International Production Chains and the Pollution Offshoring Hypothesis: an Empirical Investigation

Aurélien Saussay[a,*], Natalia Zugravu-Soilita[b]

[a] *London School of Economics, Grantham Research Institute, London*
[b] *Université de Paris Saclay, CEMOTEV/UVSQ, Guyancourt*

Abstract

Most analyses of the impact of heterogeneous environmental policy stringency on the location of industrial firms have considered the relocation of entire activities – the well-known *pollution haven hypothesis*. Yet international enterprises may decide to only offshore a subset of their production chain – the so-called *pollution offshoring hypothesis* (POH). We introduce a simple empirical approach to test the POH combining a comprehensive industrial mergers and acquisitions dataset, a measure of sectoral linkages based on input-output tables and an index score of environmental policy stringency. Our results confirm the impact of relative environmental policy stringency on firms' decisions to engage in cross-country M&As. Our findings also indicate that environmental taxation have a stronger impact on international investment decisions than standards-based policies. Further, we find that transactions involving a target firm operating in a sector upstream of the acquirer are more sensitive to environmental policy stringency, especially when that sector is highly pollution-intensive. This empirical evidence is consistent with the pollution offshoring hypothesis.

Keywords: FDI, Pollution offshoring, Global supply chain, Firm location, Environmental regulation

JEL Classification: D22, F23, F64, Q28

1. Introduction

Industrial firms face two major forces when structuring their supply chain. On the one hand, the expansion of commercial space in the context of globalization is changing the structure of competition and engaging businesses in a frantic race for productivity gains. On the other hand, climate change and other major environmental challenges urge governments to

*Corresponding author

Email addresses: a.saussay@lse.ac.uk (Aurélien Saussay), natalia.zugravu@uvsq.fr (Natalia Zugravu-Soilita)

put in place ambitious environmental policies – which can have an effect on the competitiveness of exporting firms. Under the assumption that strict environmental regulations in developed countries are detrimental to business competitiveness, pollution 'leakage' could result from pollution-intensive firms seeking to physically relocate some or all of their production to low-environmental cost economies (offshoring), or would simply be 'replaced' by similar firms in less-regulated countries (outsourcing).

A large number of studies have examined the relocation of production when faced with environmental regulations - a phenomenon commonly referred to as the *Pollution haven hypothesis* (PHH)[1]. However, as pointed out by Cole et al. (2017) in an extensive review of the recent literature, firm level studies are necessary to gain a better understanding of international firms behavior. Yet results from the body of empirical research on the PHH remains inconclusive overall, as environmental regulations appear to only marginally affect the firm's relocation decision. Indeed, environmental regulation costs are but one of the many factors considered by firms when deciding their investment locations. Our study's first methodological contribution is thus to provide an empirical assessment of the impact of environmental regulations on firms' investment decisions, by using firm- and sector-level panel data allowing for an analysis of sectoral heterogeneity and cross-country differences in environmental regulations.

Existing studies distinguish two main FDI modalities, greenfield vs mergers and acquisition, and two scopes, horizontal vs vertical, when investigating the production relocation response to environmental regulation stringency. Greenfield FDIs seem to be more sensitive to environmental regulations than mergers and acquisitions (Bialek and Weichenrieder 2015) while the PHH would be of particular relevance for vertical FDIs (Rezza 2013). To our

[1]Under this assumption, pollution-intensive firms are expected to shift from highly regulated countries to countries with less stringent environmental regulations, thus displacing pollution. This hypothesis has been extensively studied by examining either foreign direct investment (FDI) flows (e.g., Eskeland and Harrison 2003; Millimet and Roy 2016; Keller and Levinson 2002; Wagner and Timmins 2009) or net trade flows (e.g., Ederington et al. 2005; Kahn 2003; Antweiler et al. 2001; Mulatu et al. 2010)

knowledge, no study has addressed both issues simultaneously. Yet it would be of particular interest to understand the 'environmental behavior' of firms following a strategy of *vertical* international production chains integration *through M&A*. Indeed, as shown by Carril Caccia and Pavlova (2018), M&As play an increasing role in global FDI, and a leading role in the inward and outward FDI flows of advanced economies. Further, these M&As are mainly export-supporting. Carril Caccia and Pavlova (2018) estimate a gravity model to find that M&As are positively influenced by the domestic value added in exports which returns home via final and intermediate imports processed abroad (which provides evidence of vertical integration of international production chains).

Our study contributes to the literature analysing international M&As by exploring the impact of differences in environmental regulations stringency on the probability that firms engage in *cross-border* M&As. We further refine the analysis depending on the transaction's scope, vertical, horizontal or conglomerate. More precisely, by using a simple measure of upstream linkages between the acquiring and target firms (the total requirements coefficient derived from input-output analysis), we investigate the response of international supply chain location choices to environmental regulations. In practice, we estimate the sensitivity of cross-border M&As to environmental regulations as a function of sectoral linkages between the acquiring and target firms. Our data allows to distinguish between *horizontal* (where both acquiring and target firms operate in identical sectors at the 4-digit ISIC rev. 4 level), *vertical* (where the acquiring firm's sector consumes more than 3% of its total requirements from the target firm's sector) and *conglomerate* (very low to no sectoral linkage) transactions.

Indeed, we believe that the relocation of production chain subsets may have prevented previous studies from finding a strong effect of environmental regulations on FDI. This could particularly be the case for acquisitions involving the most polluting intermediate production steps. According to Cole et al. (2017), firms might be willing to relocate abroad only the most polluting steps of their production process, in order to preserve their potential advantages at home (e.g. agglomeration economies as described by Zeng and Zhao (2009), but also the availability of existing production factors such as physical and human capital. Although these firms may decide not to relocate entirely when domestic environmental regulations become stricter, offshoring specific subsets of their production process abroad allows them to reduce the pollution level of their domestic operation. Hence this mechanism, called the *Pollution offshoring hypothesis* (POH) by Cherniwchan et al. (2017), could contribute to the relocation of pollution. In a world where trade is primarily driven by intraindustrial comparative advantages, assessing the validity of this new hypothesis should improve our understanding of the mechanisms through which international trade and FDI interact with the environment (Cherniwchan et al. 2017; Cole et al. 2017). Our empirical approach makes it possible to compare the relative strength of the PHH (horizontal M&As) and POH (vertical M&As).

Finally, from a policy perspective, we check the sensitivity of cross-country M&A transactions to different dimensions of environmental policies, whether they are tax- or standards-based in particular, and depending on the acquiring firm's investment scope and on the pollution-intensity levels of the target firm's industry.

The paper is organized as follows. In section 2 we provide an overview of the literature linking firms' investment decisions to the stringency of environmental regulations, and clarify some concepts commonly used in the related literature. Section 3 presents our empirical approach while section 4 describes our data sources. We present and discuss our results in section 5. We finally conclude by briefly drawing some of our analysis' policy implications and suggest possible prospects for future research.

2. Environmental regulations and firms' investment strategies

A broad literature has explored the PHH at the country level (List and Co 2000; List 2001; Keller and Levinson 2002; Xing and Kolstad 2002; Henderson and Millimet 2007; Dean et al. 2009; Candau and Dienesch 2017 among others). If results from earlier studies were mixed and thus inconclusive, most recent works (especially those estimating models of FDI) are generally arguing in favor of the PHH.

As underlined by Cole et al. (2017), firm level evidence (e.g., Javorcik and Wei 2004; Cole and Elliott 2005; Raspiller and Riedinger 2008; Kellenberg 2009; Hanna 2010; Manderson and Kneller 2012; Ben Kheder and Zugravu 2012; Rezza 2013 among others) allows gaining a better understanding of multinational enterprises' (MNEs) behavior. Firm level studies tend to show that environmental regulations would only affect firms relocation decisions at the margin. The benefits of lower environmental compliance costs would be more than offset by other factors of attractiveness such as agglomeration economies, raw material supplies, availability and cost of labor, energy, physical and / or human capital (depending on the capital intensity of the activity), infrastructure, access to markets or transportation costs.

It should also be noted that different FDI modalities – greenfield investments or M&As – could exhibit different sensitivity to environmental regulations. For instance, Bialek and Weichenrieder (2015) show that the PHH is particularly verified for greenfield investments undertaken by German firms between 2005-2009. Similar results are suggested by Bakar et al. (2019) for FDIs in eight selected Asian countries for the period of 2003-2014. FDIs are found to reduce environmental performances in target countries. In addition, greenfield investments prove more detrimental to the environment than M&As. We would like to point out that while the validation of the PHH for greenfield investments is quite robust[2], results have been less conclusive for M&As in the very few studies exploring the link between FDI modality and environmental regulations. While severe environmental regulations are found to deter M&As in general (but to a lesser extent than greenfield investments), M&As in 'clean' sectors

[2] Greenfield FDIs have to obey new, generally more severe environmental regulations, and have to internalize all costs; by contrast, M&As might integrate future environmental protection costs into the acquisition price and/or benefit from grandfathering policies (Bialek and Weichenrieder 2015). Beyond environmental regulations, Davies et al. (2018) show that greenfield investments and M&As respond differently to policies intended to attract FDI. While M&As exhibit opportunistic behaviours and are sensitive to temporary shocks, greenfield FDIs are particularly driven by origin countries' comparative advantages and destination countries' taxation environment.

could even be attracted by destination countries enforcing stringent regulations (Bialek and Weichenrieder 2015).

By focusing on FDIs in industrial sectors, Saussay and Sato (2018) do find a robust link between M&A and cross-country energy prices, thus supporting the PHH. Yet, (i) the effect is limited in magnitude, and (ii) identification and therefore policy implications are limited to energy prices (see the *multidimensionality* limit of environmental policy proxies, underlined by Brunel and Levinson (2013)). While it is generally found that energy prices significantly affect the location of pollution-intensive activities (although the impacts can be quite small), the literature on carbon pricing generally does not provide empirical evidence of international carbon leaks – although these findings could result from generally low carbon price or overly generous (free) allocation of permits to pollute (e.g., Dechezleprêtre et al. 2019; Naegele and Zaklan 2019; Martin et al. 2014). Wagner et al. (2014), by using plant-level data for around 9,500 French manufacturing firms, find that EU ETS-regulated plants have reduced their GHG emissions by 15.7%, compared to non-ETS plants. Changes in the carbon intensity of energy carriers would have driven most of this reduction (through increases in the share of natural gas in particular, which is less carbon intensive than coal or oil). No evidence was found for within-firm carbon leakage for firms that have both ETS and non-ETS facilities. However, the authors stress that they cannot reject the absence of international carbon leakage, because they found a statistically significant reduction in employment in the ETS-regulated plants. This effect could occur as a result of outsourcing the carbon intensive parts of the production process away from the regulated facilities. Wagner et al. (2014) highlight the need for further investigation, which would require data on intermediate products and revenues in order to assess the existence and magnitude of carbon-intensive production steps' outsourcing.

Indeed, reduction in employment could also be due to complementarity with energy (from an increase in labor productivity through increased investments) or to production dislocation (from carbon leakage through decreased investments and perhaps increased trade in intermediates). In a more recent study, Marin et al. (2018) examine whether firms that rely on emission-intensive processes are likely to suffer more from carbon pricing than their less carbon-intensive counterparts. However, contrary to previous studies, they found that ETS-regulated firms have gained from the EU ETS by increasing turnover, markup, investment intensity and labour productivity. Moreover, firms that exit the ETS and remain on the market are found to experience a substantial drop in size. A number of mechanisms could explain that outcome. Firms may pass on the additional costs induced by the EU ETS to final users, increase their labour productivity by increasing investment rate (capital deepening), or increase their innovation rate, which would more than offset the negative impact of compliance costs on economic performance[3]. Additional evidence is still needed to refine the mechanisms at work and explain previous findings, for instance by analysing more explicitly the possibility for ETS-regulated facilities to relocate only specific production stages – particularly the most emission-intensive ones.

A small number of theoretical works have analyzed the possibility of relocating parts of the production process abroad in response to changes in domestic environmental regulations (Kawata and Ouchida 2013; Cole et al. 2014). Despite the abundant literature linking outsourcing to productivity gains for local firms, very few empirical works have assessed the existence and magnitude of the POH. Empirical research on country-level data (e.g., Clark et al. 2000; Levinson 2010; Brunel 2017; Lyu 2016), using highly aggregated data on trade or inbound FDI, cannot explore differences in environmental regulations' impact across sectors and/or between domestic and destination's stringency. As emphasized by Cherniwchan et al. (2017), validating the POH requires the observation of firm-level differences within sectors. Firm-level data is becoming increasingly available, yet existing studies are still scarce, partial

[3] See the Porter hypothesis, under which environmental policy can stimulate innovation and lead to positive economic outcomes, including improved competitiveness and economic performance (Porter and van der Linde (1995)).

or limited in their scope. For instance, Cole et al. (2014) note that studies that have explored offshoring in the United States generally provided no evidence that the US-based firms have systematically offshored pollution-intensive activities, as they resorted to sectoral rather than the firm-level data. Moreover, studies using trade instead of FDI data (e.g. Li and Zhou 2017) do not provide an adequate empirical setting to understand the factors driving firms' behavior. An accurate empirical investigation of the POH should allow for long-term adjustments in the firms' environmental behavior as a response to gaps in environmental policy stringency between origin and destination in a cross-border transaction. Therefore, the study of POH with cross-sectional data[4] cannot properly account for this adjustment process in MNEs' strategies.

Finally, it is worth highlighting the conceptual difference between the two main governance options facing multinational enterprises: *offshoring* and *outsourcing*. Offshoring designates relocating production while maintaining control over production processes, whereas outsourcing relates to the sub-contracting to foreign companies of specific parts of the production process previously managed by the company itself. In other words, while *offshoring* involves the relocation of value chain activities across *geographical boundaries*, *outsourcing* refers to the relocation of value chain activities across *organisational boundaries* (see Miroudot et al. 2009). For instance, Cole et al. (2014) examine the empirical evidence for 'environmental' outsourcing from Japanese pollution-intensive firms and argue that different forms of internationalization (e.g., offshoring, outsourcing) may result in different responses in the face of environmental policy. Yet, the literature has so far focused either on international wholesale offshoring (FDI in final products) or on the outsourcing of final and intermediate products in response to environmental regulations, with little attention paid to international offshoring of inputs' production. The present study focuses on this fourth MNE strategy, which has proven the least explored to date.

[4] For example in Antonietti et al. 2017, who measure environmental regulations' stringency through a single 2011-year sectoral air-emission level.

It should be noted that different forms of international governance are likely to have different impacts on the host country's environmental quality. If outsourcing – as an alternative strategy to offshoring – is less likely to have a positive impact on the environment through technological externalities, FDI from technologically advanced countries could bring in new and cleaner technologies. This would constitute an improvement over the local firms' existing production processes, thus enabling environmental improvement in the target country (Bao et al. 2011; Kim and Adilov 2012; Zugravu-Soilita 2017). However, such benefits (usually referred to as the *pollution halo effect*) would depend on the ability of the target country to absorb and benefit from environmental spillovers (Elliott et al. 2013), depending for example on human capital availability (Lan et al. 2012).

3. Empirical approach

The purpose of the present study is to measure the impact of differences in environmental policy stringency across countries on the location of industrial firms' value chain. Specifically, we would like to identify whether differences in environmental policies help explain firms' choices of investment destinations, both geographically and sectorally. Conditional on a given firm's decision to invest in another firm, offshoring drivers can therefore be identified by analysing the determinants of the probability to invest outside of the acquirer's domestic market.

The following analysis draws from the broader framework of discrete choice analysis. In particular, we assume a producer framework of foreign direct investment, whereby each firm has a profit function impacted by the characteristics of the sector and country in which it operates. The model then consists of a simple profit maximization program, where firms rank potential locations according to their expected profit, and choose the one that maximizes it.

This implies that when contemplating whether to carry out a transaction, the decision to invest abroad will depend on the comparative characteristics of the country-sector in which the target firm operates, and that of the potential acquirer. Such characteristics can include among others internal demand, labor costs or, more specifically for the present analysis, environmental policy stringency.

We implement this framework empirically by considering the probability that any given M&A deal is cross-border ($i \neq j$), conditional on a measure of environmental policy stringency (EPS) in both the acquiring i and target j countries. In practice, we estimate the following probit:

$$\begin{aligned} Pr\{i \neq j\} =& \beta_{acq} EPSit + \beta_{tar} EPS_{jt} \\ & + \gamma_1 \log MarketSize_{ikt} + \gamma_2 \log MarketSize_{jlt} + \delta_1 \log {L^{\text{int}}}_{ikt} + \delta_2 \log {L^{\text{int}}}_{jlt} \\ & + \eta FTA_{ijt} + \lambda Contiguity_{ij} + \alpha_k + \alpha_l + \alpha_t + \varepsilon_{n,t} \end{aligned} \quad (1)$$

To account for different investment strategies – both vertical and horizontal – we further control for market size ($MarketSize_{ikt}$) and for differences in labor costs (${L^{\text{int}}}_{ikt}$) on both sides of the M&A transaction (acquiring and target sectors). The origin and destination market sizes are jointly proxied in our specification by the value added of the acquiring and target firms' sectors[5] (we also test an alternate specification controlling for the country-wide GDP of origin and target countries in Table A.3 in Appendix A). The sensitivity to factor costs is captured through labor costs, measured as *labor cost intensity* L^{int} – the share of the cost of labor in gross value added in the acquiring and target sectors.

In addition to market potential, a number of difficult to observe and hard to quantify costs are associated with carrying out an international M&A transaction. These include coordination costs with foreign affiliates, trade (tariff and non-tariff barriers), legal (e.g. property laws) and cultural barriers, to name a few. We draw on the abundant literature on international trade costs (following the seminal work of Anderson and van Wincoop (2004)) to identify the main barriers to international transactions, like trade policy, cultural and geographical barriers, and focus on the most relevant for investment decisions abroad. In

[5]The sector is identified at the 2-digits ISIC rev. 4 level.

particular, we use a dummy for the existence of a Free Trade Agreement (FTA) between the origin and destination countries, in order to control for trade barriers. Indeed, Baier and Bergstrand (2007) suggest that an FTA would on average double the two member countries' trade flows after 10 years of its application. Beyond trade policy effects, our FTA variable should also capture broader measures promoting economic integration, thereby reducing the costs of operating abroad. This assumption is aligned with the recent findings of Baier and Bergstrand (2007) which reveal that belonging to a well-established regional trade agreement is significantly more effective than bilateral investment treaties in fostering (intra-regional) FDI.

More broadly, cultural similarities, such as language, tastes, distribution networks, could facilitate negotiations or ease bureaucracy, and therefore reduce the cost of operating abroad. Such determinants of location choices could at least partially be captured by the geographical proximity of the acquiring and target firms' border (Crozet et al., 2004). Thus, all our specifications also include a dummy for sharing a common border ($Contiguity$) to control for these potential cultural and geographical barriers. See Table A.2 in Appendix A for summary statistics of our regressors.

Our empirical approach allows us to identify factors that explain a firm's decision to initiate an *international* M&A (offshoring) rather than a *domestic* transaction (insourcing). Thus, our methodology cannot bring evidence on the broader decision to expand business in response to changes in environmental policy, i.e. to get involved in a M&A in the first place. But given that such a decision is already made, our model can identify the factors that explain why the investment was targeted overseas.

We also identify the 'push' and 'pull' effects commonly discussed in the literature discussing the impact of regulations' policy on FDI by comparing the impact policy stringency domestically (i) and in the target firm's country (j). We expect increased domestic policy stringency (EPS_i) to encourage domestic firms to engage in international M&As (a 'push' effect) and lower stringency abroad (EPS_j) to make target firms in country j more attractive as cross-country M&As targets (a 'pull' effect).

Since our measure of environmental regulations' stringency does not capture sectoral differences, we expect our results – in particular the 'push' effect (EPS_i) – to be potentially biased downwards when evaluating environmental policy differences at the national level. In addition, we also acknowledge that there could also be domestic 'pull' effects, i.e. when environmental regulations in the acquiring firm's sector are more severe than in other domestic sectors (which we cannot capture within our model): conversely, this could bias the 'pull' effect (EPS_j) upwards. To partially overcome these limits, we further adjust our model by considering relative (instead of absolute) cross-country differences in environmental policy stringency.

Finally, we have no real reason to suspect a risk of simultaneity bias, given that environmental policy can be sensitive to the fact of having increased inflows of FDI (in magnitude) but would be very marginally influenced by the choices of specific firms to engage in international M&As. Thus, any potential remaining bias would only stem from omitted variables. We seek to mitigate that risk by controlling for an extensive set of fixed effects including acquiring (k) and target (l) sectors, identified at the 2-digit and the 4-digit ISIC rev. 4 levels, to account for sector-specific market structure or technology; and finally time (t) fixed effects to control for the global M&A cycle.

The main purpose of our inquiry is to analyse whether industrial firms preferentially offshore certain subsets of their production chain. Equivalently, we seek to estimate whether the sensitivity of industrial firms' investment location decisions to environmental regulations is uniform along all the steps of their production process. To proceed with this analysis, we first need a way to measure the relationship between the sectors of the acquiring and target companies. In particular, we need to determine whether the target firm's main activity counts among the acquirer's upstream suppliers, and to quantify its importance among these suppliers.

To this end, we propose to use the coefficient of total requirements obtained from input-output analysis. This coefficient represents the sum of direct and indirect purchases required to produce a dollar of output in a given industry. It is usually calculated from a country-level symmetrical industry-by-industry input-output table. For each pair of sectors (k, l), the total requirement a_{kl} is defined as the sum of the amount of sector l's production used as input to produce one unit of sector k's output (*direct* requirements), and the amount of l's production necessary to produce all of the other inputs entering k's production chain (*indirect* requirements).

4. Data

4.1. Mergers and Acquisitions

We obtain data from the Thomson-Reuters Securities Data Company (SDC) Mergers and Acquisitions dataset. This dataset reports all transactions occurring between both public and private companies since 1980. It encompasses all sectors of economic activity. In this paper, we use a subset of that extensive database, and thus observe the universe of all industrial merger and acquisition transactions taking place between the years 2000 and 2015.

This dataset includes 63,596 transactions across 41 countries and encompasses both domestic and cross-border deals. For each transaction, we observe the sector of activity of the acquiring and target firms at the 4-digit level of the 1987 revision of the Standard Industrial Classification. We perform a translation of these sectoral codes to the more recent International Standard Industrial Classification (ISIC), revision 4. This presents the advantage of being compatible with the dataset used to compute the total requirement coefficients (see section 4.3). We thus observe transactions in 23 of the 24 industrial sectors represented at the 2-digit level of the ISIC rev. 4. Tables 1 and A.1 provide an overview of the M&A dataset, by sector and home/target countries respectively.

4.2. Stringency of environmental policy

Cole et al. (2017) discuss three types of environmental policy measures widely adopted in the literature on FDI and the environment: (i) measures of pollutant emissions (Xing and Kolstad 2002), energy use (Zarsky 1999; Eskeland and Harrison 2003; Cole et al. 2005), or pollution abatement costs (Keller and Levinson 2002; Henderson and Millimet 2007; Manderson and Kneller 2012) that are difficult to standardize, which makes international comparisons difficult; (ii) environmental legislation (List et al. 2004; Hanna 2010); (iii) indices of environmental regulation (Javorcik and Wei 2004; Ben Kheder and Zugravu 2012; Zugravu-Soilita 2017).

Cross-country settings usually impose an arbitrage between (a) improved identification with potentially biased results, since developing countries are often excluded from observation due to missing data on firm- or sector-specific energy or pollution intensities and (b) less biased estimates potentially suffering from identification weaknesses, using widely available, comparable yet potentially less precise environmental proxies at the national level to improve geographical coverage.[6]

In this study, we use the OECD's policy-based composite index – *Environmental Policy Stringency* (*EPS*) – which simultaneously provides cross-country comparability and high spatial and temporal coverage[8]. The EPS also considers (at least in part) the multidimensionality of environmental policy design. Several environmental policy instruments are scored separately across a wide variety of scopes, although climate and air pollution related instru-

[6]As Cole et al. (2017) highlights, "*[t]here is no perfect measure of the stringency of environmental policy, and all are essentially proxies for something that is inherently difficult to measure*". In addition to the most commonly used proxies – MEAs[7], environmental NGOs, GDP/energy – researchers have also considered the lead content of gasoline (Damania et al. 2003; Deacon 2000), the World Economic Forum's (WEF) Stringency of Environmental Regulation index (Damania et al. 2004; Kellenberg 2009; Mulatu et al. 2010), UN member country questionnaire on environmental policies, legislation and enforcement (Cole and Elliott 2003), the Yale's *Environmental Performance Index* (EPI; Bakar et al. 2019; Fredriksson and Millimet 2004) among others.

[8]The OECD EPS includes 27 OECD members, 5 BRICS countries and Indonesia included for the period 1990-2012. As of this writing, only 16 countries are surveyed from 2012 to 2015

ments do feature prominently[9]. This index measures the degree to which environmental policies impose an explicit or implicit price on environmentally harmful behaviors, and thus represents a measurement of the policy-induced cost of pollution for firms (Botta and Kózluk, 2014). More precisely, the EPS index represents the stringency of environmental policy on a scale from 0 to 6 with higher numbers representing more stringent environmental regulations. Variables included represent an expert assessment of elements of regulations written in law (e.g. the tax rate on NOx emissions) except for CO_2 and SOx emission allowance trading systems – where the simple annual average of allowance prices is used – and for public 'green' R&D expenditure – which is scored using the total annual public budget allocated for R&D as a percentage of GDP. Although focused in part on the electricity sector, the EPS index can be considered as an economy-wide indicator given: i) the inclusion of a number of additional instruments beyond the power sector (see the 3 green boxes in the Figure 1), ii) the fact that some of the policies related to the power sector are also applied beyond the electricity sector itself (e.g. taxes on air pollutants), iii) it remains largely focused on air pollution and greenhouse gas policies, thus approximating a broader set of environmental policies (Botta and Kózluk, 2014)

The EPS index can be broken down into 2 main categories: *market-based* and *non-market* instruments, as well as in sub-components: ex. '*stick*' and '*carrot*' instruments, where the former (e.g. pollution taxes, standards) represents policies punishing activities harmful to the environment, while the latter (e.g. subsidies, feed-in tariffs) reward environmentally friendly activities.

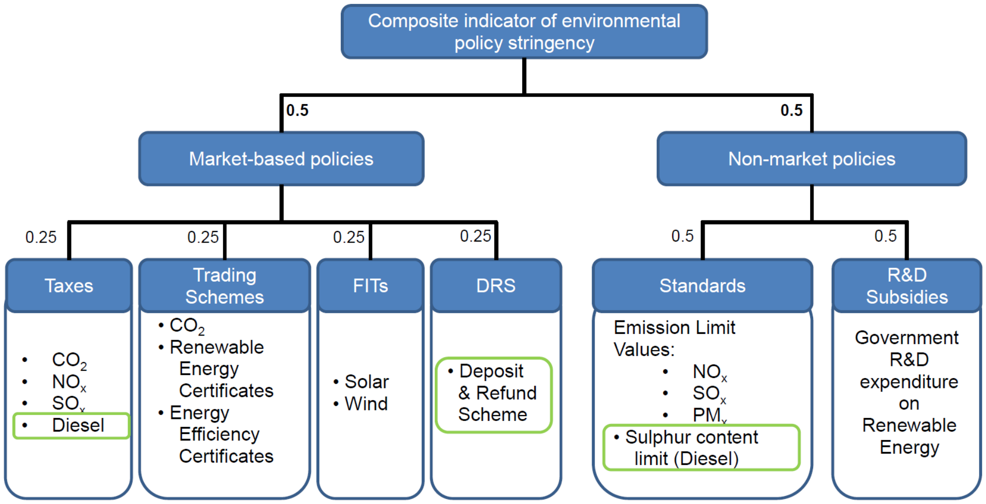
4.3. Total requirement coefficients

We use a multi-regional input-output dataset, Exiobase 3[10] to compute the total requirements coefficients for each industrial sector pair at the 2-digit ISIC 3.1 level. The Exiobase

[9]The joint constraints of broad coverage and international comparability limit the number of potential sectors and policy instruments that can be included in the index.

[10]More specficially, we use version version 3.8.1 of the Exiobase dataset.

Figure 1: Structure of the EPS Index (source: Botta and Kózluk, 2014, p.23)



dataset is now in common use in the trade and industrial organisation literatures, notably for the study of global value chains (Wang et al., 2013; Timmer et al., 2015, 2016). Exiobase notably provides symmetric industry-by-industry input-output tables, as required by our empirical design. In the following, we only consider the national submatrices of these IO tables.

Exiobase 3 provides a time series of input-output tables for each of the countries represented in our dataset over the whole 2000 to 2015 period. Compared to alternative MRIO options such as WIOD or EORA, Exiobase offers both a broader temporal and geographical coverage along with a more detailed disaggregation of the industrial sector.

The input-output accounts of Exiobase provide industry by industry direct requirements matrices, A_{it} for each country i and year t in our dataset, from which we can derive the total requirements matrix using the familiar Leontief representation of the economy, $L_{it} = (I - A_{it})^{-1}$. For each sectoral pair (k, l), the coefficient $l_{kl,it}$ represents the sum of direct and indirect purchases from industry k required to produce a dollar of output in industry l – or the total requirements of sector k's output from sector l.

In the context of this study, the total requirement coefficient aims at estimating the supply chain position[11] of the target sector in relation to the activity of the acquiring firm. For a given transaction, we therefore choose to use the coefficient computed in the country of the *acquirer*, for it better reflects the technology used by the acquiring firm. Exiobase allows to compute time-varying total requirements coefficient through our entire sample period. However, cross-country industrial investments can have an impact on the technologies of the participating countries, particularly through knowledge and technology transfers. This raises a potential endogeneity concern, which we resolve by taking the average over time of the total requirement coefficients, for each acquiring country and pair of sectors observed in our transaction dataset. The sectoral means for these coefficients are reported in Table 1.

Table 1: Summary statistics of the Mergers and Acquisitions dataset by sector

Sector (ISIC rev. 4)	Transactions	Cross-border	Horizontal	Total req.
10 Food products	6,801	31%	64%	0.10
11 Feverages	1,647	40%	75%	0.10
12 Tobacco products	163	53%	81%	0.83
13 Textiles	4,970	34%	49%	0.72
14 Wearing apparel	52	25%	50%	0.64
15 Leather and related products	303	32%	61%	0.69
16 Wood and wood products	927	26%	56%	0.84
17 Paper and paper products	2,357	29%	57%	0.37
18 Printing and recorded media	89	26%	69%	0.81
19 Coke and refined petroleum products	2,794	34%	48%	0.19
20 Chemicals and chemical products	6,668	38%	55%	0.18
21 Basic pharmaceutical products	1,349	39%	77%	0.21
22 Rubber and plastics products	1,219	36%	49%	0.60
23 Other non-metallic mineral products	2,899	33%	59%	0.12
24 Basic metals	3,300	31%	54%	0.07
25 Fabricated metal products	2,909	38%	42%	0.60
26 Computer, electronic and optics	5,448	34%	43%	0.66
27 Electrical equipment	2,345	33%	38%	0.54
28 Machinery and equipment n.e.c.	3,462	39%	45%	0.69
29 Motor vehicles and trailers	1,010	34%	48%	0.93
30 Other transport equipment	1,532	30%	64%	0.74
32 Other manufacturing	165	38%	62%	0.70
33 Repair and installation of machinery	11,187	37%	52%	0.70

Considering the joint coverage of all three datasets, M&A transactions, EPS index and

[11] In terms of prevalence in the acquiring sector's input, which need not necessarily coincide with the rank of processing steps.

total input requirements, we finally get a sample comprising *27 OECD, 5 BRICS countries and Indonesia* over the period *2000-2015* (see Table A.1, in Appendix A).

5. Results

5.1. Environmental policy stringency and cross-border investment decisions

Table 2 provides the results of the estimation of specification (1). We report the impact of acquiring and target countries' environmental policy stringency (EPS) on the acquiring firm's decision to invest (initiate an M&A) abroad. As we can observe, EPS is found to have a statistically significant impact on firms' cross-border investment behavior. Importantly, we find that coefficients on the acquiring and target sides have the expected signs under the PHH. That is, firms are likely to engage in cross-border M&A when domestic environmental regulations' stringency is higher at home ('push' effect) and/or lower abroad ('pull' effect). We note that these pull and push effects are found to be almost identical in magnitude. This result is in essence quite similar to the empirical findings of Saussay and Sato (2018), despite using a substantially different proxy for environmental regulations[12].

Our empirical results reveal that firms' decision to invest abroad is particularly influenced by *efficiency-seeking* considerations. Labor cost intensity is directly related to the share of capital in value added, since a decline in the share of labor in value added often reflects faster growth in labor productivity than in labor compensation, implying growing returns to capital. Contrary to domestic labor cost, the labor share in the value added of the target country-sector does appear to be a significant driver in cross-border investment decisions – an increase in labor costs in the destination location discourages foreign acquisitions. This result is particularly statistically significant in specifications controlling for fixed effects at a more granular level (sectoral FE at the ISIC 4-digit level and firm-level FE in columns 3 & 4). In particular, to reduce the risk of omitted variable bias due to unobserved acquiring

[12]Saussay and Sato (2018) use industrial energy prices at the country-sector level to instrument for differences in carbon taxation.

Table 2: Impact of the stringency of environmental regulations on cross-border investment decisions

	2-dig. sec. FE	2-dig. sec. FE, labor costs	4-dig. sec. FE, labor costs	Firm FE, labor costs
	(1)	(2)	(3)	(4)
EPS_i	0.338***	0.324***	0.308***	0.094
	(0.070)	(0.070)	(0.047)	(0.085)
EPS_j	-0.336***	-0.304***	-0.290***	-0.242***
	(0.069)	(0.070)	(0.046)	(0.055)
$\log(L_i^{int})$		0.118	0.153	0.093
		(0.155)	(0.116)	(0.107)
$\log(L_j^{int})$		-0.382**	-0.411***	-0.666***
		(0.150)	(0.112)	(0.165)
Market size	Yes	Yes	Yes	Yes
FTA	Yes	Yes	Yes	Yes
Contiguity	Yes	Yes	Yes	Yes
2-digits sector FE	Yes	Yes		
4-digits sector FE			Yes	
Firm FE				Yes
Year FE	Yes	Yes	Yes	Yes
N	39,768	39,768	39,768	12,355
Pseudo-R^2	0.37	0.37	0.39	0.5
AIC	31,444	31,341	30,688	13,335

Note: Standard errors clustered at the country-sector-pair level in columns (1), (3) and (3), and at the firm level in column (4). The dependent variable in all columns is the cross-country nature of an observed M&A transaction. Market size is measured by sectoral VA at the 2-digit ISIC rev. 4 level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.001$

firm's characteristics, we control for acquiring firm fixed effects in column 4. Introducing firm-level FE restricts the sample of acquiring firms to multinational enterprises that have purchased at least two distinct foreign subsidiaries over our period of observation, thereby severely reducing the number of observations.

In specifications estimated in Table 2, we proxy for origin and destination market size using sectoral value added, measured in USD at current exchange rates. We perform several robustness checks by using the country-wide GDP of origin and target countries as an alternative proxy (see Table A.3 in Appendix A) and find highly robust results for EPS, while the statistical significance of labor costs is reduced. Since GDP reflects an economy-wide outcome capturing the overall level of economic development (by contrast with a sector-specific VA), it may introduce collinearity with L^{int} which would then capture income levels rather than labour costs.

With the exception of the *push* effect, which is no longer statistically significant in model (4), which controls for firm fixed-effects, the sign of our main results remain stable and significant at the 1% level across the all specifications reported in Table 2. Since acquiring firms' fixed-effects absorb within-firm variations in domestic EPS, we further adapt our model and substitute separate EPS measurements for each side of the transaction with a measure of relative stringency, by taking the difference in EPS between the target and acquiring countries directly. This specification restores some EPS variance within each acquiring firm. We therefore define a new indicator ΔEPS as follows:

$$\Delta EPS_{ij,t} = EPS_{j,t} - EPS_{i,t} \tag{2}$$

Symmetrically, labor costs are measured as the difference between the logarithm of labor share in VA in target and acquiring country-sectors, $\Delta log(L^{\text{int}})$. With these new specifications, Table 3 provides interesting results and additional robustness checks of our base model's empirical results.

As we can see in column (1), all else equal, the stricter [laxer] environmental policies become in the target [home] country (widening the gap with environmental policies at home [abroad]) the less likely acquiring firms are to invest outside of their domestic market. Likewise, from an efficiency-seeking standpoint, firms are less willing to invest abroad when there is a larger gap between labor costs of the origin and target country-sector pairs. When controlling for firm fixed-effects, the impact of labour cost becomes even stronger, with a negative coefficient, but the magnitude of the impact of environmental policies differences decreases slightly (column 2). Both variables remain statistically significant at the 1% level.

Cross-border investment flows may have an impact on contemporaneous environmental policymaking decisions, thereby raising a risk of endogeneity of our main regressor. To mitigate this potential bias, we also estimate an alternative specification in column (3) using the 1-year lag of EPS difference between origin and destination country. Admittedly, we recog-

Table 3: Impact of the *relative* stringency of environmental regulations on cross-domestic investment decisions

	EPS		EPS_{t-1}	Taxes	Standards
	(1)	(2)	(3)	(4)	(5)
ΔEPS_{ij}	-0.315***	-0.246***	-0.268***	-0.353***	-0.151***
	(0.068)	(0.052)	(0.055)	(0.085)	(0.034)
$\Delta\log(L^{int})_{ij}$	-0.255*	-0.416***	-0.422***	-0.231	-0.289**
	(0.137)	(0.110)	(0.110)	(0.141)	(0.134)
Market size	Yes	Yes	Yes	Yes	Yes
FTA	Yes	Yes	Yes	Yes	Yes
Contiguity	Yes	Yes	Yes	Yes	Yes
2-digits sector FE	Yes			Yes	Yes
Firm FE		Yes	Yes		
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	39,768	12,355	12,349	39,783	39,827
Pseudo-R^2	0.37	0.5	0.5	0.37	0.37
AIC	31,387	13,360	13,347	31,507	31,531

Note: Standard errors clustered at the country-sector-pair level in columns (1), (4) and (5), and at the firm level in columns (2) and (3). The variable $\Delta EnvPolicy$ in columns (1) and (2) is the bilateral difference in EPS; (3) is the first lag in EPS difference; (4) and (5) are bilateral difference in OECD evaluation of environmental taxation stringency and environmental standards stringency respectively. Market size is measured by sectoral VA at the 2-digit ISIC rev. 4 level.

nize that while strong, the lagged difference remains an internal instrument to the model – thereby making its exogeneity questionable. However, there is little economic intuition suggesting that individual firms' decisions to invest abroad in year t would have a direct effect on the severity of environmental policy at the national level in year $t-1$ – even when considering that the government could be anticipatory.[13] Conversely, it is quite straightforward to assume that potential acquirers would be impacted by past environmental policy stringency. Estimation results of column (3), based on a specification which includes firm fixed-effects, confirm the robustness of our overall results with the coefficient on ΔEPS showing no sign of potential endogeneity bias. The combination of firm FE and lagged regressor of interest makes this our most restrictive specification.

Given the composite nature of the highly aggregated OECD EPS index, we estimate addi-

[13]For a model explaining the total number of M&As or the financial importance of flows at the macro (or sectoral) level, this approach may be considered less robust.

tional specifications focusing on some of its individual components to assess their respective contributions. In particular, the EPS index also includes 'carrot' instruments that might not act as a deterrent to foreign investment, by attracting FDIs promoting 'green' behavior (e.g., feed-in tariffs (FITs), deposit & refund schemes (DRS), R&D subsidies). Indeed, while environmental taxes and standards sanction polluting activities, FITs and DRS reward actions that preserve the environment. Hence, columns (3) and (4) in Table 3 report results on EPS components relating to these two commonly used 'stick' instruments. We find that the magnitude of environmental taxation's impact on firms' decisions to invest abroad is at least twice as large as that of standards. Regardless of the scope of environmental policy instruments, we find that *'stick' instruments* – whether *market-* or *non-market-based* – are significant factors shaping firms investment location choices.

5.2. Environmental regulations and intermediate production stages location

We now turn to the empirical investigation of the pollution offshoring hypothesis. Specifically, we assess whether the impact of cross-country differences in environmental policy stringency is heterogeneous along firms' production chains. Under the POH, we would expect that transactions targeting upstream sectors are particularly affected by the relative stringency of environmental policies.

To assess the POH empirically, we first classify transactions into four categories based on the degree of sectoral linkage (as defined in Section 3) between acquiring and target firms:

- ***Horizontal***: both firms have the same ISIC rev. 4 sector at the *4-digit* level;
- *Vertical-upstream,* ***High input***: the target firm's sector accounts for at least 3% of the total requirements of the acquiring firm's sector;
- *Vertical-upstream,* ***Low input***: the target firm's sector accounts for at least 1% but less than 3% of the total requirements of the acquiring firm's sector;
- ***Conglomerate***: the target firm's sector accounts for (strictly) less than 1% of the total requirements of the acquiring firm's sector.

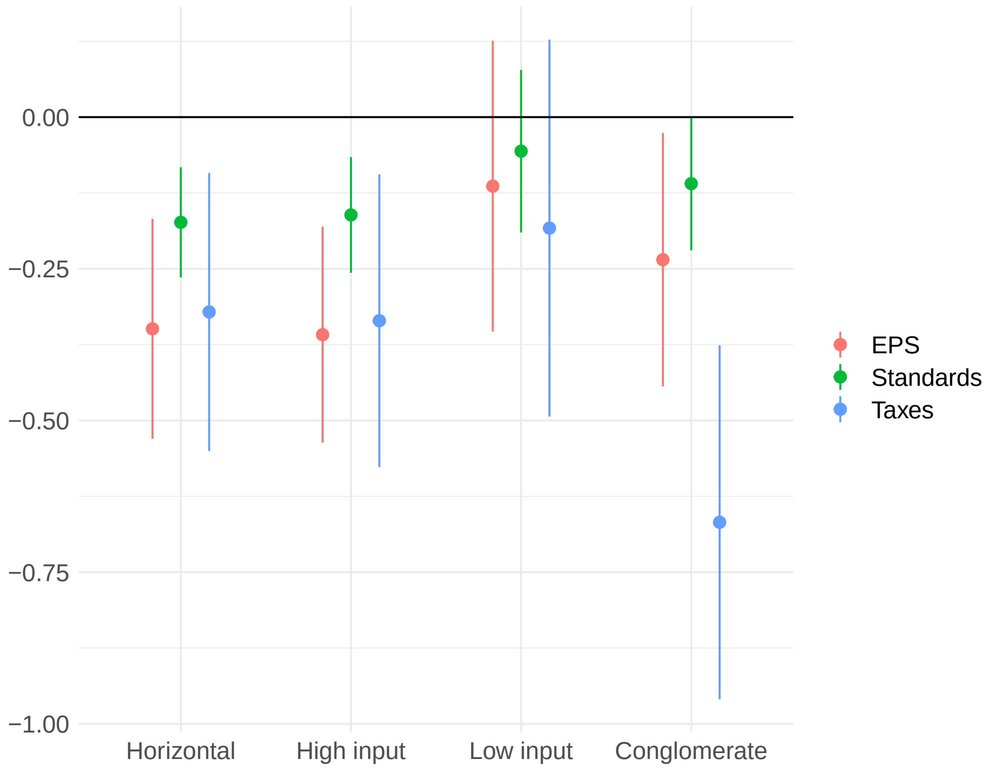
The chosen thresholds of 1% and 3% are directly derived from our dataset: the former being the median and the latter is the 75$^{\text{th}}$ percentile of the total requirements coefficients between the acquiring and target sectors in our transactions. This is keeping with common values used in the literature, in particular defining 'vertical' investments using a 1% cutoff (see Fan and Goyal 2006; Garfinkel and Hankins 2011, among others).

Figure 2 shows the values of $\beta_{\Delta EPS_{ij}}$ for each of these subgroups and both EPS and its components[14]. A first interesting result is that POH and PHH are found to act quite similarly. Indeed, deals targeting *High input* upstream sectors and those seeking *Horizontal* investments seem to be affected similarly by cross-country EPS differences, whether in terms of market-based (taxes) or non-market instruments (standards). Economic intuition suggests that production costs would not be among the most important drivers of transactions targeting *Low input* upstream sectors, thereby implying a small or non-existent impact of environmental policy. This is confirmed in our results, where neither of the components of EPS nor the index itself reach statistical significances. Similarly, we expect *Conglomerate* deals to result from MNEs' diversification strategies.

Somewhat surprisingly, *conglomerate* transactions appear to be the most affected by environmental taxes. We note however that, while vertical transactions represent supply chain-driven investment flows, conglomerate transactions (combining companies that operate in entirely different industries) are driven by more strategic and liquid investments that are in general highly sensitive to tax changes. In this instance, 'environmental' taxes may capture the global fiscal policy of the target country. This intuition is supported by the fact that environmental standards have a low (and significant at the 10% level only) impact on this type of transactions. The general response to environmental policy – measured by the aggregate EPS index – of firms targeting conglomerate acquisitions is accordingly much weaker

[14]These estimates result from intercepting a sectoral linkage categorical indicator – using each of the four categories defined above – with ΔEPS, $\Delta Standards$ and $\Delta Taxes$. They do not result from separate estimates on the four subsamples for each transaction categories. However, we do run three separate estimations for EPS, Taxes and Standards.

Figure 2: Environmental policy's impacts by category of sectoral linkage



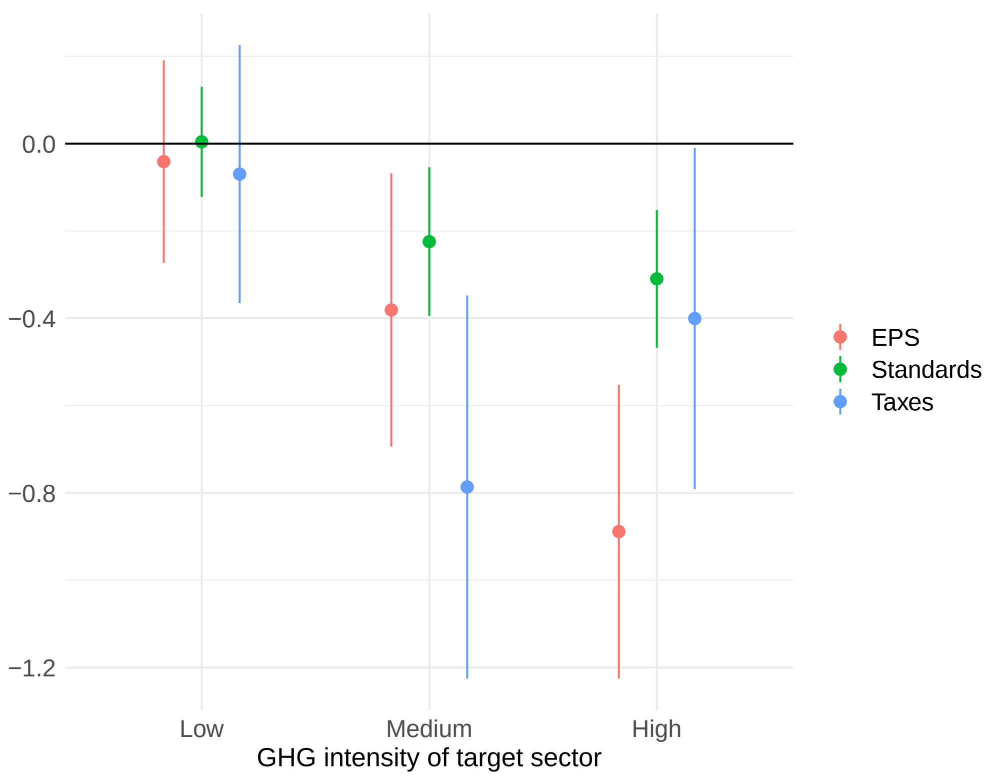
than in vertical or horizontal investments. Since in practice the boundary between low-input and conglomerate relationships is somewhat fuzzy, we choose to focus the remainder of our analysis on high input vertical transactions – which are the most relevant in assessing the POH.

5.3. Pollution intensity and pollution offshoring

The POH has raised concerns that countries with lax environmental regulations could experience environmental degradation by attracting the most polluting intermediate stages of international value chains. In this subsection, we focus more specifically on assessing the empirical validity of the POH by verifying the impact of environmental policies on the decision to vertically integrate international production chains as a function of sectoral greenhouse-gas (GHG) emissions intensity. We therefore restrict our sample to the subset of transactions involving target firms in high input upstream sectors.

Specifically, we calculate the GHG intensity (totalling emissions of GHGs documented in Exiobase 3[15], expressed in metric tons of CO_2 equivalent per million USD of production) for each ISIC sector at the 2-digit level. For each transaction, we consider the GHG intensity of the *target* firm's sector, under the assumption that it reflects both the current technology of the acquired business and the national environmental regulations under which it operates[16]. For the sake of clarity, we report the results according to three levels of GHG intensity – corresponding to the terciles observed in Exiobase (see Figure 3). As in the previous section, we alternatively interact ΔEPS, $\Delta Standards$ and $\Delta Taxes$ with a indicator variable of GHG-emission intensity.

Figure 3: EPS impact on high input vertical acquisitions by tercile of GHG intensity



Unsurprisingly, we find that firms seeking to acquire low-polluting high-input upstream

[15]These include CO_2, CH_4, N_2O, SO_x, NO_x, NH_3 and CO.

[16]In the case of greenfield investments, it would be more likely to observe a transfer of technology and know-how from the acquiring company. That would require to control simultaneously for the GHG intensity of the acquirer's sector.

production capacity abroad are not sensitive to environmental policy stringency, whether measured through the aggregate EPS index, or its taxes or standards components. As expected, environmental policy has a statistically significant impact on the choice of firms to invest in upstream production abroad only from a certain level of sectoral GHG-emission intensity. The more GHG intensive the target sector, the stronger the impact of EPS.

By comparing these results with those obtained for other types of transactions (see Appendix B for results on horizontal, vertical low input and conglomerate transactions), it is interesting to observe that the impact of environmental policies on the probability of relocating high-GHG intensive production is quite similar for vertical high input and horizontal investments. In both cases, an increase in the relative severity of environmental policy abroad discourages cross-border transactions. However, we find that the magnitude of this effect is significantly higher for upstream production stages compared to horizontal M&As (see estimates for EPS in high-GHG intensity sectors in Figures 3 and B.1). Another original finding is that acquisitions of firms in sectors which account for a very low share of total input requirements do not appear to be influenced by environmental regulations, even for pollution-intensive production stages (Figure B.2). On the contrary, the relative level of EPS has a negative effect on the Conglomerate cross-border transactions; while statistically significant this effect is much smaller in magnitude than for vertical M&As (Figure B.3).

6. Conclusion

In this paper, we assess the impact of environmental policies on international investment decisions, exploring its heterogeneity all along international production chains when organized by MNEs trough M&As. We estimate an empirical reduced form model of cross-border M&A and combine it with a simple indicator of sectoral linkage to provide strong evidence for the so-called 'Pollution Offshoring Hypothesis' in the decision to carry out an international M&A transaction. The POH suggests that polluting intermediate production stages are likely to be offshored to countries with more lenient environmental policies. More specifically, we find that firms are likely to acquire foreign firms operating in their upstream sectors when the stringency of environmental regulations is higher domestically than abroad.

Our original datasets allow us to focus this study on a particular internationalization strategy that has received little attention in the literature linking firm location and environmental policies: FDI through M&As. We recognize that this very originality may limit the external validity of our empirical results. Indeed, our methodological approach cannot account for POH scenarios whereby firms respond to environmental regulations by creating new foreign affiliates to produce their intermediate inputs (greenfield investment) or by subcontracting inputs to foreign suppliers (international outsourcing).

Still, by focusing on M&As, we identify the conditions for PHH and POH for multinational companies that account for a significant share of global FDIs. Our results may prove to be underestimates because we only identify the effect of strict environmental regulations on international M&A, and cannot capture its effect on domestic transactions. The overall impact of environmental policy could prove even stronger if observed on an earlier stage of the firm's decision-making process, *i.e.* whether to produce on-site or off-site.

From a policy perspective, it is interesting to determine if only the most polluting intermediate stages of production get relocated to countries with lax environmental regulations, or if the entire value chain is sensitive to the cross-country heterogeneity in the environmental policies – as predicted by the 'Pollution Haven Hypothesis' (PHH) – regardless of whether the transaction is a market-expanding or efficiency-seeking investment. Our empirical investigations allow us to clarify this question. We show that differences in responses to environmental policies is not quite explained by the investment's industrial organizational aim – market-expanding (horizontal), efficiency-seeking (vertical) or diversifying (conglomerate) – but rather related to the pollution intensity of the target sector. Stringent environmental regulations abroad discourage cross-border M&As of any kind provided the acquisition targets a highly polluting sector (GHG-emission intensive).

However, we find the highest sensitivity to environmental policy stringency among upstream (vertical) high-input transactions. Environmental policy does not appear to be a significant factor for upstream low-input transactions, even in highly polluting sectors. None of the above-mentioned FDI strategies seem to be influenced by differences in environmental policies when the M&A transaction targets a low-polluting sector (defined as the first tercile of GHG-emission intensity in our dataset). Another interesting result concerns policy instruments. We find that international differences in environmental taxes stringency affect cross-border M&As twice as much as relative environmental standards stringency. This difference in policy instrument effectiveness is particularly pronounced for acquisition of firms in high-polluting, highly integrated upstream sectors. We observe the opposite for conglomerate deals in high-polluting sectors, where only the standards seem to exert a statistically significant effect – the robustness of this finding should be nuanced due to the small sample size of this particular subset. The present study thus validates both the PHH and POH in the decision to engage in a cross-border M&A transaction, with particularly strong evidence of the POH.

These findings have important policy implications and highlight the need to discourage pollution offshoring that often accompany to the unbundling of production processes across borders. However, the harmonization of environmental standards across countries, oft set forth as a potential solution, may not be achieve the desired level of effectiveness – particularly in a period of increasingly ambitious climate objectives, which makes international coordination an ever-moving target. Indeed, using a North-South model of global value chains à la Baldwin and Venables (2013) with unbundling of production processes — where environmental taxes can reduce global environmental damage by avoiding the concentration of polluting processes – Cheng et al. (2021) suggest that a simple harmonization is almost never desirable and more careful coordination is necessary. Alternatively, using a quantitative general equilibrium model Shapiro (2020) suggests that if countries imposed similar tariffs and NTBs on clean and dirty industries, global CO_2 emissions would decrease, without global real income declining[17]. This effect on CO_2 emissions would be of comparable magnitude to the estimated effects of some of the most ambitious climate policies in the world. Shapiro (2020) analyzes the role of an industry's upstream location, by developing the idea that firms push (e.g. lobby) for higher protection of their own products compared to their intermediate inputs. He finds that because industries can be well organized but final consumers usually are not, downstream industries (which are cleaner) are subject to greater protections than upstream industries (which are relatively dirtier).

Our study complements this analysis by highlighting that high-polluting upstream industries are also the most sensitive to cross-country differences in environmental regulations. Greater international cooperation is therefore needed, both on the trade and environmental fronts, to prevent pollution leaks. Improved understanding of the relative strength of the various instruments of trade and environmental policy is left to future works, which would be significantly improved by including more comprehensive data at the sectoral and firm levels: *e.g.* severity of regulations, trade, environmental and production costs, for different internationalization strategies (outsourcing, greenfield FDI...) in particular. Another venue for further research would be to investigate the impact of upstream acquisitions on environmental quality in target firms' countries, which would allow to assess the *pollution halo hypothesis* empirically along entire international production chains.

[17]Shapiro (2020) discusses the fact that import tariffs and non-tariff barriers are substantially lower on dirty than on clean industries, which implies a global implicit subsidy to CO_2 emissions in internationally traded goods.

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Appendix A Additional tables

Table A.1: Transactions and average EPS by country

	Transactions		Environmental Policy Index		
Country	Acquirer	Target	EPS	Taxes	Standards
United States	17,950	16,534	1.65	1.36	2.87
Japan	4,678	3,860	1.81	2.54	2.24
Germany	4,025	4,107	2.43	1.19	3.76
China	3,606	4,392	0.89	0.99	1.54
United Kingdom	3,588	3,934	1.86	1.37	3.00
France	3,170	3,034	2.08	1.76	3.03
Canada	1,793	1,883	1.76	1.60	2.72
South Korea	1,702	1,701	1.85	1.70	2.79
Sweden	1,565	1,220	2.07	2.29	2.42
Italy	1,528	1,549	1.99	2.07	2.74
Spain	1,513	1,620	2.05	1.71	2.49
Russia	1,445	1,521	0.58	0.84	0.67
India	1,433	1,616	0.73	0.54	0.85
Netherlands	1,351	996	2.14	1.07	2.59
Switzerland	1,308	948	2.27	1.64	2.79
Australia	1,191	1,388	1.60	1.61	2.16
Finland	891	676	2.09	1.08	3.28
Brazil	807	1,206	0.44	0.35	0.52
Denmark	731	693	2.61	2.09	2.58
Belgium	630	525	1.45	1.03	2.90
Austria	611	406	2.24	1.13	3.63
Norway	461	477	1.67	1.38	2.64
Poland	428	604	1.50	2.14	2.51
Ireland	389	221	1.24	1.04	2.41

Note: For clarity, only the top 24 countries by number of transactions are reported in this table.

Table A.2: Summary statistics

	Mean	SD	P25	P50	P75
EPS_i	2.14	0.88	1.30	2.23	2.82
EPS_j	2.10	0.91	1.30	2.16	2.75
$Taxes_i$	1.58	0.64	1.00	1.50	2.00
$Taxes_j$	1.55	0.65	1.00	1.50	2.00
$Standards_i$	3.54	1.65	1.75	4.25	5.00
$Standards_j$	3.47	1.70	1.50	4.25	5.00
$TotalRequirements_{ij}$	0.46	0.52	0.03	0.16	1.06
Free Trade Agreement	0.19	0.40	0.00	0.00	0.00
Contiguity	0.08	0.26	0.00	0.00	0.00
$\log(VA_i)$	11.21	2.40	9.34	10.99	12.36
$\log(VA_j)$	11.20	2.38	9.33	10.94	12.36
$\log(GDP_i)$	28.47	1.56	27.34	28.59	30.03
$\log(GDP_j)$	28.38	1.59	27.33	28.50	29.98
L_i^{int}	0.58	0.17	0.48	0.60	0.69
L_j^{int}	0.58	0.17	0.46	0.59	0.68

Table A.3: Impact of the stringency of environmental regulations on cross-domestic investment decisions

	2-dig. sec. FE quad	2-dig. sec. FE, labor costs	4-dig. sec. FE, labor costs	Firm FE, labor costs
	(1)	(2)	(3)	(4)
EPS_i	0.329***	0.329***	0.319***	0.106
	(0.062)	(0.066)	(0.046)	(0.092)
EPS_j	-0.272***	-0.275***	-0.266***	-0.233***
	(0.058)	(0.064)	(0.043)	(0.057)
$\log(L_i^{int})$		0.045	0.081	-0.036
		(0.158)	(0.115)	(0.099)
$\log(L_j^{int})$		-0.095	-0.066	0.075
		(0.148)	(0.107)	(0.169)
National GDP	Yes	Yes	Yes	Yes
FTAs	Yes	Yes	Yes	Yes
Contiguity	Yes	Yes	Yes	Yes
2-digits sector FE	Yes	Yes		
4-digits sector FE			Yes	
Firm FE				Yes
Year FE	Yes	Yes	Yes	Yes
N	43,028	39,768	39,768	12,355
Pseudo-R^2	0.37	0.37	0.39	0.52
AIC	33,767	31,332	30,760	12,949

Note: Standard errors clustered at the country-sector-pair level in columns (1), (3) and (3), and at the firm level in column (4). The dependent variable in all columns is the cross-country nature of an observed M&A transaction.

Appendix B Additional figures

Figure B.1: Environmental policy's impacts by category of sectoral linkage
Horizontal transactions

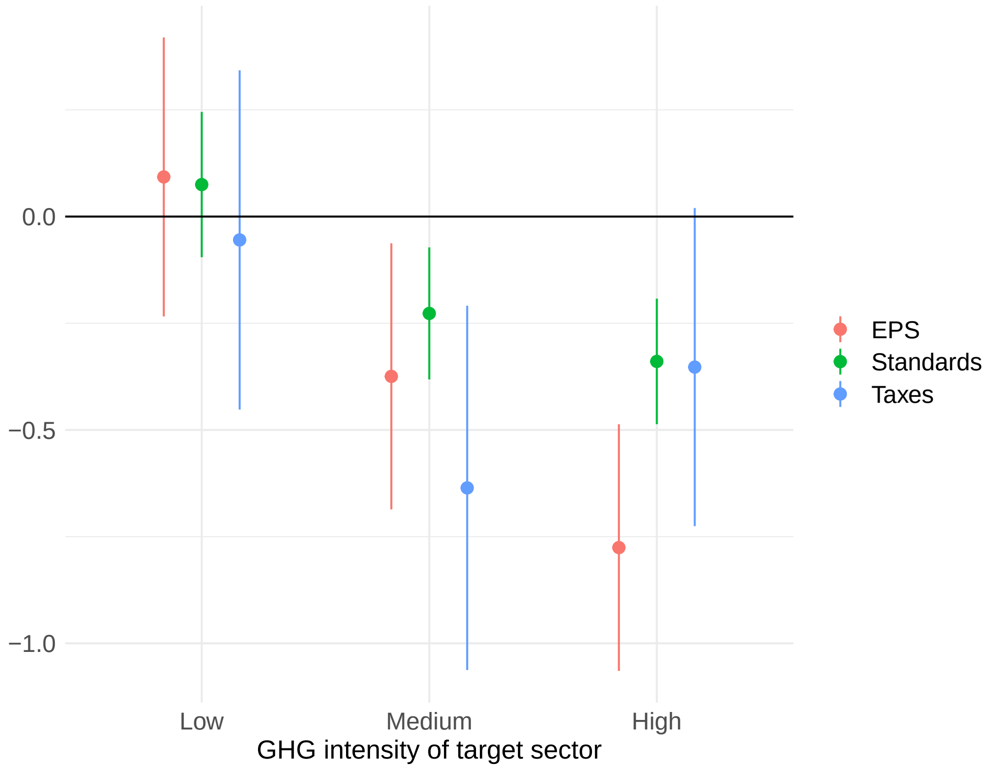

Figure B.2: Environmental policy's impacts by category of sectoral linkage
Low input transactions

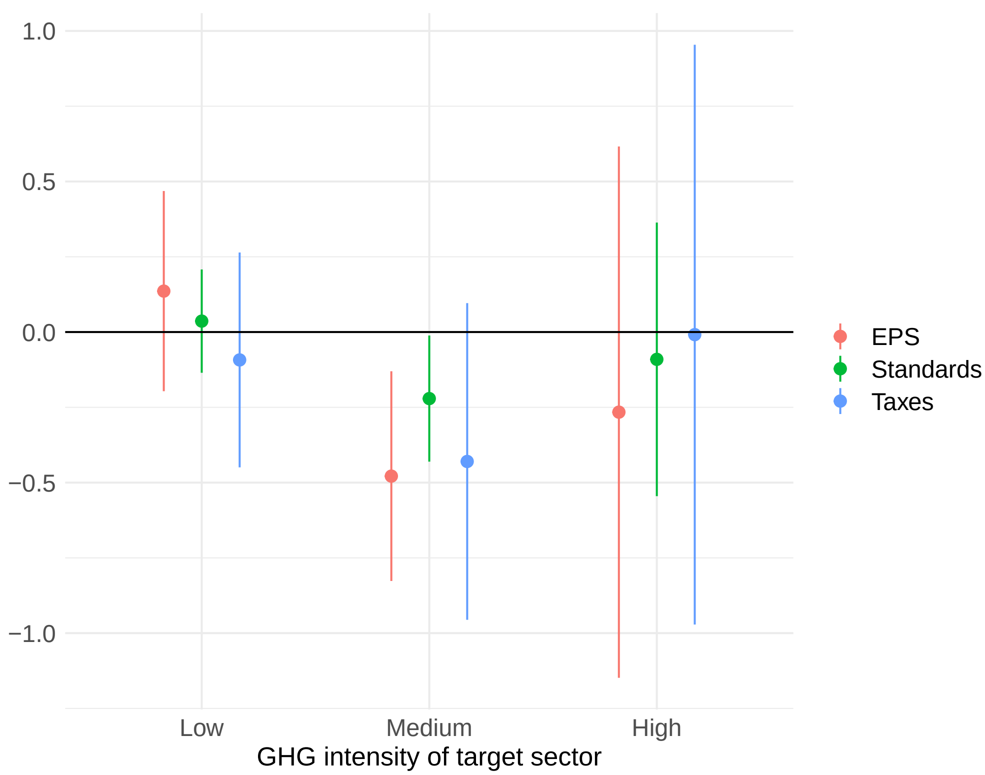

Figure B.3: Environmental policy's impacts by category of sectoral linkage
Conglomerate transactions