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RESEARCH ARTICLE

Do environmental regulations matter on Spanish foreign investment? A multisectorial approach

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Abstract

A gravity model is used to investigate the impact of the stringency and enforcement of the environmental regulation on Spanish investment flows abroad during the period 2008–2018. From the pollution haven hypothesis' (PHH) perspective, the research tests if offshoring and outsourcing processes from Spanish multinational enterprises (MNEs) were due to movements through FDI of high-polluting industries seeking refuge in countries with a low standard of legal environmental protection framework. The analysis includes FDI into primary, manufacturing, construction, wholesale and retail, professional services, leisure services, utilities, and other services. When no sectoral approach is developed, PHH seems to be not held. However, the multisectoral perspective states that MNEs in primary and manufacturing sectors seek refuge in countries with a low standard of legal environmental protection framework.

Keywords Pollution haven hypothesis · Foreign direct investment · Spain · Environmental regulations · Gravity model

Introduction

Advances in the global battle against climate change governance – mainly from Kyoto Protocol and the Paris Accord – have coincided in time with intensive offshoring and outsourcing processes. Foreign direct investment (FDI) is behind these processes. Many scholars explored this under the topics of carbon leakage risks or the so-called pollution haven hypothesis (PHH) (Gill et al. 2018).

Spain is a case of special interest from both a scientific and policy perspective. First, previous research on the PHH has focused on FDI from global top investors such as Germany, the USA, or the UK cases that might not be extendable to other countries (e.g., Manderson and Kneller 2012; Millimet and Roy 2016; Wagner and Timmis 2009). During the last 30 years, Spain's outward FDI has drastically increased and today ranks the 14th in terms of FDI stock abroad and is the main source of investment in Latin America (UNCTAD, 2020), but globally Spain is not among the top sources of FDI. Secondly, Spain has made relevant efforts in terms of tightening its environmental policy and its enforcement, although with some setbacks (see Figs. 1 and 2 in annex), and has drastically reduced the level of per capita CO_2 emissions (see Fig. 3 in annex). The Spanish authorities are showing a compromise in following this path. In fact, aligned with the United Nations 2030 Sustainable Development Agenda, the Spanish government proclaims the commitment to the reduction of greenhouse gases (GHG) and transition into a green and carbon-neutral economy. Thus, as in other countries pursuing to decarbonize their economy, it is a concern whether their domestic firms invest abroad in countries with lax environmental regulations.

Highlights • Spain ranks the 14th in terms of FDI stocks abroad.
• MNEs in primary and manufacturing sectors seek refuge in countries with a low standard of legal environmental protection framework.
• When exploring heavily polluting sectors results support PHH for Spain.
• A lax environmental regulation creates incentives for Spanish industries to move their production part to another country.
• The green paradise hypothesis holds for FDI allocated in the utilities sector.

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There is a vast literature analyzing the determinants of FDI flows (Yoon and Heshmati 2017). Part of these scientific outputs focused on the PHH approach (Pethig 1976; Siebert 1977; Grossman and Krueger 1991; Markusen et al. 1993; Chichilnisky 1994; Eskeland and Harrison 2003; Copeland and Taylor 2004; Cole and Elliott 2005; Dean et al. 2009). Despite the vast amount of literature available on this topic, the results about the relationship between environmental regulation and FDI are mixed at best (Cansino et al. 2019). The main conclusions from empirical PHH studies can be categorized into three groups (Cheng et al. 2018; Yoon and Heshmati 2017).

The first group finds significant evidence to support PHH. Their results show that environmental regulation stringency acts as a prevailing determinant factor of the FDI patterns. A reduction in environmental regulation leads to a shift in FDI allocated in pollution-intensive industries from countries with strict regulations, generally developed countries, to countries with weaker regulations, usually developing countries (Chung 2014; Xu et al. 2016; Shen et al. 2019). In a similar view, the literature has also analyzed the channels through which environmental regulation exerts an influence on FDI (Malesky 2004; He 2006; Zhang et al. 2019; Hanna 2010).

The second group clings to the pollution heaven effect (PHE) (Copeland and Taylor 2004). This theory differs from PHH in that it states that while there is evidence that environmental regulation affects FDI decisions, there is no evidence that it plays a predominant role among all other factors that determine FDI patterns. The analysis of the impact of environmental regulation on FDI flows can lead to hastily validating PHH when a simple model is conducted since the environmental regulation effect can be offset by other, more relevant factors (Kheder and Zugravu 2012; Eskeland and Harrison 2003; Mulatu et al. 2010; Mulatu et al., 2017).

Finally, the last group of academics does not support PHH. There are several theoretical and empirical arguments against PHH (Gill et al. 2018). One of the most cited theories is the Porter hypothesis (Porter and van der Linde 1995). According to this hypothesis, stricter environmental regulations in the host country could lead to an improvement in its competitiveness, which would foster an improvement in innovation, clean technologies, and the efficient use of resources. Thus, FDI would be attracted by a higher level of stringency in environmental regulation (Leiter et al. 2011; Levinson 1996; Ouyang et al. 2019; Yang et al. 2019). Another highly cited argument against PHH is the green haven hypothesis (GHH). This hypothesis claims that industries are more concerned about increasing their social responsibility, sustainable management, and ecological reputation than with avoiding environmental regulations. Some industries would be incentivized to direct their investments to countries with higher environmental regulation in order to avoid environmental issues (Herzig and Schaltegger 2006; Willis 2003). Poelhekke and van der Ploeg (2015) found empirical evidence to support this hypothesis, especially for footloose industries.

Although the debate on the validity of PHH continues, a recent group of researchers has pointed out three main issues when trying to test PHH that might explain the lack of consensus in the results (e.g., Dean et al. 2009). The first issue is the heterogeneous impact of environmental regulation on different groups of industries due to different levels of pollution intensity (Millimet and List 2004). If the entire FDI is considered, the nonproduction industries might be hiding the effect of environmental regulation on industries that produce goods (Yoon and Heshmati 2017). Second, the lack of a unique empirical proxy of environmental regulation stringency has not provided robust results (Galeotti et al. 2020). Third, the omitted variable bias. The omission of fundamental explanatory variables of FDI flows could conduct a spurious relationship with environmental regulation (Javorcik and Wei 2004).

Aiming to deal with the problem of heterogeneity impact of the environmental regulation on FDI, in this paper, we have employed an empirical model that captures the interaction between FDI flows and foreign environmental regulation stringency in eight different economic sectors. The sectors included in the analysis are primary, manufacturing, construction, wholesale and retail, professional services, leisure services, utilities, and other services.[1] As the first contribution to literature, we find evidence supporting that environmental regulations matter on Spanish FDI but not for all the economic sectors considered. The sectors that validated PHH were manufacturing and primary. These results complement the part of the literature which argues that PHH can only be found in highly polluting sectors. Furthermore, we found results that support the presence of GHH in the utilities sector.

As a second contribution to the literature, this paper has addressed the issue of the proxy variables, using two complementary variables from the World Economic Forum to measure environmental regulations in host countries: the stringency and enforcement of environmental regulations (Kellenberg 2009; Wagner and Timmis 2009; Kalamova and Johnstone 2011; Poelhekke and van der Ploeg 2015; Mulatu 2017). Additionally, to test the robustness of the results of our analysis, we employed two different alternative indicators: the environmental performance index (EPI) and countries' CO_2 per capita emissions. These two indicators allow us to consider an environmental policy from different perspectives, to analyze a longer period (1995–2014), and to study a different sample of host countries. Our results support the presence of PHH in the manufacturing sector regardless of which variable was used. Likewise, we found evidence to validate PHH in the primary sector when three of the four proxy variables of

[1] Considered sectors are based on CNAE 2009 one-digit industry classification. Due to the limited number of observations available, several sectors had to be merged.

environmental regulation stringency were used. Finally, all the proxy variables validated the presence of GHH in the utilities sector.

Finally, we address the third issue, the omitted variable bias, by using the gravity model. This model is a robust theoretical tool to analyze the determinants of FDI flows (e.g., Kleinert and Toubal 2010). The logic behind this model is that FDI is positively moderated by countries' economic size and limited by their bilateral distance (i.e., cultural, geographic, religious, etc.). In addition, the gravity model controls for a country's relative attractiveness for FDI in comparison with other potential host countries. With this model, our third important contribution to the literature is that we found a significant evidence of PHH in highly contaminated sectors even when other fundamental explanatory factors of FDI are taken into account. This means that host-country environmental regulation stringency acts as a prevailing determinant factor of FDI decisions in highly polluting industries and does not play a marginal role as established in PHE theory.

The paper structures as follows. After the Introduction, Methodology and data details the data and methodology adopted. Results are presented and discussing in Results and Discussion. Conclusions offers some concluding remarks.

Methodology and data

Data

In the interest of modeling unobserved heterogeneity across countries, this study uses panel data that contains information on 126 countries around the world during 10 years (2008–2018). The sample of countries was based on the availability of data, as was the period to be considered. Table 1 shows which countries make up the sample.

Dependent variable: FDI

FDI data were collected from the database of the Spanish Secretary of State for Commerce (2018). This data provides information about Spanish gross investment flows in host countries in 21 different sectors. Nevertheless, due to the limited number of observations (i.e., limited investment flows) into some sectors, we merged several sectors. The following eight sectors are analyzed: primary, manufacturing, construction, wholesale and retail, professional services, leisure services, utilities, and other services (see Table 2 for equivalence). FDI data are converted into US dollars. Following the recommendation from Piermartini and Yotov (2016), all financial variables included in the model are in nominal terms.

Environmental regulation

The environmental regulation level in FDI recipient countries is not directly observable. In order to solve this issue, the researchers have proposed several empirical proxies as an alternative. They can be summarized into four categories: variables measuring pollution abatement efforts, direct assessments of regulations, composite indexes, and measures based on ambient pollution, emissions, or energy use. Thus, the lack of consensus on an appropriate empirical proxy for environmental regulation quality has generated a disparity in empirical findings (Brunel and Levinson 2016; Galeotti et al. 2020). Nevertheless, during the last years, the use of the data retrieved from the Executive Opinion Survey of the World Economic Forum (WEF) has become more frequent (Kellenberg 2009; Wagner and Timmis 2009; Kalamova and Johnstone 2011; Poelhekke and van der Ploeg 2015; Mulatu 2017). This survey includes two questions posed to business CEOs in various countries around the world about their perception of the environmental policy design. The first question concerns their perception of the stringency of environmental regulation (StrigER) in their country, and the second question is to assess the consistency of enforcement of those rules and regulations (EnforER). This data set has three great advantages. First, this data set takes into account two variables that complement each other, the stringency and the enforcement of the environmental regulations. In the words of Yoon and Heshmati (2017), "Even if a country has tight regulations on the environment, if it does not enforce the regulations strongly then the degree of the regulations may not be stringent in reality." Hence, the use of both indices provides robustness to our results. The second advantage of this data set is that the respondents frequently decide on investment options, and they likely base their answers on how environmental regulation affects their own company. This subjective assessment represents unobserved cross-industry measures of environmental regulation that cannot be captured in other more quantitative measures presented above (Kellenberg 2009). Finally, the third advantage of this variable is that it covers a wider sample of countries than most other data sets on this topic (about 128 countries). The data for Executive Opinion Survey were retrieved from the World Economic Forum (2019). WEF's environmental variables are only available for the years 2008, 2009, 2011, 2013, 2015, 2017, and 2019. Missing years between 2008 and 2018 are inputted using the average of the immediately previous and subsequent year.

Control variables

Data for nominal GDP and GDP per capita in the host country were taken from the World Bank Development Indicators (World Bank 2019). Data for Political Stability and Absence

Table 1 Country sample

Albania	Dominican Republic	Kyrgyz Republic	Philippines
Algeria	Ecuador	Latvia	Poland
Angola	Egypt, Arab Rep.	Lebanon	Portugal
Argentina	El Salvador	Libya	Qatar
Armenia	Estonia	Lithuania	Russian Federation
Australia	Ethiopia	Luxembourg	Saudi Arabia
Austria	Finland	Madagascar	Senegal
Azerbaijan	France	Malaysia	Serbia
Bahrain	Gabon	Mali	Seychelles
Bangladesh	Georgia	Malta	Sierra Leone
Barbados	Germany	Mauritania	Singapore
Belgium	Ghana	Mauritius	Slovak Republic
Benin	Greece	Mexico	Slovenia
Bolivia	Guatemala	Moldova	South Africa
Bosnia and Herzegovina	Guinea	Mongolia	Sweden
Botswana	Honduras	Montenegro	Switzerland
Brazil	Hong Kong SAR, China	Morocco	Tanzania
Brunei Darussalam	Hungary	Mozambique	Thailand
Bulgaria	Iceland	Myanmar	Trinidad and Tobago
Burkina Faso	India	Namibia	Tunisia
Cabo Verde	Indonesia	Nepal	Turkey
Cameroon	Iran, Islamic Rep.	Netherlands	Ukraine
Canada	Ireland	New Zealand	United Arab Emirates
Chile	Israel	Nicaragua	United Kingdom
China	Italy	Nigeria	United States
Colombia	Jamaica	North Macedonia	Uruguay
Costa Rica	Japan	Norway	Venezuela, RB
Cote d'Ivoire	Jordan	Oman	Vietnam
Croatia	Kazakhstan	Pakistan	Yemen, Rep.
Cyprus	Kenya	Panama	Zambia
Czech Republic	Korea, Rep.	Paraguay	
Denmark	Kuwait	Peru	

Note: authors' own elaboration

Table 2 Sector equivalences

8 sector classification	21 sector classification
Primary	Agriculture, forestry, and fishing; extractive industries
Manufacturing	Manufacturing
Construction	Construction; real estate activities
Wholesale and retail	Wholesale and retail
Professional services	Financial and insurance activities; professional, scientific, and technical activities; health and social service activities; education; information and communications
Leisure services	Artistic, recreational, and training activities; food and catering services
Utilities	Water supply, sanitation, waste management, and decontamination activities; supply of electricity, gas, steam, and air conditioning; transport and storage
Other services	Administrative activities and auxiliary services; household activities; activities of extraterritorial organizations and bodies; public administration and defense; other services

Note: authors' own elaboration

of Violence/Terrorism (PolStab) were taken from *The Worldwide Governance Indicators Project: Answering the Critics* (Kaufmann and Aart 2017). The nominal bilateral exchange rate (BER) was taken from the International Financial Statistics database (International Monetary Fund 2019). Regional trade agreement (RTA) data were retrieved from the World Bank (2015). Data for bilateral investment treaty (BIT) and inward FDI stock (ifdistock) are provided by the United Nations Conference on Trade and Development (2019).

Descriptive statistics of variables are available in Table 3. Table 10 in annex details the description of the variables included in the research and expected sign of coefficients.

Methodology

We rely on the gravity model to address the PHH for FDI. The gravity equation has a sound theoretical basis for explaining the determinants of bilateral FDI (e.g., Head and Ries 2008; Kleinert and Toubal 2010; Kox and Rojas-Romagosa 2020). As described by Kox and Rojas-Romagosa (2020), the general structural gravity equation for FDI is the following:

$$FDI_{ij} = \omega_{ij} \frac{Y_i Y_j}{P_i \Pi_j} \quad (1)$$

FDI from country i to country j is negatively moderated by transaction costs and barriers to investments between pair of countries (ω_{ij}). These frictions can be a result of regulation between pair of countries (e.g., liberalization of the movement of capital) or can be natural or not determined by economic policy (e.g., geographic or cultural distance). Then, investment by a pair of countries is expected to be positively moderated by economic size from both the origin (Y_i) and destination country (Y_j). The larger is the economy, the higher is the capacity of investing abroad. Likewise, the larger is the economy, the higher is the demand and the productive capacity, and thus the more likely is to receive multinational enterprise (MNE) investment. FDI is negatively affected by the relative friction costs, that is to say, the trade-off of choosing one particular destination of investment instead of another. In Eq. (1), this is represented by P_i, and the country-level factors relative to the rest of the world might make them a less attractive destination for FDI (e.g., institutional quality, wages, or environmental regulation). Similarly, relative to the rest of the world, a country may also face friction costs (Π_j) that negatively limit their overall capacity of investing abroad (e.g., capital controls or restrictions).

Table 3 Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
FDI	8383	39.20	383	0	18,600
Log(GDP)	8383	25.66	1.82	21.01	30.65
Log(GDPpc)	8383	9.25	1.30	5.79	11.69
Log(PolStab)	8383	1.45	0.23	0.27	1.78
BER	8383	−0.01	0.16	−0.85	3.45
FTA	8383	0.27	0.45	0	1.00
EU28	8383	0.26	0.44	0	1.00
BIT	8383	0.05	0.22	0	1.00
Log($ifdistock_{t-1}$)	8383	10.66	1.87	4.32	15.53
Log(StrigER)	8383	1.43	0.25	0.55	1.89
Log(EnforER)	8383	1.36	0.27	0.59	1.86

Note: authors' own elaboration. FDI data reported in millions of US dollars

The empirical form of the gravity equation is a log-linearized model. If the model is estimated with OLS, the estimate would suffer from heteroscedasticity issues, and the zeros usually present in bilateral data would be excluded from the analysis. Thus, as proposed by Silva and Tenreyro (2006), we use the Poisson pseudo maximum likelihood (PPML) for estimating the following equation:

$$FDI_{ijkt} = e^{Z_{ijt} + X_{jt} + EnviReg_{jt} + \gamma_{ij} + \gamma_{kt}} + \varepsilon_{ijkt} \quad (2)$$

where FDI_{ijkt} are the investment flows from Spain (i) to the host country j in sector k in year t. The model includes country pair fixed effects (γ_{ij}) and sector-year fixed effects (γ_{kt}). The first controls for bilateral time-invariant determinants of FDI such as geographical distance, cultural affinity, or religious affinity are usually included in the gravity equation for explaining FDI (e.g., Head and Ries 2008). In addition, they control for the multilateral resistance (Anderson and van Wincoop 2003). The latter controls for the global time-varying characteristics of each sector and all time-varying characteristics from Spain like, for instance, GDP, institutional quality, or environmental regulation.[2] ε_{ijkt} is the disturbance term.

Z_{ijt} represent bilateral free trade agreement (FTA) and bilateral investment treaty (BIT) dummies which take a value of one whenever Spain and the host country have signed them. BIT is expected to foster bilateral FDI, as it reduces the risks that MNEs face when investing abroad (e.g., Desbordes and Vicard 2009). FTAs may foster MNE investments that are complementary to trade, such as vertical FDI or export supporting FDI. Nevertheless, FDI and trade can be alternative strategies that a MNE has for serving a foreign market. In this case, reducing bilateral trade costs would favor exports instead of horizontal FDI – see Carril-Caccia and Pavlova

[2] In accordance, our model does not include any specific variable which represents Spain's time-varying characteristics. This group of variables is collinear with the sector-year fixed effects. A similar model specification is employed by Poelhekke and Van der Ploeg (2015).

(2020) for a recent overview on the FDI-trade link literature.[3] X_{jt} is a set of host country time-varying characteristics, including GDP, GDP per capita, political stability, exchange rate, EU membership, and global inward FDI stock in year $t-1$. It is expected that FDI is positively moderated by host countries' economic size and political stability, but negatively moderated by GDP per capita as the investment is prone to go from capital-intensive countries to labor-intensive countries (e.g., Asiedu 2006; Carril-Caccia and Pavlova 2020). Then, a host country's depreciation of the exchange rate can foster inward FDI as it implies that the MNEs face a lower cost when acquiring assets and production inputs. Notwithstanding, host countries' currency depreciation also implies a risk on future profits and thus deters FDI (di Giovanni 2005). Regarding the EU membership, previous literature highlights that it has fostered bilateral FDI among its members (e.g., Coeurdacier et al. 2009). Nevertheless, our period of analysis, 2008–2018, falls on the 2008 economic crisis which had significant negative implications on FDI among EU countries and in particular in Spanish outward FDI (Carril-Caccia and Paniagua 2018).[4] Then, following the literature on the PHH, global inward FDI stock is included to control for agglomeration economies of scale (Wagner and Timmis 2009). Finally, the model includes our variable of interest which represents the host countries' environmental regulation ($EnviReg_{jt}$), which is proxied by environmental regulation stringency (StrigER) or enforcement (EnforER). If the coefficient associated with the environmental regulation stringency index is negative and significant, the result will be consistent with the PHH and imply that Spanish FDI is drawn towards countries with less strict environmental regulation. In contrast, if the resulting coefficient is positive and significant, the empirical evidence will be consistent with the GHH (i.e., the stricter the host countries' environmental regulation, the greater the Spanish FDI).

Results

PPML estimation's results

Tables 4, 5, and 6 show the results from the PPML estimation. Table 4 presents the results for the overall effect of environmental stringency and enforcement on the eight considered sectors. Tables 5 and 6 show the results of the differential effect of stringency and the enforcement of environmental regulation on each of the considered sectors. To this end, we interact the environmental regulation index with an indicator variable that takes one for the investment flows towards one of the considered sectors. In all cases, standard errors are clustered at the destination country-sector level and presented in parenthesis.

Table 4 Overall impact of environmental regulation on Spanish FDI

	1 WEF stringency index	2 WEF enforceability index
Log(GDP)	6.112**	6.408**
	(2.92)	(2.96)
Log(GDPpc)	−4.605**	−5.031**
	(2.30)	(2.33)
Log(PolStab)	3.755	4.100
	(3.21)	(3.53)
BER	−2.900	−2.945
	(1.98)	(1.99)
FTA	−0.196	−0.265
	(0.52)	(0.48)
EU28	−2.345***	−2.509***
	(0.61)	(0.56)
BIT	4.491***	4.703***
	(1.30)	(1.36)
Log(FDIstockt-1)	−0.183	−0.232
	(0.46)	(0.46)
Log(StrigER)	−2.895	
	(2.85)	
Log(EnforER)		−2.320
		(2.98)
Observations	8383	8383
R^2	0.360	0.353

Note: The dependent variable is the flows of Spanish FDI into each of the analyzed sectors. All regressions include country pair fixed effects and sector-year fixed effects. Standard errors clustered at the destination country-sector level are in parentheses. *, **, ***: statistically significant at 1%, 5%, and 10%, respectively. Authors' own elaboration

As reported in columns 1 and 2 in Table 4, the results do not support the PHH. Even though the coefficients of the environmental variables are negative in both regressions, they are not significant, indicating that the environmental regulation is not a determinant factor of total FDI inflows at the aggregate level.

The results concerning the control variables are broadly similar in both regressions. The signs of the coefficients of the GDP variable are positive and significant, which means that Spanish FDI flows are positively moderated by the size of the economic market of the host country. That also counts for the variable BIT that also obtained a positive and significant coefficient in both estimations, supporting that the presence of a bilateral investment treaty is a fundamental driver of the Spanish investment. Moreover, the coefficient of GDPpc

[3] The inclusion of country pair fixed effects (γ_{ij}) tackles the potential endogeneity issues between FDI and bilateral agreements like FTAs, BITs, or EU membership (Baier and Bergstrand 2009; Bergstrand and Egger 2013).
[4] Moreover, during this period, only Croatia becomes a member. Given the inclusion of fixed effects in the model, the EU dummy in the base analysis only captures the impact of Croatia's EU membership on Spanish FDI.

Table 5 Sectoral effect of stringency of environmental regulation

	1	2	3	4	5	6	7	8
Log(GDP)	6.057**	6.058**	6.109**	6.116**	6.113**	6.113**	5.970**	6.112**
	(2.94)	(2.98)	(2.92)	(2.93)	(2.92)	(2.93)	(2.89)	(2.92)
Log(GDPpc)	−4.637**	−4.541*	−4.606**	−4.610**	−4.606**	−4.605**	−4.530*	−4.609**
	(2.30)	(2.39)	(2.30)	(2.30)	(2.29)	(2.30)	(2.34)	(2.30)
Log(PolStab)	3.806	3.758	3.760	3.755	3.753	3.749	3.867	3.756
	(3.22)	(3.19)	(3.20)	(3.20)	(3.21)	(3.20)	(3.20)	(3.21)
BER	−2.998	−2.930	−2.912	−2.891	−2.901	−2.899	−2.990	−2.902
	(1.96)	(1.98)	(1.98)	(1.96)	(1.98)	(1.98)	(1.90)	(1.98)
FTA	−0.206	−0.171	−0.201	−0.193	−0.200	−0.194	−0.156	−0.197
	(0.51)	(0.53)	(0.52)	(0.51)	(0.52)	(0.52)	(0.51)	(0.52)
EU28	−2.379***	−2.295***	−2.361***	−2.333***	−2.400***	−2.336***	−2.304***	−2.348***
	(0.60)	(0.64)	(0.60)	(0.61)	(0.60)	(0.61)	(0.61)	(0.61)
BIT	4.538***	4.468***	4.480***	4.512***	4.433***	4.500***	4.509***	4.468***
	(1.30)	(1.30)	(1.31)	(1.28)	(1.31)	(1.30)	(1.26)	(1.31)
Log(FDIstockt-1)	−0.179	−0.191	−0.184	−0.181	−0.184	−0.183	−0.180	−0.184
	(0.46)	(0.46)	(0.46)	(0.46)	(0.46)	(0.46)	(0.46)	(0.46)
Log(StrigER)	−2.735	−2.426	−2.883	−2.860	−2.867	−2.909	−3.445	−2.874
	(2.88)	(2.65)	(2.85)	(2.86)	(2.85)	(2.85)	(2.99)	(2.85)
x primary	−5.721***							
	(1.33)							
x manufacturing		−1.639*						
		(0.97)						
x construction			−0.216					
			(1.17)					
x wholesale and retail				−0.190				
				(1.06)				
x professional					−0.076			
					(1.11)			
x leisure						0.582		
						(1.43)		
x utilities							4.070*	
							(2.12)	
x other services								−1.194
								(1.48)
Observations	8383	8383	8383	8383	8383	8383	8380	8384
R^2	0.361	0.362	0.360	0.361	0.360	0.360	0.376	0.360

Note: The dependent variable is the flows of Spanish FDI into each of the analyzed sectors. All regressions include country pair fixed effects and sector-year fixed effects. Standard errors clustered at the destination country-sector level are in parentheses. *, **, ***: statistically significant at 1%, 5%, and 10%, respectively. Authors' own elaboration

was negative and significant, which provides evidence that Spanish FDI is attracted to labor-intensive countries. Membership of the EU, contrary to what was expected according to the previous literature, obtained a significant but negative coefficient, which shows that Spanish FDI flowed more to non-European Union countries during the period of analysis. As previously mentioned, this result supports the idea that the 2008 economic crisis played a deterrent role in Spanish investment in countries belonging to the European Union. Regarding the rest of the control variables in both estimations, neither of them withstand the test of significance.

The first major finding is that when no sectoral approach is conducted, it is not possible to find evidence to support that offshoring and outsourcing processes of Spanish MNEs were due to movements seeking refuge in countries with a low standard of legal environmental protection framework. Furthermore, neither is it possible to find evidence supporting the Porter hypothesis since

Table 6 Sectoral effect of enforcement of environmental regulation

	1	2	3	4	5	6	7	8
Log(GDP)	6.355**	6.335**	6.407**	6.406**	6.392**	6.407**	6.154**	6.409**
	(2.97)	(3.00)	(2.97)	(2.96)	(2.95)	(2.97)	(2.91)	(2.96)
Log(GDPpc)	−5.044**	−4.962**	−5.031**	−5.030**	−5.017**	−5.030**	−4.826**	−5.035**
	(2.33)	(2.38)	(2.34)	(2.34)	(2.33)	(2.34)	(2.34)	(2.33)
Log(PolStab)	4.090	4.042	4.100	4.102	4.084	4.093	4.115	4.098
	(3.54)	(3.51)	(3.53)	(3.53)	(3.54)	(3.53)	(3.53)	(3.53)
BER	−3.043	−2.941	−2.948	−2.945	−2.940	−2.943	−2.971	−2.945
	(1.96)	(1.98)	(1.99)	(1.99)	(1.99)	(1.98)	(1.93)	(1.99)
FTA	−0.274	−0.237	−0.267	−0.265	−0.265	−0.261	−0.229	−0.266
	(0.48)	(0.49)	(0.49)	(0.48)	(0.48)	(0.48)	(0.47)	(0.48)
EU28	−2.532***	−2.448***	−2.514***	−2.509***	−2.561***	−2.492***	−2.496***	−2.511***
	(0.56)	(0.58)	(0.56)	(0.56)	(0.55)	(0.57)	(0.57)	(0.56)
BIT	4.732***	4.706***	4.701***	4.706***	4.625***	4.713***	4.735***	4.689***
	(1.36)	(1.38)	(1.37)	(1.36)	(1.37)	(1.36)	(1.33)	(1.37)
Log(FDIstockt-1)	−0.228	−0.239	−0.232	−0.231	−0.234	−0.231	−0.228	−0.233
	(0.46)	(0.46)	(0.46)	(0.46)	(0.46)	(0.46)	(0.46)	(0.46)
Log(EnforER)	−2.168	−1.872	−2.316	−2.321	−2.195	−2.345	−2.577	−2.308
	(3.01)	(2.84)	(2.97)	(2.98)	(2.99)	(2.97)	(2.93)	(2.98)
x primary	−4.467***							
	(0.99)							
x manufacturing		−1.118*						
		(0.68)						
x construction			−0.036					
			(0.92)					
x wholesale and retail				−0.033				
				(0.90)				
x professional					−0.325			
					(0.82)			
x leisure						0.788		
						(1.14)		
x utilities							3.108*	
							(1.75)	
x other services								−0.651
								(1.04)
Observations	8383	8383	8383	8383	8383	8383	8383	8384
R^2	0.355	0.355	0.353	0.353	0.353	0.353	0.366	0.353

Note: The dependent variable is the flows of Spanish FDI into each of the analyzed sectors. All regressions include country pair fixed effects and sector-year fixed effects. Standard errors clustered at the destination country-sector level are in parentheses. *, **, ***: statistically significant at 1%, 5%, and 10%, respectively. Authors' own elaboration

the Spanish FDI does not seem to follow a positive relationship with environmental regulation stringency. Without any distinction between industries, the empirical analysis seems to support Copeland's PHE since the environmental regulation coefficients, although negative, turn out to be nonsignificant. The effect of host environmental regulation stringency on Spanish FDI flows seems to be less significant than other variables such as the size of the economic market of the host country, labor intensity, and not belonging to the European Union. However, the second major finding advises against rejecting PHH explaining Spain FDI flows as can be seen as follows.

The results of the sector level estimation presented in Tables 5 and 6 are broadly similar to each other in terms of coefficient signs and significant levels. Concerning the core

variable, the environmental regulation, these results include a more specific approach by analyzing the crossed product between each of the eight sectors and the two complementary measures of environmental regulation. On the one hand, a nonsignificant estimated coefficient of this crossed product suggests that there is no evidence to support PPH. On the other hand, a negative estimated coefficient of this interaction variable implies that an increase in environmental regulation would cause that FDI in this specific sector to decrease compared to all other economic sectors. This result would support PHH. Finally, an interaction variable with a positive estimated coefficient would indicate that FDI in this specific sector increases compared to all other economic sectors due to high levels of environmental regulation. This result would support the green haven hypothesis (GHH).

As shown in both tables, the interaction effect of the primary and manufacturing sector presented coefficients negative and statistically significant. This implies that any rise in the level of environmental regulation stringency and enforcement meant a considerable decrease in the flows of investment from Spanish to foreign countries in these two specific sectors. The result of the coefficient of the primary sector is particularly notable for its strong correlation; its magnitude of 5.721 and 4.467 implies that each time the level of environmental regulation in the host country increases by 1%, Spanish FDI destined to this sector is 6% and 4.5% lower than in all other sectors, respectively. This result supports PHH for heavily polluting sectors. Therefore, when less pollution intense sectors as construction, wholesale and retail, professional services, and other services were used in the crossed product, the results showed negative but not significant coefficients. The last two sectors in the regressions, leisure services and utilities, presented positive coefficients, but only the utilities sector obtained a statistically significant coefficient. Thus, the Spanish FDI allocated to the utilities sector would be positively affected due to a better level of environmental regulations in the host countries. This result validates the presence of GHH in this specific sector.

The second major finding is that evidence supporting PHH is obtained when the sectoral approach is carried. In particular, any rise in the level of environmental regulation stringency and enforcement in the host country implies a decrease in the FDI flows from Spain to foreign countries in the primary and manufacturing sectors. As a consequence, PHH is supported by heavily polluting sectors. On the contrary, the Spanish FDI to the utility sector would be positively affected by a better level of environmental regulations in host countries. The not significant finding is obtained for less pollution intense sectors (construction, wholesale and retail, professional services, leisure, and other services).

The above results might be affected by potential endogeneity issues as a result of inward FDI affecting host countries' environmental policy (e.g., Poelhekke and van der Ploeg 2015). In the context of the gravity model, this type of endogeneity issue is less of a concern (Blonigen and Piger 2014; Martínez-Galán and Fontoura 2019) as it would arise if Spanish FDI had the capacity to affect host countries' environmental policy. Nonetheless, following the empirical strategy proposed by Carril-Caccia and Pavlova (2020) for addressing the potential endogeneity issue between cross-border mergers and acquisitions and countries' global value chain participation, we estimate Eq. (2) by lagging the environmental stringency variable by one period.[5] The results are reported in Table 7. As can be seen, the coefficients for the primary and manufacturing sectors remain negative, as in Table 5. However, the results do not support the GHH for the case of the utilities sector as the coefficient loses significance.

Robustness analysis

This subsection aims to deal with the problem associated with the use of an imperfect measure of environmental regulation quality. In order to validate the robustness of the results collected in the previous section, this research makes use of two contrast variables according to the findings of Galeotti et al. (2020). After analyzing 13 indicators of environmental policy stringency, they find consistency in the results of all variables based on ambient polluted emissions and composite indexes. Thus, aiming at covering these two categories, this study uses CO_2 emissions per capita (Omri et al. 2014; Brunel and Levinson 2016) and the environmental performance index (EPI), which is the revised version of the environmental sustainability index (ESI) (Mulatu 2010; Damania et al. 2004; Javorcik and Wei 2004). The CO_2 emission indicator was obtained from the World Bank (2019). The EPI variable was taken from the Socioeconomic Data and Applications Center (SEDAC) (2018). EPI was developed by Yale University and classifies 180 countries on 32 performance indicators across 11 issue categories covering environmental health and ecosystem vitality. As far as we know, this is the first time that the new version of EPI is used to address the PHH. Tables 8 and 9 show the results of the PPML regressions using these two variables as measures of environmental regulation quality.

Regarding the results shown in Table 8 obtained by using CO_2 as a variable of environmental regulation quality, on the one hand, there is evidence that Spanish FDI is oriented to

[5] Results with t-2 are not reported to save space but are available upon request. Estimates confirm the negative effect of environmental stringency on Spanish FDI in the primary sector, while in the case of manufacturing, the coefficient remains negative but loses significance. The results for the enforcement of environmental regulation in t-1 and t-2 are also available upon request; these estimates show that the enforceability of environmental regulation has a significantly larger negative effect on Spanish FDI in the primary sector.

Table 7 Sectoral effect of stringency of environmental regulation in t-1

	1	2	3	4	5	6	7	8
Log(GDP)	2.244	2.256	2.253	2.254	2.253	2.254	2.270	2.251
	(4.26)	(4.24)	(4.26)	(4.25)	(4.26)	(4.26)	(4.20)	(4.26)
Log(GDPpc)	−0.881	−0.764	−0.784	−0.787	−0.786	−0.788	−0.893	−0.796
	(4.09)	(4.11)	(4.08)	(4.08)	(4.08)	(4.08)	(4.06)	(4.08)
Log(PolStab)	1.215	1.232	1.220	1.221	1.224	1.222	1.357	1.230
	(3.27)	(3.24)	(3.28)	(3.28)	(3.28)	(3.28)	(3.22)	(3.28)
BER	−1.816*	−1.792*	−1.802*	−1.802*	−1.818*	−1.809*	−1.935*	−1.809*
	(0.99)	(1.00)	(1.03)	(1.03)	(1.02)	(1.02)	(0.99)	(1.02)
FTA	−0.192	−0.137	−0.168	−0.169	−0.180	−0.170	−0.146	−0.170
	(0.52)	(0.55)	(0.53)	(0.53)	(0.53)	(0.53)	(0.51)	(0.53)
EU28	3.937***	3.890***	3.983***	3.979***	3.879***	3.977***	4.003***	3.971***
	(1.45)	(1.45)	(1.46)	(1.45)	(1.45)	(1.46)	(1.45)	(1.45)
BIT	3.832***	3.941***	3.758***	3.753***	3.633**	3.755***	3.775***	3.717***
	(1.44)	(1.48)	(1.44)	(1.43)	(1.46)	(1.44)	(1.45)	(1.44)
Log(FDIstockt-1)	−0.338	−0.349	−0.356	−0.357	−0.361	−0.357	−0.346	−0.359
	(0.63)	(0.61)	(0.63)	(0.62)	(0.62)	(0.62)	(0.59)	(0.62)
Log(StrigERt-1)	−5.188	−4.909	−5.505	−5.511	−5.541	−5.498	−5.839	−5.454
	(4.55)	(4.05)	(4.46)	(4.46)	(4.52)	(4.45)	(4.39)	(4.46)
x primary	−5.240***							
	(1.44)							
x manufacturing		−1.540*						
		(0.90)						
x construction			0.135					
			(1.09)					
x wholesale and retail				0.262				
				(0.99)				
x professional					0.132			
					(1.02)			
x leisure						0.206		
						(1.16)		
x utilities							3.166	
							(2.06)	
x other services								−1.422
								(1.42)
Observations	7573	7583	7578	7578	7580	7578	7577	7577
R^2	0.382	0.385	0.380	0.380	0.380	0.380	0.395	0.380

Note: The dependent variable is the flows of Spanish FDI into each of the analyzed sectors. All regressions include country pair fixed effects and sector-year fixed effects. Standard errors clustered at the destination country-sector level are in parentheses. *, **, ***: statistically significant at 1%, 5%, and 10%, respectively. Authors' own elaboration

polluting countries, as the coefficient of the variable CO_2pc is positive and significant in five of the eight times that was estimated. That is also evident when analyzing the crossed product between CO_2 and the manufacturing and the other services sector, presented in columns 2 and 8. Both coefficients result positive and significant, which means that an increase of 1% in the level of CO_2 emissions in the host country causes that the Spanish FDI allocated to those sectors to be higher: by around 1% compared with all other economic sectors. This result again validates PHH for the manufacturing sector and for the first time for the services sector. On the other hand, as shown in columns 1 and 7, the coefficients when interacting CO_2 and the primary and the utilities sector are negative and significant, which means that Spanish FDI towards these two sectors decreases when pollution levels are higher. This result again supports GHE for the utilities sector.

Table 8 CO_2 estimates

	1	2	3	4	5	6	7	8
Log(GDP)	4.685***	4.490***	4.655***	4.550***	4.611***	4.550***	4.310***	4.612***
	(1.59)	(1.44)	(1.57)	(1.58)	(1.58)	(1.55)	(1.33)	(1.57)
Log(GDPpc)	−5.044***	−4.835***	−5.006***	−4.886***	−4.950***	−4.891***	−4.647***	−4.953***
	(1.91)	(1.74)	(1.90)	(1.87)	(1.90)	(1.86)	(1.64)	(1.88)
Log(PolStab)	3.365	3.444	3.371	3.403	3.394	3.391	3.374	3.394
	(2.44)	(2.41)	(2.45)	(2.46)	(2.46)	(2.46)	(2.44)	(2.46)
BER	−0.214*	−0.209*	−0.214*	−0.213*	−0.214*	−0.214*	−0.213*	−0.214*
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)
FTA	−0.141	−0.149	−0.114	−0.106	−0.091	−0.082	−0.063	−0.097
	(0.44)	(0.43)	(0.44)	(0.44)	(0.45)	(0.44)	(0.43)	(0.44)
EU28	0.456	0.389	0.475	0.465	0.500	0.499	0.453	0.488
	(1.03)	(1.01)	(1.03)	(1.03)	(1.03)	(1.03)	(1.04)	(1.03)
BIT	0.317	0.233	0.315	0.330	0.316	0.327	0.314	0.323
	(0.86)	(0.82)	(0.86)	(0.86)	(0.85)	(0.86)	(0.86)	(0.86)
Log(FDIstockt-1)	0.493	0.501	0.495	0.497	0.493	0.496	0.514	0.495
	(0.31)	(0.31)	(0.31)	(0.31)	(0.31)	(0.31)	(0.32)	(0.31)
Log(CO2pc)	3.197*	2.980	3.185*	3.196*	3.183*	3.135	3.252*	3.135
	(1.93)	(1.93)	(1.92)	(1.92)	(1.90)	(1.92)	(1.97)	(1.93)
x primary	−1.139**							
	(0.48)							
x manufacturing		1.112**						
		(0.44)						
x construction			−0.202					
			(0.32)					
x wholesale and retail				−0.351				
				(0.26)				
x professional					−0.102			
					(0.25)			
x leisure						0.549		
						(0.50)		
x utilities							−0.636*	
							(0.34)	
x other services								0.790**
								(0.36)
Observations	18,188	18,188	18,188	18,188	18,188	18,188	18,188	18,188
R^2	0.264	0.280	0.263	0.267	0.264	0.265	0.273	0.265

Note: The dependent variable is the flows of Spanish FDI into each of the analyzed sectors. All regressions include country pair fixed effects and sector-year fixed effects. Standard errors clustered at the destination country-sector level are in parentheses. *, **, ***: statistically significant at 1%, 5%, and 10%, respectively. Authors' own elaboration

Nevertheless, a negative and significant coefficient represents an ambiguous finding for the primary sector. This contradictory result when using CO_2 as a proxy variable must be treated with caution since FDI may not necessarily be attracted by the higher level of pollution but by a higher level of economic activity. In the case of the primary sector, the result contradicts the rest of the indicators, which may be due to the lower industrial economic activity of the countries in which the primary sector plays an important role. All other interaction effects had a nonsignificant impact on the decisions of the Spanish FDI.

Concerning the estimation using EPI as an empirical proxy of environmental stringency, the results again present evidence that the Spanish FDI allocated to the primary and the manufacturing sector contracts when a country's environmental performance is better. The coefficients for these variables

Table 9 EPI sectoral estimation

	1	2	3	4	5	6	7	8
Log(GDP)	6.677*	6.678	6.701*	6.583	6.770*	6.703*	6.691*	6.709*
	(3.94)	(4.25)	(3.90)	(4.23)	(3.84)	(3.90)	(3.96)	(3.90)
Log(GDPpc)	−6.930**	−6.856**	−6.927**	−6.747**	−6.981**	−6.925**	−6.925**	−6.930**
	(2.91)	(3.33)	(2.88)	(3.16)	(2.82)	(2.88)	(2.90)	(2.88)
Log(PolStab)	6.022	5.394	6.009	5.158	6.194	6.017	5.984	6.014
	(5.19)	(4.49)	(5.18)	(4.80)	(5.25)	(5.18)	(5.05)	(5.18)
BER	−3.421	−3.390	−3.433	−2.962	−3.487	−3.441	−3.434	−3.439
	(2.39)	(2.35)	(2.38)	(1.90)	(2.38)	(2.39)	(2.40)	(2.39)
FTA	0.954	0.848	0.969	0.856	0.984	0.976	0.969	0.973
	(0.70)	(0.65)	(0.69)	(0.60)	(0.69)	(0.68)	(0.68)	(0.68)
EU28	−0.780	−0.934	−0.788	−0.913	−0.741	−0.751	−0.760	−0.753
	(0.80)	(0.77)	(0.81)	(0.75)	(0.80)	(0.79)	(0.80)	(0.79)
BIT	−0.864	−1.569	−0.900	−1.009	−0.773	−0.865	−0.901	−0.875
	(1.45)	(1.49)	(1.48)	(1.54)	(1.51)	(1.45)	(1.42)	(1.45)
Log(FDIstockt-1)	0.634	0.622	0.635	0.610	0.633	0.635	0.636	0.632
	(0.66)	(0.64)	(0.65)	(0.67)	(0.65)	(0.65)	(0.65)	(0.65)
Log(EPI)	2.847	5.185	2.849	0.467	2.328	2.800	2.747	2.691
	(7.85)	(7.71)	(7.82)	(7.92)	(7.90)	(7.83)	(7.65)	(7.85)
x primary	−7.091*							
	(3.86)							
x manufacturing		−8.027***						
		(3.10)						
x construction			−0.152					
			(3.34)					
x wholesale and retail				15.711***				
				(5.26)				
x professional					2.854			
					(3.18)			
x leisure						1.182		
						(3.81)		
x utilities							0.321	
							(3.33)	
x other services								6.027
								(3.81)
Observations	7887	7876	7890	7891	7887	7886	7886	7881
R^2	0.268	0.280	0.268	0.325	0.267	0.268	0.267	0.268

Note: The dependent variable is the flows of Spanish FDI into each of the analyzed sectors. All regressions include country pair fixed effects and sector-year fixed effects. Standard errors clustered at the destination country-sector level are in parentheses. *, **, ***: statistically significant at 1%, 5%, and 10%, respectively. Authors' own elaboration

are negative and significant. The magnitude of 7.091 and 8.027 implies that a 1% increase in the EPI level of the host country causes Spanish FDI allocated to these sectors to be higher: in around 7.1% and 8%, compared to the rest of the economic sectors. This finding shows that regardless of the indicator that is used, the results for the manufacturing sector always support the PHH. Furthermore, through the use of EPI, it is possible to find again evidence that supports the PHH for the primary sector. In contrast, when interacting EPI and the wholesale and retail sectors, the resulting coefficients are positive and significant at 1%. Thus, this result supports GHH for this sector. Nevertheless, the robustness of this indicator is feeble as this is the first time in four regressions that this sector presents a significative coefficient. For the other sectors, the EPI variable appears to play a marginal role and does not affect FDI significantly.

Discussion

This research used a gravity model to investigate the impact of the stringency and enforcement of the environmental regulation on Spanish investment flows abroad. The first approximation to the empirical data, when FDI was considered without any sectoral distinction, results failed to support the PHH or Porter hypothesis. However, in a second approximation to the data, when the estimations captured the heterogeneous impact of environmental regulation across economic sectors, the results showed evidence of PHH in Spanish FDI. This empirical finding is in line with the research of Millimet and List (2004) and Mulatu (2017).

PHH was only observable in certain sectors. The manufacturing sector obtained positive and significant coefficients when the principal variables stringency and enforcement of environmental regulation were used; the same was verified in the robustness test using the variables CO_2 and EPI. In line with this outcome, the primary sector also validates PHH in three of the four estimations. On the contrary, the sectors, construction, wholesale and retail, professional, leisure, and other services, did not affect Spanish FDI significantly. Thus, the PHH is present in Spanish FDI during the study period, but this effect is hidden by the heterogeneous impact that environmental regulation has on the different types of industry. The PHH can just be found in the manufacturing, and primary sectors due to these sectors represent industries that in fact produce goods.

Finally, the result of the utilities sector is in line with the findings of Poelhekke and van der Ploeg (2015). The estimates showed that a higher level of stringency and enforcement of the environmental regulation foster the Spanish FDI allocated in this sector.

Conclusions

During the last 30 years, Spain outward FDI drastically increased being the main source of investment in Latin American. At the same time, Spain made strong efforts in terms of tightening its environmental policy and reducing its level of CO_2 per capita. In the present paper, we employ the gravity model to empirically address the PHH on Spanish outward FDI flows. To this end, a panel of data containing information on 126 countries over the period 2008–2018 was used. The multisectoral approach included 8 sectors; primary, manufacturing, construction, wholesale and retail, professional services, leisure services, utilities, and other services. Environmental regulation is proxied from the perception of business CEOs about the environmental policy design in the sample of countries explored. This allows bridging the limit of unobserved cross-industry measures of environmental regulation that cannot be captured in other quantitative measures.

From major findings, it can be concluded that analyzing Spanish FDI flows as a whole testing PHH is not the right way to reach a rich insight. When no sectoral approach is developed, the PHH seems to be not validated. However, the multisectoral perspective states that MNEs investing in the primary and manufacturing sectors seek refuge in countries with a low standard of legal environmental protection framework. We conclude that when exploring heavily polluting sectors as primary results support PHH for Spain. Any rise in the level of environmental regulation stringency and enforcement implies a decrease in the FDI flows from Spain to foreign countries in these sectors. Offshoring and outsourcing processes positively respond to movements through FDI of high-polluting industries seeking refuge in countries with a low standard of legal environmental protection framework.

A lax environmental regulation creates incentives for Spanish industries to move their production part to another country, but this does not imply moving their nonproduction part to the same place. Those nonproducing sectors may do not find any incentive, in terms of comparative advantage, to offshoring their economic activity to countries with lax environmental regulation. In other words, an investment project destined to the other services sector, for example, might not be reflecting PHH because its nonproductive industrial activities would not perceive any competitive advantage from lax environmental regulation in line with Yoon and Heshmati (2017).

Our results allow us to confirm the presence of a refugee effect of the Spanish FDI towards economic sectors that are known to be pollution-intensive (primary and manufacturing sectors). However, whether or not a concentration of FDI in polluting sectors necessarily implies a deterioration of the environmental conditions in the host countries is still subject to debate. Recent empirical research in the specialized literature has yielded contradictory results across economies. In an extensive study, Pazienza (2019) found that FDI in the OECD countries' manufacturing sectors played a detrimental role in terms of CO_2 emissions. Nevertheless, opposite results have been found in emerging and developing countries (e.g., Haug and Ucal 2019; Zubair et al. 2020). Determining the quantitative impact of Spanish FDI in the primary and manufacturing sectors on the environmental quality of receiving countries represents an excellent avenue for future research, but is beyond the scope of this paper.

Furthermore, our findings show that the green paradise hypothesis holds for FDI allocated in the utilities sector. This suggests that industries belonging to this category would be more incentivized to follow the triple bottom line (people, profit, and the planet) and maintain their green reputation.

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Availability of data and materials Upon reasonable request.

Author contribution JMC and FC conceived the idea and participated in writing the paper. JCM participated in writing the paper and processed data under the supervision of FC. RRC participated in writing the paper focusing on policy recommendations. All authors participated in Conclusions.

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Declarations

Ethics approval and consent to participate No human data involved.

Consent for publication Given.

Competing interests The authors declare no competing interests.

Annex

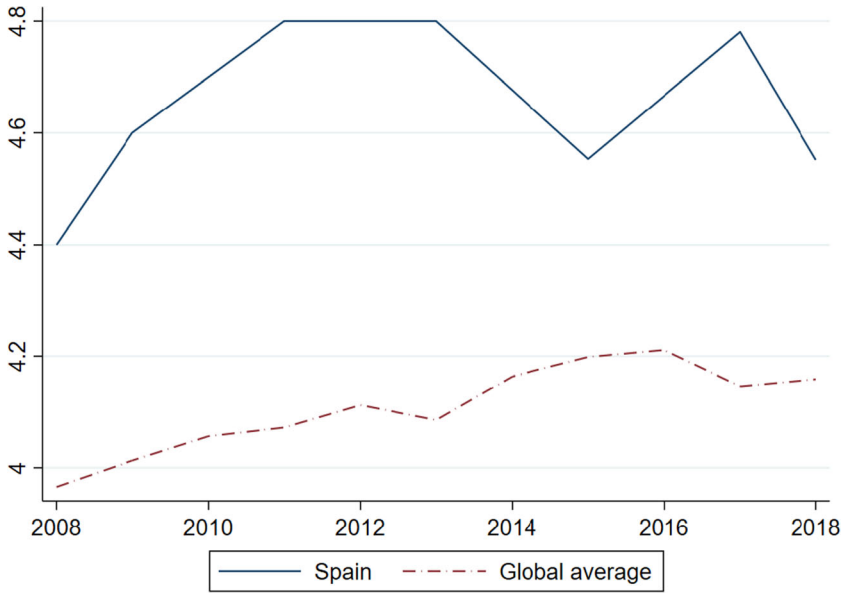

Fig. 1 Stringency in environmental regulation (WEF). Note: Stringency in environmental regulation retrieved from the World Economic Forum (WEF). The global average does not include Spain. Authors' own elaboration

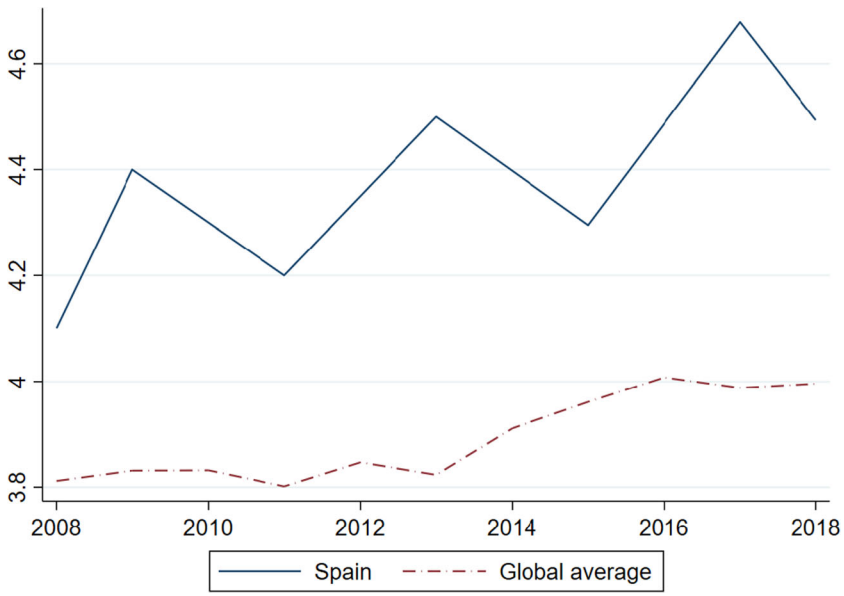

Fig. 2 Environmental regulation enforcement (WEF). Note: Enforcement of environmental regulation retrieved from the World Economic Forum (WEF). The global average does not include Spain. Authors' own elaboration

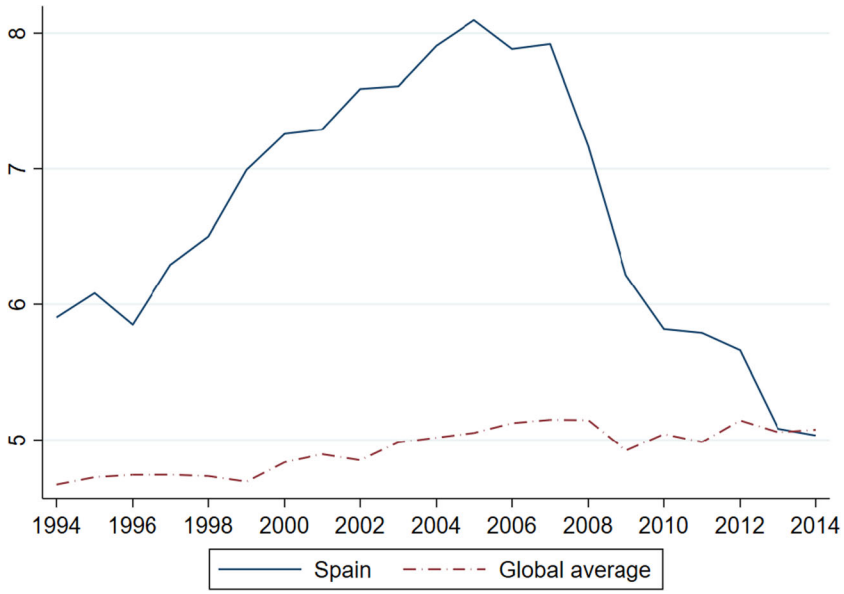

Fig. 3 CO_2 emissions per capita (in tons). Note: CO_2 emissions per capita in tons, retrieved from the World Bank. The global average does not include Spain. Authors' own elaboration

Table 10 Description of the variables included in the research and expected sign of coefficients

Variable abbreviation	Explanation	Unit	Source	Expected sign
FDI	Spanish foreign direct investment	US dollars	DataIndex	
Log(GDP)	GDP in host country	ln(GDP)	WDI	Positive
Log(GDPpc)	GDP per capita in host country	ln(GDPpc)	WDI	Negative
Log(PolStab)	Political stability and absence of violence/terrorism	ln(index). The index is converted so it takes only positive values	WGI	Positive
BER	diff of log bilateral exchange rate t and t-1	log(exchange rate in t) - log(exchange rate t-1)	IFS	±
FTA	Free trade agreement	1: if Spain and the host country have signed the treaty 0: if no FTA is signed		Positive
EU28_dest	EU28 dummy	1: if the host country belongs to the EU 0: if the host country is not a EU member		Positive
BIT dummy	Bilateral investment treaty	1: if the country pair has signed a bilateral investment treaty 0: if no BIT is signed	UNCTAD investment policy hub	Positive
Log(FDIstockt-1)	FDI stock in t-1	ln(FDIstock in t-1)	UNCTAD	+
Log(StrigER)	Stringency of environmental regulations	ln(index)	WEF	±
Log(EnforER)	Enforcement of environmental regulations	ln(index)	WEF	±
Log(CO_2pc)	CO_2 emissions	ln(metric tons per capita)	WDI	±
Log(EPI)	Environmental performance index	ln(index)	EPI	±
x Primary	Term of interaction (Primary sector X StrigER/EnforER/CO_2pc/EPI)			±
x Manufacturing	Term of interaction (Manufacturing X StrigER/EnforER/CO_2pc/EPI)			±
x Construction	Term of interaction (Construction X StrigER/EnforER/CO_2pc/EPI)			±
x Wholesale and retail	Term of interaction (Wholesale and retail X StrigER/EnforER/CO_2pc/EPI)			±
x Professional	Term of interaction (Professional X StrigER/EnforER/CO_2pc/EPI)			±
x Leisure	Term of interaction (Leisure X StrigER/EnforER/CO_2pc/EPI)			±
x Utilities	Term of interaction (Utilities X StrigER/EnforER/CO_2pc/EPI)			±
x Other services	Term of interaction (Other services X StrigER/EnforER/CO_2pc/EPI)			±

References

Anderson JE, van Wincoop E (2003) Gravity with gravitas: a solution to the border puzzle. Am Econ Rev 93(1):170–192

Asiedu E (2006) Foreign direct investment in Africa: the role of natural resources, market size, government policy, institutions and political instability. World Econ 29(1):63–77

Baier SL, Bergstrand JH (2009) Estimating the effects of free trade agreements on international trade flows using matching econometrics. J Int Econ 77(1):63–76

Bergstrand JH, Egger P (2013) What determines BITs? J Int Econ 90(1): 107–122

Blonigen BA, Piger J (2014) Determinants of foreign direct investment. Canadian Journal of Economics/Revue canadienne d'économique 47(3):775–812

Brunel C, Levinson A (2016) Measuring the stringency of environmental regulations. Rev Environ Econ Policy 10(1):47–67

Cansino JM, Román-Collado R, Molina JC (2019) Quality of institutions, technological progress, and pollution havens in Latin America. An analysis of the environmental Kuznets curve hypothesis. Sustainability 11(13):3708

Carril-Caccia F, Paniagua J (2018) Crisis financieras e inversión extranjera: un análisis de fusiones y adquisiciones. Papeles de Economía Española 158:188

Carril-Caccia F, Pavlova E (2020) Mergers and acquisitions and trade: a global value chain analysis. World Econ 43(3):586–614

Cheng Z, Li L, Liu J (2018) The spatial correlation and interaction between environmental regulation and foreign direct investment. J Regul Econ 54:124–146

Chichilnisky G (1994) North-south trade and the global environment. Am Econ Rev 84:851–874

Chung S (2014) Environmental regulation and foreign direct investment: evidence from South Korea. Journal of Development Economics, Elsevier 108(C):222–236

Coeurdacier N, De Santis RA, Aviat A (2009) Cross-border mergers and acquisitions and European integration. Econ Policy 24(57):56–106

Cole MA, Elliott RJ (2005) FDI and the capital intensity of "dirty" sectors: a missing piece of the pollution haven puzzle. Rev Devel Econ 9(4):530–548

Copeland B, Taylor M (2004) Trade, growth, and the environment. J Econ Lit 42(1):7–71

Damania R, Fredriksson PG, Mani M (2004) The persistence of corruption and regulatory compliance failures: theory and evidence. Public Choice 121(3–4):363–390

Dean J, Lovely M, Wang H (2009) Are foreign investors attracted to weak environmental regulations? Evaluating the evidence from China. J Dev Econ 90(1):1–13

Desbordes R, Vicard V (2009) Foreign direct investment and bilateral investment treaties: an international political perspective. J Comp Econ 37(3):372–386

di Giovanni J (2005) What drives capital flows? The case of cross-border MandA activity and financial deepening. J Int Econ 65(1):127–149

Eskeland GS, Harrison AE (2003) Moving to greener pastures? Multinationals and the pollution haven hypothesis. J Dev Econ 70: 1–23

Galeotti M, Salini S, Verdolini E (2020) Measuring environmental policy stringency: approaches, validity, and impact on environmental innovation and energy efficiency. Energy Policy 136:111052

Gill FL, Viswanathan KK, Karim MZA (2018) The critical review of the pollution haven hypothesis (PHH). Int J Energy Econ Policy 8(1): 167–174

Grossman, G.M., and Krueger, A.B. (1991). Environmental impacts of a north American free trade agreement. National Bureau of economic research, NBER Working Papers. Cambridge: NBER. Page 3914

Hanna R (2010) US environmental regulation and FDI: evidence from a panel of US-based multinational firms. Am Econ J Appl Econ 2(3): 158–189. https://doi.org/10.1257/app.2.3.158

Haug AA, Ucal M (2019) The role of trade and FDI for CO_2 emissions in Turkey: nonlinear relationships. Energy Economics, Vol 77:297–307

He J (2006) Pollution haven hypothesis and environmental impacts of foreign direct investment: the case of industrial emission of sulfur dioxide (SO_2) in Chinese provinces. Ecol Econ 60(1):228–245. https://doi.org/10.1016/j.ecolecon.2005.12.008

Head K, Ries J (2008) FDI as an outcome of the market for corporate control: theory and evidence. J Int Econ 74(1):2–20

Herzig C, Schaltegger S (2006), Corporate sustainability reporting. An overview. Sustainability Accounting and Reporting. Netherlands: Springer. Page 301–324

International Monetary Fund, International financial statistics. (2019). Real effective exchange rate base on the CPI [data file]. Retrieved from https://data.imf.org/?sk=4c514d48-b6ba-49ed-8ab9-52b0c1a0179bandsId=1539887168442

Javorcik B, Wei S (2004). Pollution havens and foreign direct investment: dirty secret or popular myth? Contrib Econ Anal Pol 3 (Article 8)

Kalamova, M., and Johnstone, N. (2011). Environmental policy stringency and foreign direct investment. OECD Environment Working Papers No. 33. Paris: OECD

Kaufmann, D. and Aart, K. (2017). Worldwide governance indicators. Retrieved December 1st, 2017 from https://data.worldbank.org/data-catalog/worldwide-governance-indicators

Kellenberg DK (2009) An empirical investigation of the pollution haven effect with strategic environment and trade policy. J Int Econ 78: 242–255

Kheder SB, Zugravu N (2012) Environmental regulation and French firms location abroad: an economic geography model in an international comparative study. Ecol Econ 77:48–61

Kleinert J, Toubal F (2010) Gravity for FDI. Rev Int Econ 18(1):1–13

Kox HL, Rojas-Romagosa H (2020) How trade and investment agreements affect bilateral foreign direct investment: results from a structural gravity model. World Econ

Leiter AM, Parolini A, Winner H (2011) Environmental regulation and investment: rvidence from European industry data. Ecol Econ 70(4): 759–770

Levinson A (1996) Environmental regulations and industry location: international and domestic evidence. J Public Econ 62(1–2):5–29

Malesky EJ (2004). Push, pull, and reinforcing: the channels of FDI influence on provincial governance in Vietnam. In Beyond Hanoi (pp. 285–333). https://doi.org/10.1355/9789812305947-013

Manderson E, Kneller R (2012) Environmental regulations, outward FDI and heterogeneous firms: are countries used as pollution havens? Environ Resour Econ 51(3):317–352

Markusen JR, Morey ER, Olwiler N (1993) Environmental policy when market structure and plant locations are endogenous. J Environ Econ Manag 24:69–86

Martínez-Galán E, Fontoura MP (2019) Global value chains and inward foreign direct investment in the 2000s. World Econ 42(1):175–196

Millimet DL, List JA (2004) The case of the missing pollution haven hypothesis. J Regul Econ 26:239–262

Millimet DL, Roy J (2016) Empirical tests of the pollution haven hypothesis when environmental regulation is endogenous. J Appl Econ 31(4):652–677

Mulatu A (2017) The structure of UK outbound FDI and environmental regulation. Environ Resour Econ 68:65–96

Mulatu A, Gerlagh R, Rigby D et al (2010) Environmental regulation and industry location in Europe. Environ Resour Econ 45:459–479

Omri A, Nguyen DK, Rault C (2014) Causal interactions between CO 2 emissions, FDI, and economic growth: evidence from dynamic simultaneous-equation models. Econ Model 42:382–389

Ouyang X, Shao Q, Zhu X et al (2019) Environmental regulation, economic growth and air pollution: panel threshold analysis for OECD countries. Sci Total Environ 657:234–241

Pazienza P (2019) The impact of FDI in the OECD manufacturing sector on CO_2 emission: evidence and policy issues. Environ Impact Assess Rev 77:60–68

Pethig R (1976) Pollution, welfare and environmental policy in the theory of comparative advantage. J Environ Econ Manag 2:160–169

Piermartini, R., and Yotov, Y. (2016). Estimating trade policy effects with structural gravity. WTO staff working paper, no. ERSD-2016-10

Poelhekke S, van der Ploeg F (2015) Green havens and pollution havens. World Econ 38:1035–1178

Porter ME, van der Linde C (1995) Toward a new conception of the environment competitiveness relationship. J Econ Perspect 9(4): 97–118

Shen J, Wang S, Liu W, Chu J (2019) Does migration of pollution-intensive industries impact environmental efficiency? Evidence supporting "pollution haven hypothesis". J Environ Manag 242

Siebert H (1977) Environmental quality and the gains from trade. Kyklos 30:657–673

Silva JS, Tenreyro S (2006) The log of gravity. Rev Econ Stat 88(4):641–658

Socioeconomic Data and Applications Center (SEDAC), Environmental performance index. (2018). [Data file]. Retrieved from https://sedac.ciesin.columbia.edu/data/collection/epi/sets/browse

Spanish Secretary of State for Commerce, DataInvext (2018). Gross investment flows [Data file]. Retrieved from http://datainvex.comercio.es/principal_invex.aspx

United Nations Conference on Trade and Development, Foreign direct investment. (2019). [Data file]. Retrieved from https://unctadstat.unctad.org/wds/ReportFolders/reportFolders.asx

Wagner U, Timmis C (2009) Agglomeration effects in foreign direct investment and the pollution haven hypothesis. Environ Resour Econ 43:231–256

Willis A (2003) The role of the global reporting initiative's sustainability reporting guidelines in the social screening of investments. J Bus Ethics 43(3):233–237

World Bank, Content of deep trade agreements. (2015). [Data file]. Retrieved from https://datacatalog.worldbank.org/dataset/content-deep-trade-agreements

World Bank, World development indicators. (2019). [Data file]. Retrieved from https://databank.worldbank.org/source/world-development-indicators

World Economic Forum, The travel and tourism competitiveness report. (2019). [Data file]. Retrieved from https://www.weforum.org/reports/the-travel-tourism-competitiveness-report-2019

Xu J, Zhou M, Li H (2016) ARDL-based research on the nexus among FDI, environmental regulation, and energy consumption in Shanghai (China). Nat Hazards 84:551–564

Yang X, Liyan H, Li W, Libo Y (2019) Dynamic link between oil prices and exchange rates: a non-linear approach. Data Energy Economics 84:104488

Yoon H, Heshmati A (2017). Do environmental regulations effect FDI decisions? The pollution haven hypothesis revisited. Institute of Labor Economics Discussion Paper Series- IZA DP, 10897

Zhang M, Liu X, Ding Y, Wang W (2019) How does environmental regulation affect haze pollution governance?—an empirical test based on Chinese provincial panel data. Sci Total Environ 695: 133905. https://doi.org/10.1016/j.scitotenv.2019.133905

Zubair AO, Samad AA, Dankumo AM (2020) Does gross domestic income, trade integration, FDI inflows, GDP, and capital reduces CO_2 emissions? Empirical evidence from Nigeria. Current Research in Environmental Sustainability 2