-level studies conclude that foreign ownership promotes environmental protection. But what does firm-level data say about the matter? We contribute to the scarce and controversial evidence about this topic at the firm level by using data from a large sample of Spanish manufacturing firms. Our results show that foreign capital drive decisions on expenditure and, especially, in investment in environmental protection. We also reveal that the role played by foreign ownership in the adoption of environmental protection measures is particularly relevant for small businesses, and it is most evident in industries which are subject to less environmental regulation. These findings provide useful insights about the effectiveness of foreign capital participation as a mechanism for overcoming potential barriers in the adoption of environmental protection measures. This is particularly relevant in the case of small firms, which are predominant in the manufacturing sector of most countries.

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1 Introduction

Since the Paris Agreement on climate change, there has been a growing need to examine the factors that may play a crucial role in reinforcing environmental protection worldwide. This paper focuses on this question and provides new insights about the relevance of foreign ownership as a driver of improvement in firms' environmental behaviour. Whereas much of the literature in this research area is based on aggregate time series data, the present paper addresses this topic by using an extensive dataset at firm level. The empirical analysis carried out allows us to explore whether greater participation of foreign capital in a firm increases the probability of adopting expenditure and investment decisions that foster environmental protection, and—as a particularly novel contribution to the literature—the extent to which the effect of this participation may differ in small firms. We thereby contribute to the small business economics literature by highlighting the relevance of accounting for firm size heterogeneity and analysing the extent to which the interaction between firm size and foreign ownership could affect the decision-making process about expenditure on and investment in environmental protection.

Most companies owned by external investors are multinationals, which are subject to greater public scrutiny regarding their efforts to protect the environment (Collins & Harris, 2005) and may employ more energy-efficient and cleaner technologies in compliance with stringent international regulations (Cole et al., 2008; Dyck et al., 2019). Multinational companies tend to be larger and more technologically intensive than domestic firms in the host countries, and as such, they can facilitate the implementation of new technologies as well as the adoption of better managerial practices that have an energy-reducing effect (Eskeland & Harrison, 2003; Herzer & Schmelmer, 2022). That is the reason why most previous macro-level studies about this topic have focused on inward foreign direct investment (FDI) flows. According to the pollution halo hypothesis, inward FDI may serve as a channel for the international transfer of environmentally friendly technologies and practices, thus directly contributing to environmental progress in the destination country (see Liu et al., 2017; Brucal et al., 2019 and Herrerías et al., 2013; among others). However, FDI might also be deliberately targeted at

regions or countries with relatively weak environmental regulations. Polluting industries in developed countries tend to move to developing countries due to strict regulations and the rising cost of pollution abatement in developed countries (pollution haven hypothesis). Thus, FDI would be detrimental to the environment, especially in developing countries (Cole et al., 2011; Shahbaz et al., 2015; Zhu et al., 2016).

To the best of our knowledge, the most recent in-depth review of this topic is the meta-analysis carried out by Demena and Afesorgbor (2020), who concluded that inward FDI significantly reduces environmental emissions. This result is robust to disaggregating the effect by countries at different levels of development, as well as by different environmental indicators of pollutants. In spite of this evidence at the macro level, there are few studies at the firm level. As far as we are aware, there are only two studies—the one by Haller and Murphy (2012) as well as its recent extension by Siedschlag and Yan (2021)—that have examined this subject by applying an empirical approach to manufacturing industries. Both are focused on Ireland and their results show that foreign affiliates are less likely than local firms to invest in environmental protection.

Our paper contributes to the evidence on the role of foreign ownership in firms' environmental behaviour using microdata for a large sample of Spanish manufacturing firms, therefore examining this issue for a country other than Ireland. A second contribution is based on the distinction between current expenditure and investment, which allows us to differentiate between the firms' environmental strategies in the short and long term (Sueyoshi & Goto, 2009). The existence of differences can have significant implications regarding the role played by foreign ownership as a main driver of a firm's decisions regarding environmental protection. Also, this distinction can be pertinent at the macro level due to the significant differences between the evolution of European Union member states' national environmental expenditures or investments (see Eurostat, 2021). Finally, we contribute to the scarce evidence about this topic at the firm level. More specifically, we highlight the relevance of accounting for certain structural characteristics such as size as well as the sector of activity where the firm operates. Small firms, which are predominant in the Spanish manufacturing sector, face greater difficulties than large firms in adopting advanced

environmental protection measures (Murillo-Luna et al., 2011). Nevertheless, the literature about the behaviour of small and medium-sized enterprises (SMEs) regarding environmental practices shows two opposite views. While some studies argue that SMEs are more reluctant than large firms to engage in environmental practices, others find that certain characteristics of SMEs may facilitate their engagement in environmental protection activities (Hoogendoorn et al., 2015). As well as directly examining the effect of the size of the firms on these decisions, we focus on how the effects of foreign ownership differ depending on whether they are small or large firms. In addition, the potential role played by foreign shareholders as drivers of environmental protection expenditure and investment decisions may differ depending on the level of stringency of environmental regulation that the different industries face.

The rest of the paper is organised as follows. Section 2 highlights our contribution to the existing literature focused on the firm level and explains the need to account for firm heterogeneity. Section 3 describes the data source and the main variables used in the empirical analysis. Section 4 presents the methodology and the empirical results. Section 5 discusses these results, and Sect. 6 concludes.

2 Background

The role played by foreign ownership in promoting the use of environmentally friendly technologies in host countries has been thoroughly investigated. As mentioned above, there is macro evidence to support a positive impact of foreign ownership on environmental protection. Nevertheless, the positive impact of this variable on the environmental performance of host locations cannot be taken for granted. While greater foreign ownership of a firm could reasonably be expected to provide greater access to foreign technology, with the associated positive environmental impact, whether such technology is actually utilised may depend on the characteristics of the firm (Cole et al., 2008). In other words, besides mere access to technology, what matters when it comes to improving firms' environmental behaviour is their ability to use this technology, which seems to be highly dependent on certain characteristics of the firms. These characteristics may also play a relevant role in mediating the

impact of foreign ownership on both expenditure and investment and, therefore, on the environmental strategies of firms in the short and long run, respectively.

However, evidence about how firm-level characteristics may be channelling the possible benefits of inward FDI is scarce. Moreover, firms can face barriers (both external and internal) related to financial constraints, knowledge, human resources, managerial issues and regulation, which might prevent them from adopting environmental protection strategies (Murillo-Luna et al., 2011). From a resource-based view, the participation of foreign capital may help to overcome these barriers by bringing in resources, technology and managerial skills.

We focus mainly on size as small firms are predominant in the Spanish manufacturing sector. These firms might face greater difficulties than large firms in adopting environmental protection measures because of their lack of resources, their negligible market share and their low media and public profile (see Hoogendoorn et al., 2015 and Murillo-Luna et al., 2011). Also, the impact of different greening activities on firm performance varies across the size distribution of the firms (Shrivastava & Tamvada, 2019). Size is expected to have a positive impact on both the firm's propensity to spend on and invest in the environment, as well as on the amount spent (Cole et al., 2008; Costa-Campi et al., 2015; Haller & Murphy, 2012). Nonetheless, small- and medium-sized enterprises (SMEs) have recently been recognised as central contributors to sustainable development (Klewitz & Hansen, 2014). Small firms can offer radical solutions to the challenges of sustainability (Shrivastava & Tamvada, 2019). As has been highlighted by Hoogendoorn et al. (2015), the role of SMEs in this regard remains underexplored, and, too often, policies are based on insights from large firms. By using large-scale harmonised data for almost 8000 SMEs across 12 sectors in 36 countries, these authors clearly reject the prevailing idea that small firms are reluctant to invest in environmental practices. More specifically, they conclude that SMEs are more likely to engage in greening their product and service offerings when environmental legislation is strict. Our findings provide additional insights about this question, as we show that, even in less polluting industries, the participation of foreign capital is an important factor explaining SMEs' investment decisions aimed at reducing emissions and pollution. Finally,

while both large and small companies can engage in sustainability-oriented innovation (SOI), SMEs will innovate differently. For example, Klewitz and Hansen (2014) note that SMEs behave more proactively when it comes to integrating ecological aspects into products, processes and organisational structures. According to these authors, interaction with external actors can ultimately increase SMEs' innovative capacity for SOI. The main hypothesis of their paper is supported by the evidence obtained in our paper about the higher impact of foreign ownership on the environmental decisions of small firms.

Regarding the sectorial dimension, countries can gain significant energy productivity improvements as they shift from energy-intensive to less energy-intensive sectors (Deichmann et al., 2019). Empirical evidence shows that FDI flows into manufacturing and non-financial services increase pollution, while those flowing into services support the halo effect hypothesis (Doytch & Uctum, 2016). Similarly, Haller and Murphy (2012) found that Irish firms/sectors that are more energy intensive require more environmental expenditure or capital investment in pollution reduction due to the emissions created by their extensive use of fossil fuels. Our focus is on the industrial sector as it is one of the main culprits behind environmental degradation. However, it is important to consider the relevance of heterogeneity within that sector as regulations vary across activities. As an example, at the firm level, Collins and Harris (2005) show that the impact of foreign ownership on chemical plant pollution abatement expenditure in the UK differs substantially from that in other industrial sectors. The relevance of accounting for sectoral heterogeneity is also highlighted by Haller and Murphy (2012). These authors do not find evidence of a significant role played by foreign ownership as a determinant of investment in environmental protection. They argue that this result is likely due to the fact that the largest shares of foreign-owned firms tend to be in sectors where capital investment in equipment for pollution control is rather low. This may be because they had already invested in environmental equipment when they first became subject to the European Union's Emissions Trading System (EU ETS). These findings show the relevance of accounting for the sectorial dimension, which also allows us to consider the effect of specific regulations that may differ between sectors and activities. Demirel and Kesidou (2011) also point

to the need to consider the sectorial dimension by distinguishing between highly and medium polluting sectors. According to these authors, regulations have a particularly strong impact in terms of motivating companies to adopt eco-innovations, while they have a smaller yet still significant impact on the intensity of investments in eco-innovations. De Vita et al. (2021) also found that the impact of FDI differed across sectors and concluded that policymakers interested in fostering energy efficiency need to treat inward FDI inflows across the various sectors differently.

Furthermore, accounting for sectoral heterogeneity enables a better identification of spillovers, as aggregate studies usually fail to detect them (Görg and Greenaway, 2004). These spillovers (as a secondary channel of technology transfer from FDI) may result in productivity growth or higher export growth in the host economy through several channels such as knowledge externalities, imitation, skill acquisition, competition and an increase in exports. Spillovers may occur within the industry (horizontal) as well as across industries due to customers (forward linkages) or suppliers (backward linkages) (Havranek and Irsova, 2011; Görg and Strobl, 2001; Belderbos et al., 2001, 2021). Our analysis does not incorporate these potential spillovers as our dependent variables refer to environmental investment and expenditure instead of an increase in productivity or exports, which would be a more appropriate way to account for spillovers. This might constitute a potential limitation of the present study and opens up an avenue for further research. In contrast, one of the main contributions of our analysis is that it provides evidence at the firm level, which, according to Görg and Greenaway (2004), is the most suitable level of scrutiny for this type of research.

Besides these two variables (size and the sector of activity where the firm operates), we also include as controls three additional variables that have been used in previous studies. The relevance of family ownership, which accounts for the majority of businesses in both developed and developing countries, has attracted growing attention. Once again, the evidence here is controversial. On the one hand, firms with a greater degree of family ownership may perform worse on environmental indicators because they do not have the management and financial resources to invest in environment-friendly initiatives. Besides, tighter family control can lead to more activities

which focus on individual benefits. In cases where the ownership structure is heavily concentrated within the family, firms may exhibit more self-focused behaviour and ignore investments that do not bring personal benefits (Rees & Rodionova, 2015). Moreover, managers in family firms tend to be risk averse and mainly interested in preserving the wealth of the firm (see Dal Maso et al., 2020). On the other hand, by concentrating power within the family, family-owned firms can execute their strategy more quickly than non-family firms (Adomako, et al., 2019). Using panel data from Spanish manufacturing firms, Garcés-Ayerbe et al. (2021) recently concluded that the financial benefits derived from environmental investment are positive and significant in family firms, while this is not the case in non-family firms. According to their study, the business management literature provides evidence on distinctive features of family firms, such as their concern for defending and preserving the family reputation, their vision and long-term commitment, or the greater involvement and loyalty of their employees, which suggests that the economic effects of environmental strategies could be greater in this kind of firm. But what happens when external investors come into play? According to Zhu and Lu (2020), foreign capital can influence family business decisions regarding environmental responsibility. When external shareholders have significant ownership, the reputational and ethical pressure to behave in an environmentally responsible way is more intense. This is especially true when investments come from more developed economies that have more rigorous environmental standards and regulations. In fact, when firms receive investments from foreign investors with strong corporate social responsibility norms, their own subsequent social performance is likely to improve (Dyck et al., 2019). Therefore, the prevalence of foreign investments will strongly mitigate the negative relationship between family ownership and corporate environmental responsibility spending.

The age of firms is another variable that may affect the adoption of environmentally friendly technologies. It can have a twofold effect. On the one hand, older firms might have lower resource constraints and a greater ability to obtain funding. Furthermore, the firm's experience can be important for the growth benefits of green technologies, possibly due to the complexity of their management (Leoncini et al., 2019). On the other hand, younger firms will have

newer machinery with some new technology which is likely to incorporate environmental standards. As a result, it may be cheaper for them to invest in additional measures (Haller & Murphy, 2012). Generally speaking, young firms can offer radical new solutions to the challenges of sustainability as they have an advantage in terms of innovation. They also show a greater environmental commitment and are more attractive to environmentally aware customers. Their close connection to suppliers, customers and competitors enables them to benefit from an open innovation approach (Coad et al., 2016; Leoncini et al., 2019). According to Shrivastava and Tamvada (2019), green products and services offered by older firms may not be radically different from their existing product portfolio and producing these products may not have a huge impact on their performance. In contrast, the green products and services offered by new market entrants are more likely to provide for an emerging trend and are more likely to positively impact firm performance.

Finally, there is abundant literature pointing out that human capital and skill endowment are important drivers of innovation (Bhaskarabhatla et al., 2021; Falk & Hagsten, 2021; Leiponen, 2005; Piva & Vivarelli, 2009). In particular, Leiponen (2005) shows that there is a positive association between human capital and innovation performance, and Piva and Vivarelli (2009) state that there is a positive relationship between ex ante available skills and R&D investments. Human capital availability also seems to be a determinant of the environmental behaviour of the firm (Brucal et al., 2019); indeed, some studies (Horbach, 2008) have shown that having a high share of qualified employees promotes the introduction of environmental product innovations. Nevertheless, the literature is not entirely conclusive regarding the existence of a positive relationship between highly educated employees and eco-innovations (Del Río et al., 2016; Horbach & Jacob, 2018).

In addition, by using firm-level data for manufacturing firms in Ghana, Cole et al. (2008) reveal that the variable that has the most notable effect in terms of reducing fuel use is whether the firm's decision-maker has foreign training. This foreign training is most effective at reducing fuel use in firms with greater foreign ownership. Similarly, Lan et al. (2012) conclude that FDI is negatively associated with pollution emission in those

Chinese provinces with higher levels of human capital, whereas FDI is positively related to emissions in provinces with lower levels of human capital. An additional and related question pertains to the role played by R&D in augmenting the technological absorptive capacity, which might have a positive effect on firms' environmental behaviour. According to the absorptive capacity argument of Cohen and Levinthal (1990), domestic firms need to possess a certain level of human capital and technological knowledge in order to understand, assimilate and exploit knowledge and technologies from foreign affiliates. De Vita et al. (2021) have recently highlighted the existence of a threshold effect of R&D in the FDI-energy intensity nexus in OECD countries. According to these authors, whenever the level of sectoral R&D is below a certain threshold, FDI to non-primary sectors increases the level of energy intensity, but that effect decreases when the sectoral R&D level is above the threshold. In contrast, Costa-Campi et al. (2015) conclude that investments in R&D per employee in the manufacturing sector in Spain do not directly affect the firm's capacity to improve its energy efficiency.

The two previous sections highlight the controversy regarding the impact of foreign ownership on environmental decisions as well as the scarce evidence about this topic at the firm level. Our main aim is to analyse those firm-level characteristics that may interact with foreign ownership to either augment or block its positive impact on environmental protection for a large sample of Spanish manufacturing firms. To the best of our knowledge, no previous studies have provided evidence about this topic. In a nutshell, the empirical analysis carried out in the following sections seeks to fill several gaps in previous literature. More specifically, we examine if there is a change in the firm's probability of adopting environmental protection measures when foreign participation increases. Also, unlike previous studies, we distinguish between expenditure and investment and, therefore, between the impact of foreign capital on the firm's environmental strategies in the short and long run, respectively. Moreover, we highlight the relevance of accounting for firm-level heterogeneity with a special emphasis on the firm's size as well as the sector to which each firm belongs.

3 Data and variables

In this paper, we use information for the year 2016 from the Survey on Business Strategies (*Encuesta Sobre Estrategias Empresariales*, henceforth ESEE), which has been frequently used in empirical analyses (e.g. Arqué-Castells, 2013, and Doraszelski & Jaumandreu, 2013). Since 1990, the ESEE has collected information about the decisions and strategies of manufacturing firms operating in Spain, under an agreement between the Spanish Ministry of Industry and the SEPI foundation (http://www.funep.es/esee/en/). It compiles extensive data on around 2000 companies, through a sampling procedure which ensures representativeness applying both exhaustive and random sampling criteria depending on the number of employees of the firms. Specifically, those firms with more than 200 employees are included in the first category, and therefore, a survey questionnaire is sent to all these firms. The second category is composed of firms with between 10 and 200 employees (although in some of the firms the number may be lower if they lost employees since the year in which they began to participate in the survey). The firms in this second category were selected through a stratified, proportional and systematic sampling with a random seed. Reflecting the structure of the manufacturing industry in Spain, most of the firms of our sample are SMEs. Specifically, 83.4% of the firms have 200 employees or fewer.

Following the recommendation for collecting environmental protection data (European Union, 2021), the survey distinguishes between current expenditures and investment. Current expenditures on environmental protection are defined as "the expenditures for operating and maintaining an activity, technology, process, equipment (or parts thereof) designed to prevent, reduce, treat or eliminate pollutants and pollution or any other degradation of the environment resulting from the operating activity of the company" (European Union, 2017). They include in-house expenditure (e.g. labour costs and maintenance of environmental protection equipment) and purchases of environmental protection services. Investments are defined as the capital expenditures with the same purpose as defined above for current expenditures on environmental protection. They involve investment in plant and equipment for pollution control and special anti-pollution accessories (end-of-pipe equipment)

and investment in plant and equipment linked to cleaner technology (integrated technology).

Firms can make two types of corporate effort regarding environmental protection: a short-term effort with current expenditures or a long-term effort with capital expenditures spent on assets with a useful life longer than one year. Our data show that in 2016, around 54% of the firms in this survey registered expenditures on environmental protection while 25% invested in equipment and facilities related to environmental protection. Investments in environmental protection are very frequently accompanied by current expenditures, with a correlation of 0.43 between these two variables. In our survey, 92% of the firms that invested in environmental protection also registered current expenditures in 2016. Conversely, 58.1% of the firms had made current expenditures without having invested (see Tables 1 and 2 for descriptive statistics and correlations, respectively).

We are interested in knowing whether environmental protection efforts are affected by foreign capital participation (*Foreign*), a research question strongly motivated by the fact that foreign investors have a notable presence in the Spanish manufacturing industry. In our sample, we observe foreign capital participation in 18% of the firms. The ESEE provides data about the percentage of direct or indirect participation of foreign capital in the company's share capital. Unfortunately, it does not offer more information about the type of foreign investment. Nevertheless, in 80% of the firms in Spain with foreign capital participation, the ownership is entirely in the hands of foreign investors; the participation of foreign capital is below 50% in only 6.2% of the firms, while none of the firms has foreign capital participation of less than 10%. Usually, a firm is considered foreign if 10% or more of its share capital is in hands of foreign investors. In addition, it is assumed that the strategies are dictated by the parent companies when they own more than 50% of the firm's capital (Kohler and Smolka, 2011). These figures suggest that in almost all the

Table 1 Descriptive statistics (1716 observations)

Variable	Description of the variable	Mean	Std. Dev	Min./Max
Expenditure	Environmental protection expenditure. Dummy = 1 if the firm has made current expenses in environmental protection, 0 otherwise	0.542	0.498	0/1
Investment	Environmental protection investment. Dummy = 1 if the firm has invested in environmental protection, 0 otherwise	0.247	0.431	0/1
Foreign	Participation of direct or indirect foreign capital in the company (as per unit)	0.122	0.320	0/1
Size	Total number of employees (average number of employees during the year)	149.731	527.100	2/11,598
Family	Dummy = 1 if a familiar group is actively involved in the control or management of the firm, 0 otherwise	0.444	0.497	0/1
Age	Number of years that the firm has been operating	32.009	17.890	0/132
Skill	Number of graduates (university and 3-year degree course) employed per worker	0.702	1.039	0/23.6
R&D	Total personnel (full-time equivalent) engaged in R&D activities	5.060	43.946	0/1650

Source: Spanish Survey of Business Strategies (2016)

Table 2 Correlation matrix (1716 observations)

	Expenditure	Investment	Foreign	Size	Family	Age	Skill	R&D
Expenditure	1							
Investment	0.434	1						
Foreign	0.205	0.229	1					
Size	0.158	0.232	0.221	1				
Family	0.059	0.043	−0.176	−0.040	1			
Age	0.103	0.149	0.086	0.092	0.095	1		
Skill	0.128	0.081	0.169	0.055	−0.013	0.069	1	
R&D	0.086	0.113	0.101	0.691	−0.029	0.056	0.101	1

firms with foreign capital, the strategic decisions are taken by foreign investors.

We are also interested in examining the effect of the size of the firms (*Size*), measured as the total number of employees, and also its mediating role in the effects of foreign capital participation on environmental protection expenditure and investment. There are notable differences in the decisions on environmental protection according to the size of the firms. While 82.4% of big firms (more than 200 employees) have made expenditures on environmental protection, the corresponding figure for firms with fewer than 200 employees is slightly less than 50%. For smaller firms (fewer than 50 employees), 35.6% of them have spent on environmental protection. Regarding investments, these percentages are 58.6% for big firms, 17.9% for firms with fewer than 200 employees and only 9% for the firms with fewer than 50 employees, revealing the importance of considering the size of the firms in the empirical analysis.

We also take into account other structural characteristics of firms, including the number of years since the firm was established (*Age*), and whether the firm is family-owned (*Family*). Two other control variables related to human capital and R&D are also considered, namely, the number of engineers and graduates as a percentage of total employees (*Skill*) and the total number of personnel engaged in R&D activities (*R&D*).

Finally, it should be noted that in the empirical analysis in the next section, we further distinguish between regulated industries covered by the European Union Emissions Trading System (EU ETS) and other manufacturing industries. The propensity of firms to spend on and invest in environmental protection may be different depending on the sector they belong to. Industries present a high degree of heterogeneity in environmental regulations and in pollution intensity and they may have greater or lesser incentives to invest in environmental protection. For instance, it is very likely that the most polluting industries have more private incentives to invest in energy-efficient technologies. The industries covered by the EU ETS (phase 3) are paper (17, NACE Rev. 2), chemicals (20), non-metallic mineral products (23) and basic metals (24). In Spain, as in other countries (Demirel & Kesidou, 2011), these industries are highly polluting and are very energy intensive. To examine whether there are differences in the effects foreign capital has on the decision-making process about spending on and investing in environmental protection, the estimations have been carried out separately for these four industries and for the other less regulated industries. These two groups of industries present some differences regarding environmental protection. While in the industries covered by the EU ETS, more than 70% of the firms report current expenditure on investment in environmental protection; the equivalent figure in the other industries is 52.3%. Therefore, although the percentage is smaller, these figures show that non-regulated industries are also taking significant action on environmental protection (Table 3).

4 Empirical results

We begin this section by specifying a two-equation system in order to empirically examine the probability that participation of foreign capital in firms' ownership and firm size affect spending and investment in environmental protection. We use a bivariate probit specification where each of these probabilities can be determined by the level of each variable of interest, specifically, by the ratio of foreign capital participation (*Foreign*), and the size of the firm measured in terms of the number of workers (*Size*). A set of control variables is also introduced in both equations.

Table 3 Spending and investment decisions by type of sector

	High-regulated sectors		Low-regulated sectors		All sectors	
	Obs	Percentage	Obs	Percentage	Obs	Percentage
Without protection	98	28.4	654	47.7	752	43.8
Expense or investment	113	32.8	461	33.6	574	33.4
Both decisions	134	38.8	256	18.7	390	22.7
Total observations	345		1371		1716	

These control variables capture information about the industrial sector to which each firm belongs, as well as some firm characteristics that are assumed to be exogenous and could be affecting decisions on environmental protection, according to the literature. We specifically refer to the age of the firm (*Age*), whether a family group is involved in overseeing or managing the firm (*Family*), the number of graduates as a percentage of total workers (*Skill*) and the total number of employees engaged in R&D activities (*R&D*). An extended bivariate probit with an interaction term for our variables of interest (i.e. *Foreign* x *Size*) is considered as an alternative.

The nature of our cross-sectional data will allow us to control for firm heterogeneity, but not to test the direction of causality between variables, which is a limitation of the empirical analysis. Consequently, we can only trust that the characteristics of firms selected here as regressor variables are basically independent of their decisions to spend on and invest in environmental protection. Therefore, in order to strictly interpret the outcomes that we will present below in terms of causal links, we need to assume exogeneity of the regressors in line with other analyses with firm-level data discussed in Sect. 2 (e.g. Cole et al., 2008; Costa-Campi et al., 2015; Hoogendoorn et al., 2015; Horbach, 2008; Shrivastava & Tamvada, 2019). In Table 4, we show the estimation results of both models described above using the maximum likelihood procedure. Regardless of the model considered, the null hypothesis of no correlation with unobserved determinants of both expenditure and investment decisions is clearly rejected. This indicates that the results presented here are preferable to those that could be obtained by estimating an individual probit equation for each type of decision. We also ask whether the model with the interaction term can better explain both dependent variables: because the simplest model is nested within the other, this question is easy to answer. The outcome from the corresponding Wald test indicates that adding the interaction term as a regressor leads to a statistically significant improvement in the fit of the bivariate probit model. Therefore, we focus below on the results from the model extended with this interaction term.

Table 4 Empirical results for all industrial sectors

Dep. variable:	Bivariate probit		Bivariate probit		Equality test (x^2)	Probit I
	Expenditure	Investment	Expenditure	Investment		Env. protection (y)
Foreign	0.4726*** (0.1296)	0.5533*** (0.1209)	0.4711** (0.1858)	0.9455*** (0.1450)	6.09 (0.014)	0.9045*** (0.1458)
Size	0.0012*** (0.0005)	0.0010* (0.0006)	0.0017*** (0.0006)	0.0025*** (0.0006)	6.62 (0.010)	0.0022*** (0.0005)
Foreign×size			0.0000 (0.0010)	−0.0021*** (0.0006)		−0.0018*** (0.0006)
Family	0.2654*** (0.0659)	0.2519*** (0.0716)	0.2625*** (0.0662)	0.2479*** (0.0738)		0.3129*** (0.0759)
Age	0.0029 (0.0020)	0.0073*** (0.0019)	0.0026 (0.0020)	0.0067*** (0.0019)		0.0048** (0.0020)
Skill	0.0712* (0.0456)	−0.0081 (0.0382)	0.0724 (0.0456)	−0.0065 (0.0386)		−0.0101 (0.0366)
R&D	0.0224*** (0.0084)	0.0046 (0.0045)	0.0205** (0.0081)	0.0026 (0.0034)		0.0032 (0.0034)
Number of obs	1716		1716			1716
Log likelihood	− 1022.08 − 1726.14	−808.47	− 1021.51 − 1699.14	−783.85		−752.45
ρ	0.666 (0.034)		0.668 (0.034)			
Wald test of ρ = 0	177.41 (0.000)		212.45 (0.000)			
Wald test for models	15.17 (0.000)					

Regressions contain a dummy variable for each one of the twenty industrial sectors. Robust standard errors and *p*-values are in parenthesis. The symbols ***, ** and * denote statistical significance at 1%, 5% and 10% level, respectively

An overview of our estimates indicates that most of our regressors have some influence on the decision-making about spending on investment in environmental protection. Let us focus on the estimates relating to the importance of foreign capital participation and the size of firms. On the one hand, it is revealed that the probability of adopting strategies to reduce pollution increases significantly as foreign capital participation increases. While it is true for both spending and investment decisions, it is shown that the impact on investment is appreciably larger. In fact, the equality of the coefficients associated with expenditure and investment strategies can be rejected with a high level of confidence. Results are also quite unambiguous when we focus on firm size. Although a larger size helps the adoption of both spending and investment, this firm characteristic is especially relevant for investment decisions.

According to the estimation results, not only are the coefficients of foreign capital participation and firm size statistically significant at conventional levels, the coefficient associated with the interaction of the two variables for the investment case is also significant with a negative sign. However, because our specification is nonlinear, we recognise that the results of the interaction term do not give precise information on the sign of the effect and the statistical significance. In fact, unlike in a conventional linear model, the correct interaction effect is not only a function of the coefficient but is also dependent on the other covariates. To address this concern, we use marginal effects following the empirical procedure proposed by Ai and Norton (2003) and Norton et al. (2004). This approach, which has been quite influential in the empirical literature (Anzola-Román et al., 2018; Berger & Bouwman, 2013; Kim et al., 2011; Maluccio et al., 2009), is based on a correction of marginal effects and their corresponding standard errors considering the covariances within a single equation. Thus, in order to better evaluate the specific interaction term in question, we have simplified our model specification. Since our results suggest that the two sorts of environmental protection decisions are clearly correlated, it seems reasonable to specify a synthetic model, where the dependent variable represents the probability of deciding on both spending and investing (i.e. *Expenditure × Investment*). As can be seen

in the last column of Table 4, the resulting probit model provides estimates very similar to those obtained in the equation explaining investment in the bivariate model. This is not surprising considering that most firms that make investment decisions about environmental protection also generate related expenses (see Sect. 3).

From the Ai and Norton (2003) approach applied to the probit equation, we find the interaction effect for different probabilities of adopting the two types of environmental protection decisions. As can be seen at the top of Fig. 1, the sign of the interaction effect is negative except for extreme values of the predicted probability. It is generally significant (at a 95% confidence level) in a range of predicted probability between 0.3 and 0.8, as is shown at the bottom of Fig. 1. There is no clear evidence of a negative
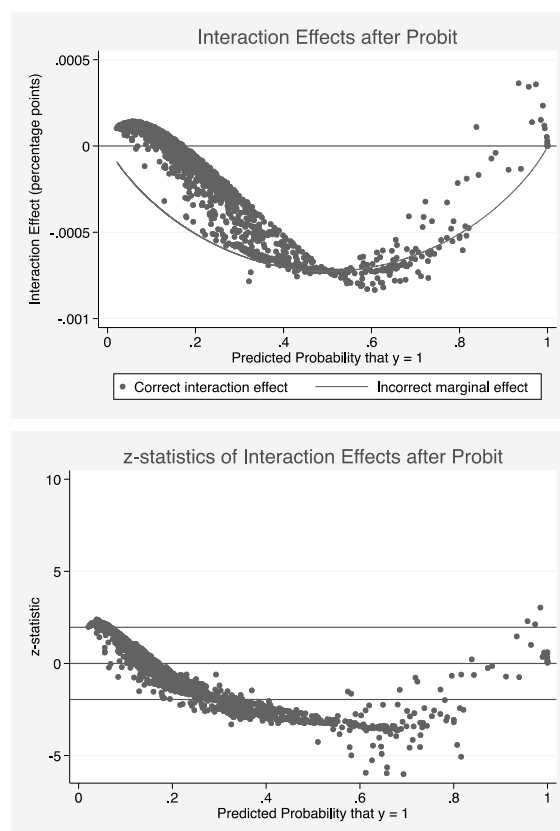

Fig. 1 Evaluation of the interaction term (*Foreign × Size*) in *Probit I*

interaction effect in those cases where the predicted probability is very low.

We also recognise that our baseline model specification assumes that both variation of foreign capital and size have a symmetrical impact on environmental protection. In order to confirm that, in general terms, an increase in the participation of foreign capital has a greater effect on environmental improvement decisions in smaller firms; let us estimate a restricted model where the continuous variable Size is transformed following the division used by our survey (i.e. ESEE). On the one hand, we have a dummy variable that equals one when the number of workers is less than or equal to 200, and zero otherwise. On the other hand, we have another variable that equals one when the number of workers is greater than 200, and zero

otherwise. We can see in the Appendix (Table 6) that the empirical results from this complementary analysis are consistent with those obtained from our baseline model; that is, at least for investment decisions, it is revealed that an increase in the participation of foreign capital is more important in smaller companies than in the larger ones.

We are also interested in examining whether the impacts of foreign capital and size on the expenditure on and investment in environmental protection are critically dependent on the stringency of the environmental regulation of the industries. To this end, we divide our data set according to the type of sector to which each firm belongs (as defined in Sect. 3). The corresponding outcomes are displayed in Table 5. While results from the low regulated industries are quite similar to those

Table 5 Empirical results grouped by types of industrial sectors

Dep. variable:	Highly regulated industries(A)				Low regulated industries(B)			
	Bivariate probit		Equality test (x^2)	Probit II-A	Bivariate probit		Equality test (x^2)	Probit II-B
	Expenditure	Investment		Env. protection (y)	Expenditure	Investment		Env. protection (y)
Foreign	0.2887 (0.3225)	0.6766** (0.3122)	1.22 (0.269)	0.6276** (0.3032)	0.4433* (0.2333)	0.9706*** (0.1576)	4.78 (0.029)	0.9450*** (0.1579)
Size	0.0021* (0.0010)	0.0049*** (0.0012)	9.37 (0.002)	0.0045*** (0.0011)	0.0017*** (0.0007)	0.0023*** (0.0006)	4.04 (0.044)	0.0019*** (0.0005)
Foreign×size	−0.0002 (0.0016)	−0.0022 (0.0014)		−0.0020 (0.0013)	0.0005 (0.0013)	−0.0020*** (0.0006)		−0.0017*** (0.0005)
Family	0.0854 (0.1625)	0.4325*** (0.1628)		0.4447*** (0.1668)	0.2956*** (0.0724)	0.1979** (0.0836)		0.2758*** (0.0812)
Age	0.0065 (0.0050)	0.0137*** (0.0047)		0.0129*** (0.0048)	0.0017 (0.0022)	0.0046** (0.0022)		0.0024 (0.0023)
Skill	0.1304 (0.1358)	−0.0232 (0.1120)		−0.0351 (0.1061)	0.0645 (0.0466)	−0.0072 (0.0411)		−0.0113 (0.0391)
R&D	0.0238 (0.0171)	−0.0147* (0.0087)		−0.0114 (0.0086)	0.0199** (0.0090)	0.0033 (0.0036)		0.0037 (0.0035)
Number of obs	345			345	1371			1371
Log likelihood	−181.68	−176.71		−175.52	−838.45	−597.14		−566.87
	−333.20				−1353.67			
ρ	0.7144 (0.0678)				0.6620 (0.0381)			
Wald test of $\rho = 0$	41.93 (0.000)				137.41 (0.000)			

Regressions contain a dummy variable for each one of the four industrial sectors in (A), and the sixteen industrial sectors in.(B). Robust standard errors and *p*-values are in parenthesis. The symbols ***, ** and * denote statistical significance at 1%, 5% and 10% level, respectively

previously shown in Table 4, there are some interesting differences when we consider the results from firms belonging to highly regulated industries: namely, foreign capital participation is only significant for investment decision types in this group of firms. With respect to the size of firms, results indicate for both high and low regulated industries that the probability of adopting both sorts of environmental strategies rises as firm size increases. These results consistently indicate that the size of the company is more relevant for investment strategies.

Ai and Norton's approach applied to a single probit equation for high and low regulated industries allows us to evaluate once again the effect of the interaction (*Foreign × Size*) for different probabilities of implementing both types of environmental strategies. As shown at the top of Fig. 2, in the case of highly regulated industries, the sign of

the marginal effect is negative except for extreme predicted probability outcomes. However, as we can also observe at the bottom, the interaction effects cannot be considered significant for most of the observations for the firms in these industrial sectors. On the other hand, these results are in line with that obtained for the entire dataset for the low regulated industries. That is, as shown at the top of Fig. 3, the sign of the interaction effect is negative except for observations generating very low and high probabilities. As can be seen at the bottom of Fig. 3, the effect is generally significant for these intermediate cases.

5 Discussion

The objective of this paper has been to examine the effects that foreign ownership has on firms'
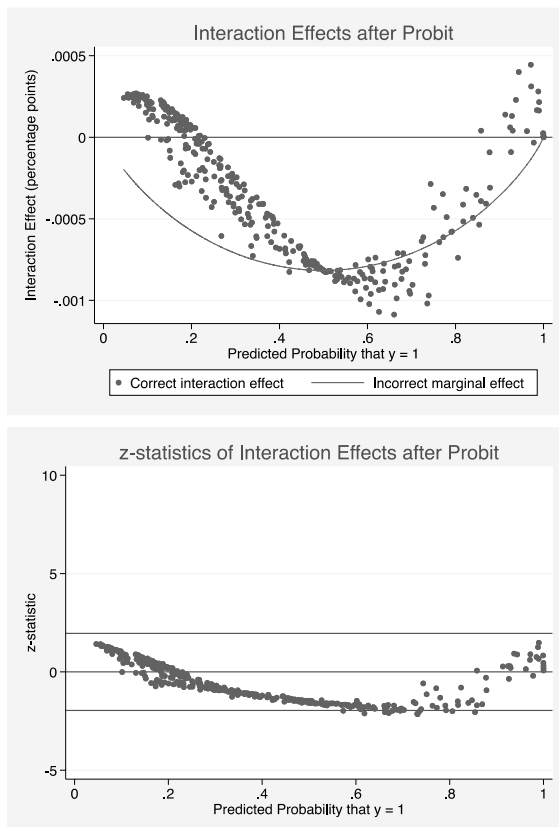
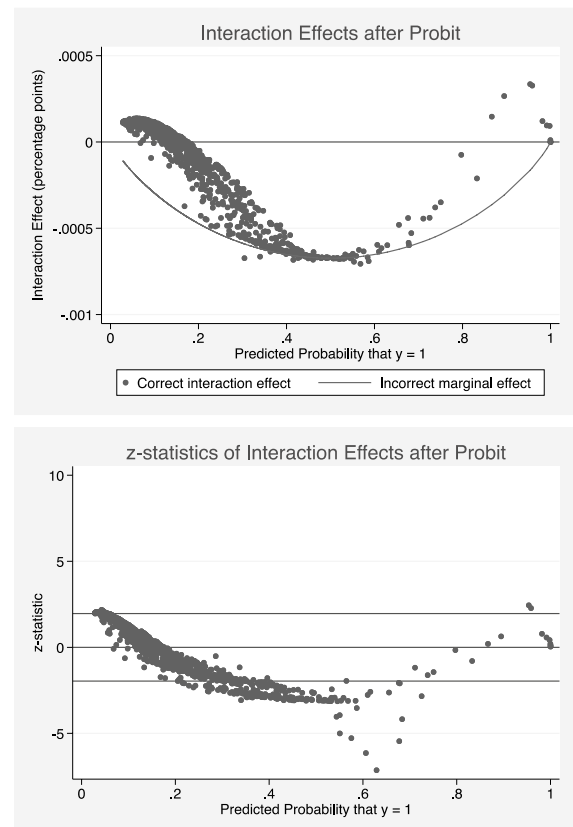**Fig. 2** Evaluation of the interaction term (*Foreign × Size*) in *Probit II-A*

Fig. 3 Evaluation of the interaction term (*Foreign × Size*) in *Probit II-B*

decision-making process about expenditure on and investment in environmental protection. In this analysis, we account for the potential heterogeneity at the firm level by focusing on certain structural characteristics such as the size and the sector. From the empirical analysis, we can highlight the following results.

First, foreign ownership has a positive effect on firms' decision to invest in environmental protection. As we have explained in the first two sections, previous literature has shown that firms may face obstacles related to financial constraints, lack of knowledge and inappropriate management practices (among other factors) that may prevent them from investing in environmental protection. From a resource-based view, the participation of foreign capital may help to overcome these barriers, bringing in resources, technology and managerial skills. In addition, multinational firms are more likely to be subject to greater public scrutiny and this may also encourage investment in environmental protection. Our results also show that foreign participation has a positive effect on current expenditure on environmental protection. The positive effect of foreign participation on both investments and current expenditures and the estimates of the correlation parameters indicate that these two decisions are highly correlated and suggest that they are likely complementary. In particular, some expenditure on the operation and maintenance of environmental equipment is closely related to investment decisions. Also, the adoption of environmental management systems that help firms to make decisions about the means to prevent environmental pollution may have a significant relationship with the decisions on investments. Nevertheless, a proper analysis of potential complementarity (Milgrom & Roberts, 1990; Cassiman and Vegeulers, 2006; Ozusaglam et al., 2018) between these two decisions would require a performance variable such as the reduction of pollutant emissions—information that is not available in our database.

These results differ from those reported by Haller and Murphy (2012) and Siedschlag and Yan (2021), both focused on Ireland. Contrary to our findings, the results obtained by both studies show that foreign affiliates are less likely than local firms to invest in environmental protection. According to the authors, this result might reflect the fact that foreign affiliates already have adequate equipment for pollution control

and cleaner technologies and there is no need for further investment. In contrast, we show that foreign ownership is an important driver of environmental protection in Spanish manufacturing firms.

Second, our results, like those of other empirical analyses (Haller & Murphy, 2012), show that size has a positive effect on firms' current expenditure on and investment in environmental protection. Larger firms usually have more financial and human resources, and may enjoy economies of scale and have better management practices that allow them to easily deal with the complexities of investment and the adoption of practices regarding environmental protection. These firms are also usually more affected by environmental regulations. Nevertheless, other studies (Hoogendoorn et al., 2015) have pointed out that SMEs are more likely to engage in greening their products and services.

The results, both in the main estimations and in the estimations presented in the Appendix, regarding the interaction between foreign ownership and size show that the role of foreign capital is particularly important for small firms. The participation of foreign capital may help small firms to overcome their disadvantages related to their size and to foster investment in environmental protection. This result is especially relevant for the manufacturing sector in Spain where small firms are, as in many countries, predominant. As previously mentioned, these firms face greater difficulties in adopting environmental protection measures (Murillo-Luna et al., 2011).

Third, our analysis shows that the effect of foreign participation on firms' environmental protection decisions differs among industries. For both decisions (expenditure and investment), the impact of foreign participation is particularly important for the less regulated industries. Conversely, there is only a significant impact on investment decisions for the most highly regulated industries covered by the EU ETS as well as other regulations. These results show that, even in less polluting industries, the participation of foreign capital is an important factor explaining investment decisions aimed at reducing emissions and pollution. Multinationals face greater scrutiny regarding their environmental behaviour, and this may explain why in these industries there is a positive relationship between foreign participation and

environmental protection decisions. These effects of foreign capital in less regulated industries are again more important for small firms, while for highly regulated industries, there is no evidence of a positive interaction between foreign ownership and size.

Finally, regarding the control variables, it is worth highlighting the importance of family group ownership when it comes to encouraging spending and investment, as well as the relevance of age as a driver of investment. We also obtain evidence that a greater presence of qualified employees and R&D activities positively affects the probability of spending.

6 Conclusions

A large number of macro-level studies have highlighted that foreign participation may reinforce environmental protection. Using firm-level data, this paper examines the role played by foreign ownership as a driver of the improvement in firms' environmental behaviour. There is still scarce evidence about how firm-level characteristics may be channelling the potential benefits of foreign ownership. This paper contributes to the literature on small business economics by analysing the role of firm size and its interaction with foreign ownership in the decisions about environmental protection. By using firm-level data for Spanish manufacturing firms, our analysis provides useful insights into the mediating role of firm characteristics.

Our results reveal that the probability of adopting strategies to reduce pollution increases significantly as foreign capital participation increases. We also find that foreign ownership plays a role in expenditure decisions, and even more so in investment decisions. They also suggest a high correlation between these two decisions in the environmental behaviour of Spanish manufacturing firms. However, the results seem to be crucially dependent on the attributes of firms. More specifically, for a large number of observations, we find that the positive impact of foreign participation on environmental protection is channelled through small companies. Additionally, we find that foreign participation is more relevant for less regulated industries.

Our findings show that size has a positive effect on firms' current expenditure on and investment in environmental protection, reinforcing the view that small firms face barriers to adopting environmental practices, particularly when it comes to investment decisions. The results support the relevance of foreign participation as a mechanism for overcoming barriers to the adoption of environmental protection measures, which can be especially important for small firms. This is undoubtedly a significant result due the predominance of small firms in the Spanish manufacturing sector. These findings also suggest that it would be appropriate to provide policy support to SMEs to foster environmental practices. While foreign capital may help some small businesses to overcome the barriers hindering environmental investment decisions, for most of them, policy measures seem necessary to facilitate these investments. Finally, industry heterogeneity matters and the impact of foreign ownership are focused mainly on less regulated sectors, which may point to the importance of FDI as a driver of change in management decisions with the potential to affect firms' environmental protection. In other words, foreign investors can act as drivers of environmental protection, especially in those sectors where the adoption of measures is not mandated by specific regulation.

We believe that the analysis of the determinants of the environmental behaviour of firms is timely as the entire productive system must contribute now to reducing emissions and achieving the objectives related to mitigating climate change. Future extensions could focus on analysing whether expenditure and investment decisions are complements and whether certain performance outcomes of the firms are enhanced by this potential complementarity; examining the impact of environmental decisions on a firm's performance; and exploring the implications of the country of origin of foreign investors.

Appendix

Table 6 Restricted bivariate probit model

Dep. variable:	Expenditure	Investment
Foreign×Z_{SME}	0.5576***	0.6533***
	(0.1467)	(0.1456)
Foreign×Z_{LE}	0.3622	0.2817*
	(0.2267)	(0.1709)
Z_{LE}	0.5701***	0.9600***
	(0.1208)	(0.1108)
Family	0.2704***	0.2626***
	(0.0660)	(0.0738)
Age	0.0031	0.0071***
	(0.0019)	(0.0019)
Skill	0.0674	−0.0152
	(0.0459)	(0.0399)
R&D	0.0262***	0.0044*
	(0.0084)	(0.0022)
Number of obs	1716	
Log likelihood	−1033.83	−793.37
	−1716.45	
ρ	0.6744	
	(0.0322)	
Wald test of $\rho = 0$	191.81 (0.000)	
Equality between coef. of *Foreign*×Z_{SME} and *Foreign*×Z_{LE}	0.53 (0.467)	2.83 (0.092)

Z_{SME} is a dummy variable that equals one when the number of workers is less than or equal to 200, and zero otherwise. Z_{LE} is a dummy variable that equals one when the number of workers is greater than 200, and zero otherwise. Regressions contain a dummy variable for each one of the twenty industrial sectors. Robust standard errors and *p*-values are in parenthesis. The symbols ***, ** and * denote statistical significance at 1%, 5% and 10% level, respectively

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