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Research article

The scope of implementation of ISO 14001 by multinational enterprises: The role of liabilities of origin

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ABSTRACT

This research contends that MNEs from polluting and emerging countries are subject to liabilities of origin that compel them to signal that they differ from the stereotypes of their home countries to attain environmental legitimacy. ISO 14001 adoption, which signals a commitment to environmental protection, may help MNEs from polluting and emerging countries overcome their legitimacy deficits. The wider the scope of ISO 14001 adoption, the greater its power to signal environmental awareness, and therefore, the greater its efficacy in counteracting liabilities of origin. Accordingly, this research proposes that the scope of ISO 14001 adoption by MNEs from the considered countries is wider than that of MNEs that are not subject to liabilities of origin. This contention is tested in a multisector sample of 733 MNEs over the period 2002–2019.

1. Introduction

Environmental management has become a central issue on the agendas of firms due to growing concerns about the impact of their activities on natural resources. Several certifiable environmental management standards have been developed to help firms minimize their negative effects on the environment. One of the most prominent is ISO 14001, a process-based standard that guides firms in implementing an environmental management system (EMS). Certification of ISO 14001 adoption by a third-party auditor shows a credible commitment to environmental protection and thus helps improve a firm's image (Boiral, 2007).

ISO 14001 adoption is voluntary, and several previous studies have focused on identifying drivers of its adoption. Most empirical studies analyze drivers of ISO 14001 adoption at the country level (e.g., Delmas and Montes-Sancho, 2011; Potoski and Prakash, 2004; Neves et al., 2017) or facility level (e.g., Delmas and Toffel, 2008; Montiel and Husted, 2009). This research focuses on drivers of ISO 14001 adoption at the corporate level, which is an underexplored level of analysis. Specifically, this study analyzes the reasons that multinational enterprises (MNEs) adopt ISO 14001. As multisite organizations, MNEs must decide whether to strongly commit to ISO 14001 by achieving certification at all sites or weakly commit to ISO 14001 by certifying only a subset of sites. Thus, the scope of ISO 14001 adoption, which refers to the percentage of sites certified under ISO 14001, is a decision made at the corporate level (Darnall, 2006; Delmas and Toffel, 2008). This research explores the factors that determine the scope of ISO 14001 implementation by MNEs.

An MNE's home country greatly shapes its strategic choices (Harzing and Sorge, 2003). In that sense, home country may be an important determinant of how and to what extent MNEs decide to control their environmental impact. In the case of ISO 14001, we contend that home country shapes the adoption choices of MNEs by imprinting them with a need to prove their *environmental legitimacy* abroad. Environmental legitimacy refers to the "*generalized perception or assumption that a firm's corporate environmental performance is desirable, proper, or appropriate*" (Bansal and Clelland, 2004, p. 94). Attaining environmental legitimacy is in the interest of firms, as it may bring advantages such as financial support from green investors or green consumers willing to pay higher prices (Berrone et al., 2017).

We argue that the readiness with which an MNE is perceived as an environmentally legitimate actor depends on certain home country characteristics, namely, the country's environmental performance and whether it is an emerging economy. We consider that these two characteristics of the home country may impose an extra burden on MNEs trying to attain environmental legitimacy. This extra burden results from

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liabilities of origin. Liabilities of origin entail negative perceptions of the firm's ability to conduct legitimate business that arise not necessarily from the firm's own behavior but from the behavior of other agents within the home country (Amankwah-Amoah and Debrah, 2017; Marano et al., 2017). These liabilities are associated with a firm's origination in a particular region of the world (Asmussen, 2009). For instance, Chinese firms may be perceived as polluting entities simply because they are based in a country where environmental protection is not a priority. MNEs often take proactive measures to overcome the stigma of their geographical origin and differentiate themselves from the attributes of their home countries (Cuervo-Cazurra et al., 2018). For instance, firms may use corporate social responsibility (CSR) reporting (Fiaschi et al., 2017; Marano et al., 2017) or affiliations with prestigious parties (Amankwah-Amoah and Debrah, 2017) to reduce the extent to which stakeholders evaluate them based on stereotypes about their home countries.

This research considers that the scope of ISO 14001 adoption is a strategic variable that may help MNEs overcome their liabilities of origin and be perceived abroad as legitimate entities. We argue that stakeholders tend to attribute to MNEs from highly polluting countries and emerging countries the poor environmental performance of their home countries and assume that such MNEs do not care about the environment. Consequently, these MNEs need to publicly and credibly show their willingness to protect the environment to engage in business relations. In our framework, this means that they are more likely to adopt ISO 14001 at all or most of their sites with the aim of showing a genuine environmental awareness that frees them from prejudices about their home countries. We test these contentions by using a sample of 733 MNEs from 44 countries over the period 2002–2019. The results provide evidence that MNEs from highly polluting countries and emerging countries tend to certify a higher percentage of their sites as ISO 14001-compliant.

This article contributes to expanding knowledge about the factors underlying the adoption of voluntary environmental certifications. Explorations of why firms participate in this type of initiative usually treat the participation decision as a dichotomous variable and miss the broad range of approaches to participation adopted by firms (Aragón-Correa et al., 2020). By focusing on the overall level of ISO 14001 adoption across the firm rather than adoption at individual sites, our research allows us to assess the varying degrees of commitment of MNEs to this particular environmental standard. In addition, the paper addresses the behavior of MNEs from emerging economies, where, as Earnhart et al. (2014) point out, empirical research on corporate environmental strategy remains limited.

2. Theoretical background

2.1. Why do firms adopt ISO 14001?

ISO 14001 is an international certifiable environmental management standard that was created in 1996 by the International Organization for Standardization (ISO). As a process-oriented standard, ISO 14001 does not dictate specific environmental goals to be achieved (Heras-Saizarbitoria and Boiral, 2013). Instead, it assists firms in designing and implementing systems to manage their impact on the environment (Aragón-Correa et al., 2020). Its adoption is voluntary, which means that no central authority gives rewards for adoption or sanctions for lack of adoption (Ingram and Silverman, 2002). Compliance with ISO 14001 can be certified by private third-party auditors that are accredited for this purpose by a national accreditation body. Certification is generally granted at the facility level.

ISO 14001 adoption brings both costs and benefits (Bansal and Bogner, 2002). The costs include third-party audit fees, the costs of creating an EMS or modifying an existing one, and the annual cost of maintaining documentation (Darnall and Edwards, 2006). These costs are at the site level, so in the case of MNEs, they can be very substantial. ISO 14001 adoption may also provide the following benefits. First, it allows firms to show their commitment to preserving the environment in a credible way, which improves their image and helps them establish cordial relationships with stakeholders (King et al., 2005). In the case of MNEs, achieving a good image requires strong coordination among sites. The lack of implementation of ISO 14001 at a given site might seriously damage the entire MNE's environmentally friendly image. Second, ISO 14001 adoption increases the transparency of the firm's operations, which reduces information asymmetries and, in turn, favors coordination with stakeholders (Heras-Saizarbitoria and Boiral, 2013). For MNEs, the standardization of internal operations to allow ISO 14001 certification also facilitates site coordination, which is usually associated with greater organizational efficiency. Finally, ISO 14001 adoption guides managers in developing an environmental policy by specifying the routines to apply to control the firm's environmental impact (Delmas and Montes-Sancho, 2011).

The literature on ISO 14001 can be broadly classified into three research streams. One stream primarily focuses on analyzing whether the routines of ISO 14001 are implemented symbolically or substantially (e.g., Aravind and Christmann, 2011; Testa et al., 2018). A second group of studies examines the impact of ISO 14001 adoption by considering its environmental, operational and economic consequences (e.g., Nishitani et al., 2012; Boiral and Henri, 2012; Boiral et al., 2018; Arocena et al., 2021). Finally, a third group of papers investigates what drives firms to adopt ISO 14001.

Regarding the third stream of research, previous empirical studies have analyzed both internal and external factors that influence the choice to adopt ISO 14001 (González-Benito and González-Benito, 2005). First, studies focusing on internal motivations have identified cost efficiency, staff welfare and top management's agenda as factors that lead to ISO 14001 adoption (Quazi et al., 2001). Export orientation (Liston-Heyes and Heyes, 2021), the interests of particular departments within the firm (Delmas and Toffel, 2008), and firm characteristics, such as the availability of resources (Montiel and Husted, 2009), financial performance and size (Baek, 2017), have also been revealed as internal drivers of ISO 14001 adoption. Second, ISO 14001 certification is often conceived as a means to respond to external pressures (Bansal and Bogner, 2002; Boiral, 2007). In that sense, empirical evidence has shown that firms adopt ISO 14001 with the aim of conforming to demands from governments (Potoski and Prakash, 2004), civil society and non-governmental organizations (Delmas and Montes-Sancho, 2011; Delmas and Montiel, 2008), professional associations (Delmas and Toffel, 2004), and customers (Quazi et al., 2001). As mentioned previously, drivers of ISO 14001 adoption have mainly been identified at the facility level (e.g., Darnall et al., 2008; Delmas and Toffel, 2008) or macro level (e.g., Delmas and Montes-Sancho, 2011; Potoski and Prakash, 2004).

2.2. Signaling value of ISO 14001

MNEs are facing increasing public and market pressures to address their environmental impact (Pinkse and Kolk, 2012). These pressures increase firms' incentives to communicate their environmental performance positively to their stakeholders to be recognized as environmentally friendly. Such communication is important because a firm's environmental performance is a dimension that is particularly challenging for outside parties to assess (Lyon and Maxwell, 2011). Since the public has limited and non-verifiable information about corporate environmental performance, firms can manipulate the dissemination of information to mislead the public about their environmental practices. More precisely, poor environmental performers may engage in greenwashing to present an unfounded public image of environmental responsibility (Ramus and Montiel, 2005; Parguel et al., 2011). Thus, an environmentally friendly firm has an interest in differentiating itself from those that are not and in demonstrating that its environmental strategy is real and not mere greenwashing.

In the absence of complete and verifiable information, outside parties cannot simply rely on firms' statements about their environmental practices. Under these circumstances, ISO 14001 functions as a credible signal that allows firms to publicly display the quality of their internal procedures and credibly indicate their commitment to environmental protection (King et al., 2005). The credibility of ISO 14001 is based on both certification and the required commitment for implementation. First, a demanding audit process developed by an independent auditor must be passed to obtain ISO 14001 certification. This certification credibly signals the higher quality of certified firms compared with non-certified firms (Terlaak and King, 2006). Second, the adoption of ISO 14001 involves irreversible costs that have high commitment value. Implementing ISO 14001 generates costs associated with the incorporation and creation of specific procedures, technologies and equipment and the establishment of relationship-specific contracts with suppliers, consumers and investors. Therefore, the firm faces risk if it fails to match its words with its actions.

Signals may differ in their signaling power. For instance, green patents signal a strong willingness to protect the environment, as they require firms to invest significant effort, time and money in the underlying research (Berrone et al., 2013). By contrast, firms' participation in environmental programs sponsored by the government shows a limited commitment to environmental preservation, as such participation does not require relevant costs to be incurred (Berrone et al., 2017). In this sense, we argue that the signaling power of ISO 14001 generally increases with the scope of adoption. The greater the number of sites where ISO 14001 is implemented, the greater the effort and resources that must be invested to reconfigure the MNE's operations according to environmental criteria. Thus, global ISO 14001 implementation, which involves certifying all of an MNE's sites, may lead stakeholders to perceive a greater willingness on the part of the MNE to avoid environmentally detrimental practices. In other words, MNEs send a stronger signal of environmental commitment when they broadly implement ISO 14001.

Our basic contention is that country features determine whether MNEs decide to send strong or weak signals. We argue that MNEs from polluting and emerging countries are subject to liabilities of origin, as stakeholders usually attach the poor environmental profile of the home country to an MNE. As a result, these MNEs are more interested in sending strong signals to counteract the legitimacy deficit that they suffer due to their origin in a particular region of the world. As global adoption of ISO 14001 is a strong signal of commitment to environmental preservation, MNEs may try to overcome their liabilities of origin by implementing ISO 14001 at most of their sites.

3. Hypothesis development

As stated above, the scope of ISO 14001 adoption by an MNE is a strategic choice made at the corporate level because of its value in signaling the overall environmental legitimacy of the organization internationally. Enhancing the environmental legitimacy of an MNE requires a shared strategy among its subsidiaries, as their individual behavior affects the overall environmental image of the organization. Thus, if a particular subsidiary in one specific host country behaves irresponsibly, the parent company will also be perceived as irresponsible (Asmussen and Fosfuri, 2019). Indeed, stakeholders in a particular country may punish an MNE for irresponsibility in other settings. Like any corporate strategic decision, environmental strategy is set by the MNE headquarters in the home country. Thus, just as the effectiveness of ISO 14001 implementation and performance in a plant is arguably more conditioned by contextual factors in the host country, the extent of ISO 14001 adoption by an MNE is mainly conditioned by the MNE's home country. In other words, the country of origin plays a larger role than the host countries of the individual plants in deciding the extent of adoption of certified environmental standards throughout the MNE.

Our theoretical framework revolves around two hypotheses. First, we discuss how home country environmental performance influences MNEs in determining the scope of ISO 14001 application. Second, we argue that incentives for global ISO 14001 implementation differ for MNEs from emerging countries.

3.1. Environmental performance of the home country

A country's environmental image or reputation refers to the public's assessment/perception of its awareness of and efforts to mitigate the negative impact of its economic activity on the environment. Such a reputation is largely shaped by a country's past environmental performance relative to those of other countries over time (Fombrun and Shanley, 1990; Norheim-Hansen, 2015). The weak environmental reputation of a home country due to poor environmental performance can be transferred to its MNEs as a stigma, imbuing them with a negative image of low environmental concern (Amankwah-Amoah and Debrah, 2017; Marano et al., 2017). For example, MNEs from highly polluting countries run the risk of being prejudged as companies that are not taking the necessary actions to promote clean and low-greenhouse-gas-emitting production. Hence, MNEs from countries with poor environmental performance may face obstacles in attaining environmental legitimacy (Bansal and Clelland, 2004; Berrone et al., 2017). The difficulty of achieving environmental legitimacy makes it even more necessary for MNEs to send strong signals that differentiate them from the poor environmental profiles of their home countries. Given that a wide scope of ISO 14001 implementation signals a strong commitment to environmental preservation, our first hypothesis is as follows:

H1. *The scope of ISO 14001 adoption is wider for MNEs from countries with poorer environmental performance than for MNEs from countries with better environmental performance.*

3.2. Emerging countries

Emerging economies are countries with low to middle per capita income, rapid economic growth, and growth rates higher than those of developed countries; in these countries, governments tend to favor the adoption of a free-market system as a means of fostering economic development (Hoskisson et al., 2000). Thus, emerging economies typically adopt a series of market-oriented reforms with the main objective of boosting industrialization, employment generation and GDP growth, based largely on the production and export of low-cost goods to richer nations. These economies aim to reduce their dependence on primary activities such as agriculture and mining and promote sectors with higher value-added final products. They also seek significantly increased trade relations with other countries.

At this stage of economic development, goals generally override environmental considerations, and emerging economies tend to have less stringent environmental regulations and lower environmental standards. As a result, emerging economies are often seen as potential "pollution havens" whose loose environmental regulations attract pollution-intensive production from countries with tighter environmental regulations. Thus, a large percentage of global CO_2 emissions are concentrated in large emerging economies. It is true, however, that the emission volumes in per capita and GDP terms of several developed countries (e.g., Australia, Canada or the United States) are similar to or higher than those of various large emerging countries (e.g., Brazil, Indonesia, Malaysia and India).

Emerging economies present various risks, such as political instability, infrastructure deficiencies, and exchange rate volatility. Furthermore, transparency, accounting standards, intellectual property rights and market regulation are typically less developed and less reliable than those in developed countries (Marquis and Raynard, 2015). In general, the institutional framework in emerging economies is characterized by greater informality and poorer regulatory structure. The

weaker institutional framework of emerging countries further undermines MNE valuation and increases the credibility and legitimacy deficits of MNEs. These deficits have been labeled the *liability of emergingness,* which refers to the extra burden borne by a firm from an emerging economy (Madhok and Keyhani, 2012).

In summary, MNEs from emerging economies must overcome additional hurdles to achieve environmental legitimacy, which increases the pressure they face to send stronger signals to help them mitigate the negative spillover effects associated with liability of origin (Amankwah-Amoah and Debrah, 2017; Marano et al., 2017). As a wide scope of ISO 14001 implementation signals a strong willingness to preserve natural resources, our second hypothesis posits the following:

H2. *The scope of ISO 14001 adoption is wider for MNEs from emerging economies than for MNEs from non-emerging economies.*

4. Empirical analysis

4.1. Data and variables

We collect firm-level information from the Refinitiv-Eikon database and gather data on country characteristics from the ISO survey, the World Bank, and Transparency International. Based on the available information, our sample comprises 733 MNEs from 44 countries over the period 2002–2019, resulting in 2915 firm-year observations. Table 1 shows the home countries of the considered MNEs and indicates whether they are classified as emerging or non-emerging by the International Monetary Fund (IMF).[1] Of the total number of observations, 19.3% correspond to MNEs from emerging countries, while 80.7% belong to MNEs from non-emerging countries.

Our dependent variable is the scope of ISO 14001 adoption by an MNE (*ISOscope*), measured as the percentage of sites where an MNE has this environmental certification. This variable therefore ranges from 0 to 100.

Table 1
Number of observations by country.

Non-emerging countries		*Emerging countries*	
Australia	48	Argentina	5
Austria	23	Brazil	33
Belgium	15	Chile	17
Canada	103	China	84
Denmark	22	Colombia	15
Finland	59	Egypt	4
France	206	India	65
Germany	183	Indonesia	22
Greece	10	Republic of Korea	100
Hong Kong	6	Kuwait	2
Ireland	49	Malaysia	17
Israel	4	Mexico	29
Italy	62	Peru	10
Japan	875	Philippines	2
Luxembourg	30	Poland	13
Netherlands	51	Russia	11
Norway	8	Saudi Arabia	5
Portugal	10	South Africa	103
Singapore	3	Thailand	13
Spain	96	Turkey	13
Sweden	110		
Switzerland	81		
United Kingdom	215		
United States	83		
Total	2352	Total	563

The key explanatory variables in our analysis are the environmental performance of the home country and whether the MNE comes from an emerging country. We measure the country's environmental performance by its carbon intensity (*CI*). *CI* is calculated by dividing the country's greenhouse gas emissions (*GHG*), measured in total tons of carbon dioxide equivalent (CO_2eq), by the country's GDP, measured in international dollars using purchasing power parity rates (PPP) at constant 2017 prices.[2] CO_2eq is the mass of total greenhouse gas emissions, also referred to as the carbon footprint, measured by their CO_2 equivalents. Specifically, CO_2eq is the amount of CO_2 that would warm the earth as much as a given amount of the gas of interest. Thus, CO_2eq provides a common scale for measuring the climate effects of different gases. *CI* is therefore the measure of the carbon footprint per unit of value produced. It is important to note that GHG emissions have become the main global environmental concern in recent decades because of their impact on climate change, so *CI* is widely used as a measure of overall environmental performance.[3] Moreover, unlike other environmental aspects (e.g., soil or seawater pollution), GHG emissions are regularly measured over time with a consistent methodology for all countries in the world.

The dummy variable *EMERGING* is used to identify whether the home country of an MNE is an emerging economy. Specifically, this variable takes a value of 1 for MNEs whose country of origin is classified as an emerging economy and 0 otherwise.

Our model introduces a number of additional control variables. At the firm level, we control for firm size *(SIZE*), the presence of quality management standards (*QMS*), capital intensity (*KINTENSITY*), firm age (*AGE*), leverage (*LEVERAGE*) and return on assets (*ROA*). *SIZE*, measured as the logarithm of the firm's total assets, is introduced because firm size is positively associated with the availability of resources to implement the operating procedures of ISO 14001. Moreover, larger firms are more visible and usually attract more attention from the media and stakeholders (Earnhart et al., 2014; Arocena et al., 2021). *QMS* is a dummy variable that takes a value of 1 if the MNE has a certified quality management standard and 0 otherwise. Previous studies show that firms with quality management standards such as ISO 9000 certification are more likely to adopt ISO 14001 due to the cost savings and synergies arising from the joint implementation of both standards (Darnall, 2006; Albuquerque et al., 2007). *KINTENSITY* is calculated as the ratio of assets to the total number of employees (Arocena et al., 2021; Uchida and Ferraro, 2007). Equipment-intensive production processes tend to require more energy consumption to produce goods and services than labor-intensive processes, which translates into higher levels of emissions. As a result, capital-intensive companies have more incentives to implement EMSs in their plants to reduce their energy bills and associated emissions.

AGE is calculated as the total number of years since the MNE's foundation. We expect that organizational age is positively associated with more and mature learning and knowledge effects, which motivate

[1] The only exceptions are South Korea and Egypt, which are not listed as emerging economies according to IMF criteria but are frequently classified as such by other recognized lists, such as the *Emerging Market Multinationals Report* produced by the Emerging Markets Institute at Cornell University and the *Emerging Markets Global Players* provided by the Columbia Center of Sustainable Investment at Columbia University.

[2] CO_2 equivalent (CO_2eq) includes the seven greenhouse gases included in the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrogen oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6) and nitrogen trifluoride (NF_3).

[3] We are aware that carbon intensity does not capture all dimensions of a country's environmental performance. Other environmental performance indicators could be used instead, such as the Environmental Performance Index (EPI), which is based on the weighted sum of several indicators across diverse issue categories. However, the categories and weighting schemes of the EPI have changed over time, which limits its use consistently over time. Furthermore, as the EPI began to be published in 2006 on a biannual basis, its use would omit more than half the observations in our sample. In any case, there is a positive and statistically significant correlation between the carbon intensity index and the EPI (Pearson's $r = 0.6$).

and facilitate more extensive adoption of certified EMSs compared with younger firms. *LEVERAGE* is defined as the ratio of total long-term debt to total equity. In principle, we expect that a high level of indebtedness will limit the expansion of ISO 14001 adoption. Finally, *ROA* controls for the fact that more profitable firms may have greater access to financing and thus greater ease in making the necessary investments to improve environmental management (Cole et al., 2006).

At the country level, we control for the diffusion of ISO 14001 (*ISODIFF*), which is measured as the number of ISO 14001 certifications awarded in the MNE's home country divided by GDP in PPP international dollars at constant 2017 prices. Previous studies have shown that peer pressure may induce firm participation in voluntary environmental initiatives (Delmas and Montes-Sancho, 2010). *ISODIFF* measures the grade of diffusion of ISO 14001 within the MNE's home country while controlling for the peer pressure to which the focal MNE is subjected. We expect that a wider diffusion of ISO 14001 in the home country boosts the adoption of ISO 14001 by the focal MNE. We also control for international trade openness (*TRADE*) as measured by the home country's trade openness ratio, i.e., the sum of imports and exports divided by GDP. This variable reflects the extent to which companies interact with firms from other countries. Since more international transactions typically require dealing with multiple and diverse institutional contexts, *TRADE* is expected to be positively associated with a wider scope of ISO 14001 adoption.

Finally, to control for exogenous variation in the industry environment over the research period, the model includes year and industry dummy variables that are coded according to the NAIC classification.

Table 2 presents the descriptive statistics and correlations between study variables. The maximum value of the variance of inflation factor (VIF) test is 1.19, well below the generally accepted cutoff of 10, indicating that there are no multicollinearity problems in the model (Neter et al., 1996).

4.2. Econometric analysis: Tobit model

As noted above, the dependent variable (*ISOscope*) is a percentage measure and thus conditioned on positive values between 0 and 100. The most appropriate method to analyze such left- and right-censored data is Tobit analysis. Because of the censoring of these data, ordinary least squares (OLS) regression is not applicable, as its estimates are not consistent when the residuals are not normally distributed. Therefore, we use a random Tobit model specified as follows:

$$y_{it}^{*} = \alpha_i + \beta_1 CI_{it} + \beta_2 EMERGING_{it} + \beta_3 SIZE_{it} + \beta_4 QMS_{it} + \beta_5 ISODIFF_{it} + \beta_6 TRADE_{it} + \beta_7 KINTENSITY_{it} + \beta_8 LEVERAGE_{it} + \beta_9 ROA + \beta_{10} AGE_{it} + \gamma Industry_s + \delta Year_t + \varepsilon_{it} \quad (1)$$

The observed dependent variable (y) is expressed as follows:

$$y_{it} = y_{it}^{*} \text{ if } y_{it}^{*} > 0$$

$$y_{it} = 0 \text{ if } y_{it}^{*} \leq 0$$

where y_{it}^{*} refers to the latent (unobserved) variable, which is the willingness of MNEs to obtain certification for all sites. $Industry_s$ is a vector of industry-specific dummy variables; $Year_t$ is a vector of time-specific dummy variables, and α, β, γ, δ are the parameters to be estimated. The random effects α_i and the error term ε_{it} are assumed to be identically distributed $N(0, \sigma_\alpha^2)$ and $N(0, \sigma_\varepsilon^2)$ and independent of $(x_{i1}, \ldots, x_{it})$, with zero means and variances σ_α^2 and σ_ε^2, respectively.

The interpretation of the results of nonlinear models demands special attention, as the interpretation of the estimated coefficients can often lead to incorrect and incomplete conclusions regarding the tested hypothesis (Hoetker, 2007). As Wiersema and Bowen (2009, p.682) highlight, '*in a limited dependent variable* (*LDV*) *model, an explanatory variable's estimated coefficient can rarely be used to infer the true nature of the relationship between the explanatory variable and the dependent variable*'. Instead, the focus of analysis in LDV models such as the Tobit model should be the value and statistical significance of the marginal effects of the explanatory variables. Wiersema and Bowen (2009) suggest testing the values and statistical significance of the marginal effects of explanatory variables and computing the marginal effect of each variable for each observation along with the z-statistic values. We note that the marginal effect of an explanatory variable, i.e., the effect of a unit change in an explanatory variable on the dependent variable, is not equal to the estimated coefficient for that variable. Thus, the value of the marginal effect varies with the value of all model variables, and accordingly, we plot the direct effect and z-statistic values at the values of each explanatory variable's marginal effect against the predicted values of the dependent variable over all values of the model variables. Since our sample contains 2915 observations, we obtain 2915 marginal effect values and the corresponding z-statistic for each independent variable.

4.3. The random-ordered probit model

As a robustness check and complementary analysis, a random-ordered probit model is also estimated. In this case, the dependent variable can take a value of 1, 2 or 3 to indicate a low, medium or high scope of ISO 14001 adoption. Thus, firms are ordered from lowest to highest levels of implementation. The first group includes MNEs with a level of ISO 14001 adoption below 50%, i.e., $y < 50\%$. This group comprises 19.3% of the observations. The second group is composed of MNEs with an adoption level above 50% but below 100%. The third group includes MNEs with complete ISO 14001 implementation level (y = 100%), which corresponds to 40.5% of the observations. The random-ordered probit model is defined on the basis of a latent continuous

Table 2
Descriptive statistics and correlations.

Variables	Correlation Coefficients										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) ISOscope	1										
(2) CI	0.196***	1									
(3) EMERGING	0.129***	0.557***	1								
(4) SIZE	0.029	−0.123***	−0.135***	1							
(5) QMS	0.007	−0.029	0.064***	−0.052***	1						
(6) ISODIFF	0.038**	−0.184***	−0.303***	0.076***	−0.026	1					
(7) TRADE	−0.009	−0.258***	−0.041**	0.037**	−0.010	−0.218***	1				
(8) KINTENSITY	0.033*	−0.062***	0.009	−0.049***	−0.042**	0.027	−0.008	1			
(9) LEVERAGE	−0.020	−0.039**	−0.027	−0.008	−0.033*	−0.025	0.069***	0.017	1		
(10) ROA	0.023	0.027	0.059***	0.003	0.044***	−0.011	0.081***	−0.104***	−0.090***	1	
(11) AGE	0.005	0.012	−0.123***	0.029	−0.056***	0.149***	−0.136***	−0.040**	−0.061***	−0.034*	1
VIF	1.18	1.07	1.08	1.19	1.19	1.15	1.15	1.19	1.19	1.19	1.18

Notes: *, ** and *** indicate significance at the 5%, 1% and 0.1% levels, respectively. S.D. = standard deviation; VIF = Variance Inflation Factor.

variable Y_i as follows:

$$Y_i^* = X_i\beta_i + \varepsilon_i$$

where X_i is a vector of the explanatory variables, including the control variables mentioned above; β_i is a vector of the coefficients to be estimated; and ε_i is the randomly distributed error term, which is assumed to be normally distributed with zero mean and unit variance (Jalayer et al., 2018).

Although Y_i^* is unobserved, the ordered probit model translates the latent variable into the observed scope of ISO 14001 adoption outcome Y_i as follows:

$$y_i = 0 \; if \; y_i^* < 0$$

$$y_i = 1 \; if \; y_i^* < \mu_1$$

$$y_i = 2 \; if \; \mu_1 < y_i^* < \mu_2$$

$$y_i = j \; if \; y_i^* < \mu_{j-1}$$

where μ_i refers to the threshold levels, which are empirically estimated. To calculate the probabilities of implementing ISO 14001 for a given X_i, we use the following equations:

$$Pr\,(y=1) = \Phi(\mu_1 - X\beta) - \Phi(-X\beta)$$

$$Pr\,(y=2) = \Phi(\mu_2 - X\beta) - \Phi(\mu_1 - X\beta)$$

$$Pr\,(y=3) = 1 - \Phi(\mu_2 - X\beta)$$

where Φ denotes the standard normal cumulative distribution function and $y = 1, 2, 3$ indicate low, medium and high levels of adoption, respectively.

Since the sole interpretation of the estimated coefficients of an ordered probit model is not straightforward, we report the marginal effects of all independent variables on the probability of each level of adoption scope. The marginal effects give the change in the scope of ISO 14001 adoption outcome probabilities caused by a one-unit change in a continuous independent variable or by a change from 0 to 1 for a dummy variable and are computed as follows:

$$\frac{P_i(y=j)}{\partial X} = \left[\varphi\left(\mu_{j-1} - \beta X\right) - \varphi\left(\mu_j - \beta X\right)\right]\beta$$

where μ represents the upper thresholds corresponding to the outcome j and all other terms are as described previously.

5. Results

Table 3 presents the estimation results for the random Tobit model. To deal with potential endogeneity problems due to reverse causality, we estimate the Tobit model with all explanatory variables lagged by one year. The results, which are shown in column (2) of Table 3, are similar to those obtained with the non-lagged model.

Figs. 1 and 2 plot the average marginal effects of *CI* and *EMERGING* and their z-statistic values, respectively. In both figures, the circle markers represent the values of the marginal effects recorded on the left axis, while the triangle markers indicate the values of the z-statistics recorded on the right axis.

The marginal effect values are all positive and range from 2.103 to 3.296 for *CI* and from 7.160 to 10.253 for *EMERGING*. Furthermore, all values of the z-statistic related to any marginal effect value are greater than 1.96. These results strongly support hypotheses H1 and H2, confirming that both the level of pollution and the emerging nature of the

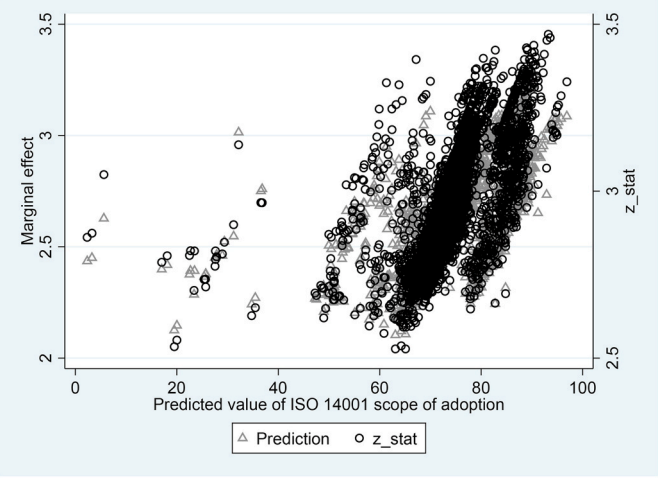

Fig. 1. *The marginal effect of carbon intensity on the scope of ISO 14001 adoption.*

Table 3
The random-effect Tobit model.

	(1) Non-lagged				(2) Lagged (t-1)			
	Control variables	H1.CI	H2. Emerging	Full model	Control variables	H1.CI	H2. Emerging	Full model
CI	–	3.970*** (0.898)	–	2.340** (1.035)	–	11.191*** (1.678)	–	6.678*** (1.968)
EMERGING	–	–	12.481*** (2.532)	9.141*** (2.922)	–	–	36.438*** (4.951)	26.575*** (5.916)
SIZE	0.009 (0.662)	0.136 (0.656)	0.279 (0.659)	0.281 (0.655)	−2.528* (1.354)	−2.095 (1.308)	−1.599 (1.315)	−1.581 (1.302)
QMS	1.190 (0.930)	1.135 (0.929)	0.992 (0.929)	1.012 (0.929)	2.640 (1.598)	2.140 (1.600)	2.066 (1.592)	1.904 (1.592)
ISODIFF	1.461*** (0.251)	1.620*** (0.253)	1.537*** (0.251)	1.611*** (0.253)	2.084*** (0.434)	2.551*** (0.439)	2.495*** (0.434)	2.681*** (0.437)
TRADE	0.001 (0.018)	0.023 (0.019)	0.006 (0.018)	0.017 (0.019)	−0.043 (0.045)	0.013 (0.043)	−0.026 (0.044)	0.003 (0.044)
KINTENSITY	0.637 (0.773)	0.899 (0.768)	0.789 (0.765)	0.903 (0.765)	−0.239 (1.479)	0.524 (1.439)	−0.149 (1.434)	0.284 (1.430)
LEVERAGE	0.026 (0.060)	0.025 (0.061)	0.028 (0.061)	0.027 (0.061)	−0.469* (0.269)	−0.486* (0.266)	−0.439** (0.269)	−0.456* (0.265)
ROA	−0.033 (0.059)	−0.037 (0.059)	−0.036 (0.059)	−0.038 (0.059)	−0.329*** (0.105)	−0.327*** (0.105)	−0.323*** (0.105)	−0.325*** (0.105)
AGE	−0.028 (0.032)	−0.028 (0.031)	−0.020 (0.031)	−0.022 (0.031)	−0.016 (0.064)	−0.013 (0.060)	0.016 (0.062)	0.009 (0.061)
N. observations	2915	2915	2915	2915	2342	2342	2342	2342
Log likelihood	−12102.46	−12092.85	−12090.52	−12087.97	−6376.41	−6360.56	−6355.61	−6351.34
Wald chi^2	99.76***	120.53***	125.36***	131.01***	102,12***	151,54***	157,45***	173,86***

Note: *, ** and *** indicate significance at the 5%, 1% and 0.1% levels, respectively. Year and sector dummy variables are included in the estimations, but their coefficients are not shown here.

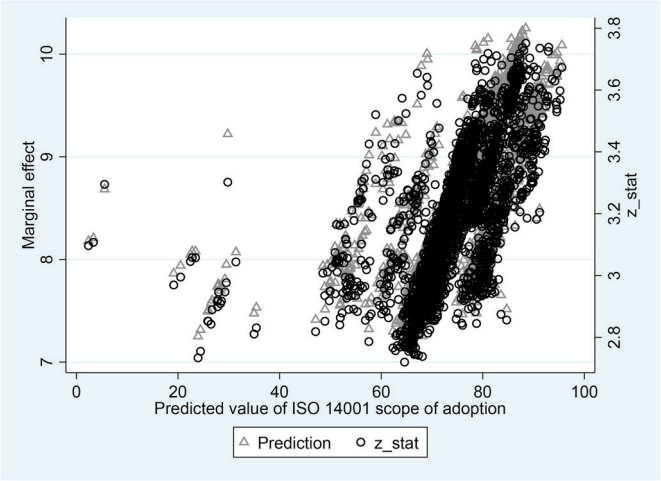

Fig. 2. *The marginal effect of emerging country on the scope of ISO 14001 adoption.*

economy of the home country have positive and significant impacts on the scope of ISO 14001 implementation within the 95% confidence interval.

Table 4 shows the results of the random-ordered probit model. The estimated coefficients in column 1 confirm that *CI* and *EMERGING* have positive and significant impacts on the scope of ISO 14001 adoption. The marginal effects of the three categories of ISO implementation defined above are reported in columns 2, 3 and 4 of Table 4. The first row indicates that a one-unit increase in *CI* reduces an MNE's probability of low ISO 14001 adoption by 7.3 percent and of medium ISO 14001 adoption by 3.6 percent. On the contrary, column (4) shows that a one-unit increase in *CI* increases the probability that the MNE will carry out full ISO implementation by 10.9 percent. Likewise, being an MNE from an emerging country decreases the probability of a low or medium scope of ISO implementation by 7.8 percent and 5.1 percent, respectively, compared with MNEs from non-emerging economies. On the other hand, being an MNE from an emerging country increases the probability of global ISO 14001 implementation by 12.9 percent.

Finally, both increased international openness (*TRADE*) and diffusion of ISO 14001 in the home country (*ISODIFF*) increase the probability that the MNE will fully implement ISO 14001 and reduce the probability of choosing a low level of adoption.

6. Discussion and concluding remarks

Our research shows that home country largely determines the scope of ISO 14001 implementation by MNEs. We find that MNEs from highly polluting countries and emerging economies tend to implement ISO 14001 at a higher percentage of their sites. In fact, our results provide evidence that these MNEs are more likely to undertake global rather than partial adoption of such standards. These findings are consistent with our argument that MNEs subject to liabilities of origin (Amankwah-Amoah and Debrah, 2017; Marano et al., 2017) have incentives to adopt stronger signals to achieve environmental legitimacy (Berrone et al., 2017).

Previous studies have highlighted CSR reporting (Fiaschi et al., 2017; Marano et al., 2017) or affiliation with prestigious parties as means by which MNEs differentiate themselves from their negative home country stereotypes. Our study argues that global adoption of ISO 14001 may also be useful to achieve this purpose. Importantly, the effectiveness of ISO 14001 in this endeavor might be higher than that of CSR reporting or affiliation with prestigious parties, as global ISO 14001 adoption requires a greater commitment in terms of operative adaptations and certification costs. The signaling power of ISO 14001 seems to be higher than that of CSR reporting and affiliations (Berrone et al., 2017), and future research could empirically explore this issue.

With respect to the signaling value of the ISO standard, our research provides a more fine-grained view of the drivers of ISO 14001 adoption, which is usually considered a signal of environmental quality (Delmas and Montes-Sancho, 2010; King et al., 2005; Orcos and Palomas, 2019). Instead of treating the adoption of ISO 14001 as a binary choice, we recognize that the scope of implementation may vary substantially, especially in the case of MNEs. This approach complements knowledge on the reasons that firms adopt environmental quality signals by exploring the different levels of commitment that they may show when deciding to use a signal. In this way, we make progress in understanding the extent to which firms adopt a particular signal, whereas most previous studies explore the effectiveness of the signaling process (Connelly et al., 2011).

The results suggest that MNEs rely on international certified standards to counteract their liabilities of origin. MNEs are key agents in the international dissemination of management practices (Guler et al., 2002). In that sense, MNEs that undertake global ISO 14001 implementation may make a larger contribution to the international diffusion of green behaviors. These MNEs can require their suppliers in different countries to adopt environmental practices as a condition of establishing business relationships, thus enhancing the positive externalities of the diffusion of ISO 14001 at the international level (Prakash and Potoski, 2014; Garrido et al., 2020). Moreover, Arocena et al. (2021) show that the environmental benefits of ISO 14001 adoption increase with the scope of implementation. Furthermore, as He and Shen (2019) argue, ISO 14001 facilitates the emergence of new technology and contributes to firm innovation. If so, a global ISO 14001 implementation strategy

Table 4
The random-effect ordered Probit.

	(1) Scope of ISO adoption		(2) Low level of adoption		(3) Medium level of adoption		(4) Global adoption	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
CI	0.281***	0.026	−0.074***	0.018	−0.036	0.023	0.109***	0.012
EMERGING	0.329***	0.072	−0.078***	0.024	−0.051*	0.026	0.129***	0.028
SIZE	−0.023	0.017	0.006	0.004	0.003	0.002	−0.008	0.006
QMS	−0.010	0.050	0.003	0.013	0.001	0.006	−0.003	0.019
ISODIFF	0.052***	0.011	−0.014***	0.004	−0.007	0.004	0.020***	0.004
TRADE	0.002***	0.000	−0.004***	0.001	−0.002	0.001	0.006***	0.001
KINTENSITY	0.025	0.021	−0.007	0.005	−0.003	0.003	0.009	0.008
LEVERAGE	−0.003	0.005	0.008	0.010	0.004	0.006	−0.001	0.001
ROA	0.002	0.004	−0.005	0.010	−0.002	0.005	0.007	0.006
AGE	−0.006	0.006	0.001	0.010	0.008	0.008	−0002	0.002
No. observations	2915		–	–				
Log likelihood	−2852.15							
Wald chi^2	443.89***							

Note: *, ** and *** indicate significance at the 5%, 1% and 0.1% levels, respectively. Year and sector dummy variables are included in the estimations, but their coefficients are not shown here.

may generate technology spillover effects across MNE sites. Consequently, it is suggested that public decision-makers develop specific policies and incentives for MNEs to adopt global environmental standards and thus contribute to minimizing the negative impact of economic activity on the environment.

Our research is not without limitations. First, we focus on the factors that explain the percentage of sites that MNEs select for ISO 14001 certification without exploring whether implementation is substantial or symbolic at each site (Boiral et al., 2018; Christmann and Taylor, 2006). Since the impact of ISO 14001 can vary widely depending on the degree of internalization of the standard's practices by a company, future efforts can enrich our research by jointly analyzing the extent of adoption and the type of implementation.

Second, although we argue that the home country plays a major role in defining the scope of an MNE's ISO 14001 certification strategy, the geographic concentration of an MNC's production and/or sales in certain regions and markets may affect the adoption of ISO 14001. Specifically, the interaction between home and host country effects warrants further research.

Credit author statement

Pablo Arocena: Conceptualization, Writing - Original Draft, Investigation, Data Curation, Writing - Review & Editing, Visualization, Supervision, Project administration, Funding acquisition, **Raquel Orcos**: Conceptualization, Writing - Original Draft, Investigation, Data Curation, Writing - Review & Editing, Visualization, Supervision. **Ferdaous Zouaghi**: Data Curation, Investigation, Methodology, Software, Writing - Original Draft.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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