Environmental regulatory stringency, firm's strategies and offshoring decisions: evidence from Italy

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Abstract

With this paper, we provide further evidence on the relationship between firm's internationalization strategies and environmental regulatory stringency. We enlarge the attention on small and medium-sized firms, where in most cases the focus is on how large firms and multinationals organize their value chains internationally and tackle environmental issues. Second, we consider both international outsourcing activities and outward foreign direct investments, where most studies tend to focus on the latter. We rely on an original dataset of 684 Italian manufacturing firms provide by TeDIS Centre, Venice International University. We merge this survey information with environmental data from ISTAT, through which we define different measures of environmental policy stringency in terms of emissions and ETS respectively.

We estimate a series of probit models for identifying the effect that an increase in the environmental stringency of the industry has on the likelihood of Italian firms in the same industry to outsource production activities, either through subcontracting abroad or through FDI. In addition, we clearly account for the area of sourcing destination, distinguishing between Northern and Southern countries, with the former being more environmentally stringent than the latter. Firms belonging to more polluting industries, which are indirectly subject to higher environmental policy stringency, are more likely to develop at least part of their production abroad, either via FDI or through international outsourcing. When distinguishing by area of destination, we find that this is particularly true when firms offshore their production to Southern countries, i.e. where the environmental regulation is less stringent.

1. Introduction

Addressing the environmental impacts of production activities is getting a priority for firms, as a response to the increasing pressure of consumers, policy makers and stakeholders at large. Policy pressure, in particular, is identified by many studies as the most important driver for the reduction of environmental impacts by industry (Testa et al., 2012; Berrone et al, 2013). Such an increasing pressure is intended to spur firms to implement green practices to mitigate the negative environmental implications of their production and distribution activities, focusing on how to produce and to conceive products and services in a more environmental friendly manner (Vezzoli et al, 2012). Considering for the diverse governance modes enabled by globalization, however, scholars suggest that high environmental stringency may simply imply a new relocalization of polluting activities toward less environmental-aware countries (the so-called 'Pollution-Haven Hypothesis'), with no net improvements in terms of global pollution (Cole et al., 2013). Indeed, in order to effectively realize green products, it is important that all the activities that concur to its realization are aligned toward the same sustainability goals (Seuring and Muller, 2008, De Marchi et al. 2013).

In this paper we focus on how governance decisions of the firms in the context of the distribution of production activities at the global level is related to policy pressure and firm's environmental performance. In particular, we aim at answering the question how the decision to outsource production abroad is related to the policy stringency when considering for the firm's strategy and if any differences occur across developed and developing countries?

The way in which the management of environmental related issues is intertwined with internationalization choices of firms has been studied from two opposing perspectives. At the macroeconomic level, the debate focused on the 'Pollution-Haven Hypothesis', implying that highly polluting activities are likely to be offshored where environmental policies are laxer (Copeland and Taylor, 2003; Levinson and Taylor, 2008; Cole et al., 2014), with mixed empirical result. At the microeconomic level, instead, scholars supported that governance choices implying vicinity between the different production stages and even between production and consumption systems better support greening outcomes and firm performance (Roberts, 2004; Da Ronch et al., 2013 De Marchi et al., 2013), considering also for reputation aspects.

By exploiting a novel dataset in this paper we aim at providing evidence on the relationship between environmental policy stringency, firms' environmental strategies and their international governance choices bridging these two perspective. We provide two main contributions to the literature. First, we consider different international governance choices at a time – international outsourcing activities and outward foreign direct investments (FDI) – being often two alternative options for firms, which have different characteristics and implications. Cole et al., (2013) suggests that the two forms of internationalization may allow for a different response to the same external (policy) pressure but the literature so far, instead, has focused either on FDI (e.g. Eskeland and Harrison 2003; Cole et al. 2006; Wagner and Timmins, 2009), either on global sourcing (Cole et al., 2013). Third, where the literature focused mostly on how large firms and multinationals organize their value chains internationally and tackle environmental issues, we focus on small and medium-sized firms, being the large majority of firms in developed countries and yet having a peculiar approach to those issue, considering for the smaller set of resources they can access (Biondi et al, 2002).

The paper is organized as follows: in section 2 we review the literature on the relationship between pressures for increasing environmental performance and both global sourcing and outward FDIs. In section 3 we discuss the data and the variables used and the empirical models adopted and in paragraphs 4 and 5 we presents the main results and discuss the emerging policy implications.

2. Global sourcing, outward FDIs and pressures for increasing environmental performance

In the global context, the major governing decisions firms face amounts basically to i) the choice of what to produce within the company and what to buy on the market or to co-produce through network forms, and to ii) the choice or where to produce it, either in the home country or abroad (Contractor et al, 2010). As far as production in foreign countries is concerned, if production is conducted in-house within proprietary plants we speak about outward Foreign Direct Investments (FDIs), whereas if activities are carried out by external and independent producers we speak about international subcontracting or global sourcing. If both forms of internationalization may be driven by the same objectives (market, resource, efficiency or innovation-seeking), they entail a different cost structure, with FDI being a major initial investment (and therefore being less volatile) that allows greater control on activities relocated than global sourcing. Indeed, international business studies highlight that difference exists considering for firms' size, with SMEs being less likely to follow a proprietary path of investments to internationalize but network mechanisms (e.g., Lu and Beamish, 2001).

The growing environmental concerns by policy makers and stakeholders to improve sustainability performance of companies pose a challenge for international firms, considering that environmental regulation, technological capabilities and consumer awareness varies significantly from country to country (Christmann, 2004). The relationship between internationalization and the environment has been investigated in recent years especially within the so-called

Pollution Haven hypotheses (PHH) literature and has focused both on FDIs (e.g. Eskeland and Harrison 2003; Cole et al. 2006) and on international outsourcing (Cole et al, 2013). The basic assumption behind this hypothesis is that a firm, when confronting with an increasing pressure for improving environmental performance, may decide to move activities in countries characterized by weaker regulation or laxer enforcement - usually in emerging or developing countries - instead of reducing their pollution levels (Cole, 2004). This is supposed to be the case especially within intense polluting industries, where the abatement costs required to obey to the environmental policy, the only environmental pressure usually considered, may be higher. The vast literature on the topic has produced a large yet inconclusive empirical evidence, partly driven by the different estimation techniques used (Levinson and Taylor, 2008). As far as FDIs are concerned, for example, Cole et al (2013), using data on Japanese manufacturing companies support that firms undertaking environmental activities are more likely to internationally outsource, but they not investigate toward which countries. Manderson and Kneller (2012), instead, finds no evidence for the PHH in the context of UK manufacturing firms and support that dirtier MNEs are not more likely than greener MNEs to relocate to environmental-lax countries.

In contrast, micro-level analyses spanning from the management literature suggest that multinational firms may have private incentives to exceed (local) policy requirements, both to avoid potential reputational risks and to easy the management of global activities by requiring to all plants to adapt to the same standards, the highest ones. Indeed, multinational corporations are suggested as playing a key role for the environmental upgrading of Third World companies (Jeppesen and Hansen, 2004), being a channel to import environmental technologies and best practices and a key driver for their improvements. Based on survey data, Christmann and Taylor (2001) discovered that Chinese companies part of multinationals or serving foreign customers in developed countries have stronger pressures to improve their performance beyond local standards and are more likely to adopt voluntary environmental managing schemes (EMS) like ISO14001. In many cases, multinational companies employ a corporate code of conduct, in addition or as an alternative to EMS, which they enforce directly in all the countries in which they produce or supply. It is for example the case of IKEA, just one of the many multinational companies studied in the literature being committed and having invested to improve environmental performance at suppliers in developing countries so to reach their global standards. (Andersen and Skyott-Larsen, 2009, De Marchi et al., 2014, Ivarson and Alvstam, 2010).

Other than suggesting that firms may have the incentive to export their environmental standards even when going to countries characterized by laxer environmental requirements, management contributions support that firms may even have the incentive to keep the production at home to support their environmental strategy. Indeed, firms can benefit from physical proximity in order to increase efficiency in the management of processes oriented to reduce environmental impacts of their economic activities as in the case of industrial districts (Daddi et al. 2010; Da Ronch et al., 2013), both when producing in-house and when outsourcing to a network of suppliers. The fact that suppliers are located close to the company adds also to its ability to control and influence their activities, especially in the case of high-end and innovative productions and/or of SMEs (De Marchi et al., 2013). Finally, there is evidence that also the proximity with the final customers may be beneficial for the implementation of environmental innovations, to reassure about the green features of products and processes; in both the Italian and Spanish context, export has been found to be negatively or not related with green innovations (De Marchi, 2012; Chiarvesio et al, 2014; Cainelli et al, 2012).

Against this background, we aim at understanding what is the impact of environmental policy pressure on SMEs' decision to internationalize – either via FDI or international sourcing – when considering for firm's strategy.

3. Empirical strategy

3.1. Data and variables

We test our main hypotheses using a new dataset on 684 Italian manufacturing firms administered by TeDIS Centre[1] and representative of the Made in Italy industry (fashion, home products and furniture, plus mechanics sectors, electronics, plastics and rubber industries). The firms were randomly selected from a population of companies with a turnover of more than one million euros (last balance sheet available as of 2009) and stratified by industry and size. We use the 2011 survey, which provides information on a series of firm characteristics and activities like: the structure of the (global) value chain, the marketing strategies, R&D and innovation, design and technology endowment and investments. The industry, size and geographic distribution of firms are presented in Table 1.

< Table 1 >

Dependent variables. Section B1 of the questionnaire concerns the value chain of the firm. In particular, a set of questions specifically ask whether the firm externalizes

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[1] TeDIS is the Center for Studies on Technologies in Distributed Intelligence Systems of Venice International University. For more information, please visit the website: http://www.univiu.org/research-training/research-tedis.

at least part of its production process and, in case, whether it uses external suppliers. If the answer is 'yes', a further question asks about the location of the suppliers, including foreign countries. In case of sourcing to a foreign supplier, a description of the main areas of destination is provided. Areas include: Europe 15 countries, USA/Canada, Japan, Eastern Europe, Far East countries (including China and India), Africa, Latin America and few other countries (among them Turkey, Switzerland, Australia and New Zealand). We use all these information to define a dummy equal to 1 if the firm outsources its production activities to a foreign supplier (IO), and two dummies identifying, respectively, outsourcing to a developed country (IO NORTH: EU15, USA/Canada and Japan), where the environmental regulation is supposed to be stricter, and outsourcing to a less developed country (IO SOUTH: East Europe, Far East, Latin America, Africa and other countries), where the environmental regulation is, on average, laxer.

Sub-section B1-A of the questionnaire is specifically devoted to outward foreign direct investments. As before, firms are asked whether they are engaged in any foreign direct investment and, if yes, in which area of the world. With this information, we define a dummy (FDI) equal to 1 if the firm engages in outward FDI in 2011 and two additional dummies for FDI in the North (FDI NORTH: EU15, USA/Canada and Japan) and FDI in the South (FDI SOUTH: Eastern Europe, Far East, Latin America, Africa and other countries)[2]. The variable OFFSHORING is a

[2] We also adopt an alternative criterion to distinguish between Northern and Southern countries. We take the World Economic Forum (WEF) survey, which asks business executives about their countries' environmental regulatory stringency. The answers are arranged on a scale from 1 to 7, where 1 stands for an extremely lax environmental regulation. On the base of these answers, a ranking of countries is provided. We take the ranking in the 2006/07 survey and we include in the 'North' those countries with an average environmental regulatory stringency index higher than that of Italy, and in the 'South', those countries where the same index is lower or equal. When using this alternative specification f the dependent variables, we do not find any significant change in the estimation results.

dummy taking value one if the variables IO or FDI are equal to one. Figure 1 illustrates the distribution of FDI and IO by macro area of destination. The major part of FDI and IO are directed to Far East countries, China and India in particular, EU-15 and Eastern European countries, especially Romania. The industries most involved in offshoring are manufacturing of wearing apparel (14%), manufacturing of non-metallic mineral products (18%) and production of machinery and equipment (27%).

< Figure 1 >

Summary statistics for all the dependent variables are presented in Table 2. We have that 24.4% of firms offshore production; among them, 70% recur to subcontracting to a foreign supplier, while 51% to FDI, and around 22% to both IO and FDI.

< Table 2 >

Environmental regulatory stringency variables. We use two indicators to measure environmental regulatory stringency. Since we do not have information on private abatement costs at the firm level, we collect such an information at the industry level. The first indicator is given by the private investments of Italian firms on environmental protection, as a share on the total amount of gross fixed investments, and averaged across 2008, 2009 and 2010. This indicator is similar to the US Pollution Abatement Costs and Expenditures ($PACE_{2008\text{-}10}$). These investments include expenditures in equipment and plant for pollution control and anti-pollution accessories (mainly 'end-of-pipe', which represents the large share of these investments) and expenditures in equipment and plant linked to cleaner technology (i.e. integrated technology). In addition, to give account of the dynamics in pollution abatement costs, we also computed the ratio between *PACE* in 2010 and *PACE* in 2008 ($\Delta PACE_{2010/08}$): the higher the ratio, the increasing the effort of firms in the industry to engage in reducing pollution during the period considered.

As stressed by Brunel and Levinson (2013), *PACE* would be an ideal measure of environmental regulatory stringency, since it reports the costs firms incur to reduce pollution. In practice, this measure suffers from some limitations, ranging from the potential inaccuracy of answers to questions related to pollution abatement costs at the firm level to the difficulty to separate out costs by their environmental intent. Moreover, it is difficult to distinguish what part of these expenditures is driven by environmental policy and what part by profit or market motivations (Kozluk and Zipperer, 2013).

For these reasons, we include a second measure of environmental regulatory stringency, which is more related to the emergence of the carbon leakage phenomenon, i.e. the possibility that firms transfer polluting activities to third countries where the environmental regulation is less stringent, thus increasing their total amount of emissions. We refer to the European Union Emissions Trading Schemes (ETS), which is a 'cap and trade' system aimed at limiting the amount of greenhouse gas (GHG) emissions of factories. Within such a cap, firms can receive or buy emission allowances, and they can trade them with one another if needed. Launched in 2005, the EU-ETS is now in its third phase (2013-2020) and is considered the main policy instrument for climate change mitigation in the European Union. In order to increase the competitiveness of the whole EU-ETS system, not all industries are subject to ETS allowances. In particular, sectors that are more exposed to leakage risk (according to its carbon and trade intensity) are

exempted from auctioning (European Commission, 2009; Martin et al., 2014). Therefore, we define a dummy equal to 1 (*ETS*) if the firm belongs to a (4 digit) sectors which is subject to EU-ETS, according to the list included in the Decision of the European Commission 2010/2/EU 'Determining, pursuant to Directive 2003/87/EC of the European Parliament and of the Council, a list of sectors and subsectors that are deemed to be exposed to a significant risk of carbon leakage'.
With respect to *PACE*, the ETS variable has the advantage to be fully policy driven and so to respond to a clear, unique, source of environmental pressure for the firm, that is the European Union. Moreover, ETS represents an input measure of environmental stringency: the policy maker sets the allowances and the rules of the auctioning system, and then firms react to these constraints. On the other hand, *PACE* comprises a wider range of pollutants other than only GHG, and provides an output measure of stringency, since it represents actual expenditures and costs directly aimed at reducing pollution. However, the pressure on firms to reduce pollution can come from different stakeholders: policy makers, NGOs, media and press, industries, associations, consumers and the market. For those reasons, we believe that these two measures can be complementary in providing a complete picture of the environmental regulatory stringency to which firms are subject in Italy.

Firm-level covariates. Other than policy stringency, other aspects, linked with the specific strategy of the firms, its reference market and its overall capabilities may influence its decision to offshore production activities and or control for its environmental aspects. Among the available firm-specific characteristics, we identify the following variables as being potentially correlated with the decision of firms to offshore production.

First, we control for firm's structural characteristics and its capabilities. We therefore control for firm's size, including four dummies for *MICRO* (less than 10 employees, used as the reference term), *SMALL*, *MEDIUM* and *LARGE* firms and for the technological intensity of the industry, using a dummy equal to 1 if the firm belongs to a low-tech or a medium-low tech industry (*LOW TECH*), according to the OECD classification.

Then, we include variables to control for the international strategy of the firm. First, we control if the firm is part of a foreign-owned business group through the dummy *FOREIGN GROUP*. Unfortunately, our dataset does not provide information on whether the firm is a multinational, or a branch of a multinational, so we use this only available information that can be related to the international governance of the firm. Secondly, we introduce a dummy equal to 1 if the firm exports goods into foreign markets (*EXPORT*), used in order to control for other internationalization modes that can simultaneously be adopted by the firm.

Third, we included a set of variables to account for the strategy of environmental sustainability and the technological capability of the firm. Environmental sustainability is proxied by two dummies: one is equal to 1 if the firm obtained an environmental standard certification (*ENV STANDARD*) related to the entire production system or to its products (like eco-labels or ISO 14000), while the other is equal to 1 if the firm introduced an environmental innovation (*ENV INNO*) related to new product or new processes. By including these variables, we control for the 'environmental behavior' of the firm, the so-called technology-push effect (Rennings, 2000), which can potentially confound the effect of environmental regulatory stringency on global sourcing strategies. Technological capability is measured by three variables. The first is the R&D budget (*R&D BUDGET*) of the firm, given by the share of R&D investments on total turnover. The second is a dummy equal to 1 if firms cooperate in R&D projects with outside partners, like firms, universities or other public or private entities (*R&D COOP*). The third is a dummy equal to 1 if the firm is endowed with ICT equipment and software, which is targeted to support the offshoring activities (*ICT*), like videoconference facilities, extranet for suppliers, extranet for logistics and Supply Chain Management solutions.

The market strategy of the firm is captured by two dummy variables. The dummy *B2C* – business-to-consumer – captures the degree of closeness of the company to its final customers and is equal to 1 if the main client of the firm is a commercial activity or a final consumer; the other is equal to 1 if the firm registered a trademark (*TRADEMARK*). Both variables are meant as a way to capture the role of the relationship with the final customers in influencing the internationalization strategy of the firm and its attitude toward environmental issues: indeed, the more the firm is visible to its final customers, also by the mean of its branding activities, the more their pressures may represent a strong driver for reducing emissions and the higher the reputational risk in case their activities (in-house of abroad) may be found not compliant to the highest international standards.

Another important variable that can affect the offshoring decision of firms is labour cost (Abraham and Taylor, 1996). Since we do not have such information at the firm level, we use labour cost per capita at the industry level (*ULC*), as provided by the Italian Statistical Institute (ISTAT), and averaged across 2008, 2009 and 2010. Savings from labour compensation is one of the main motivations behind outsourcing, and so we do expect that firms operating in high-wage industries are more likely to contract out production with respect to firms belonging to low-wage industries.

Finally, we include four geographic dummies at NUTS1 region level (North West, North East, Centre and South) to capture potential location-specific attributes that can affect the outsourcing and FDI decision, or proximity to neighboring countries. Table 3 summarizes all the firm-level and industry-level covariates.

< Table 3 >

3.2. Empirical model

The basic regression equation is given by:

$$(1)\ \Pr(OFFSHORING_i = 1 \mid \mathbf{X}_i, \mathbf{X}_j) = \Phi(\boldsymbol{\beta}_0 + \mathbf{X}_i'\boldsymbol{\beta}_i + \mathbf{X}_j'\boldsymbol{\beta}_j)$$

where Φ is the standard normal distribution, $\boldsymbol{\beta}_0$ is the vector of constant terms, $\mathbf{X}_i'$ is the vector of firm-level covariates and $\mathbf{X}_j'$ is the vector of industry-level covariates, which are described in Table 3. We first estimate the propensity of Italian manufacturing firms to offshore production, either through FDI or through international outsourcing. Then, we run two separate estimates for FDI and IO, and finally we distinguish between the area of destination, i.e. North Vs South.

When we use the *OFFSHORING* dummy, the counterfactual (i.e. the zeros) is made by firms that do not relocate production at all. When the dependent variables is *FDI*, the counterfactual is given by firms that do not relocate production at all and firms that outsource production to foreign suppliers. When the dependent variables is *IO*, the counterfactual is given by firms that do not relocate production at all and firms that engage in outward FDI.

Since all the dependent variables are binary, we first estimate Equation 1 through a series of univariate probit models, where we cluster the standard errors at the 4 digit industry level to account for the potential correlation within groups of observations (Moulton, 1990). To interpret, and more easily compare, the estimated average marginal effects, the industry-level variables *ULC* and *PACE* are standardized.

When estimating Equation 1 with FDI and IO as dependent variables, we also use an alternative estimation technique. Since we observe a 22% of offshoring firms that engage both in FDI and in IO, the univariate approach ignores that these two offshoring modes might be correlated. Using a multivariate framework, we also estimate Equation 1 using a bivariate probit model, which accounts for the correlation between the error terms of the FDI and IO equations. With this model, we can also estimate the effect of our firm and industry-specific covariates on the sole probability to engage in FDI (that is the probability of FDI when IO is zero), as well as on the sole probability to engage in IO (that is, when FDI is zero).

Finally, we estimate Equation 1 using FDI and IO by area of destination, i.e. North and South respectively. We also test the robustness of the univariate probit results by estimating the joint probability to engage in FDI and in IO in the South again through a bivariate probit model.

4. Results

Estimation results are presented in Tables 4 and 5. Tables 6 and 7 present some robustness checks. In Table 4, we sow the estimation results of equation 1 when the dependent variable is *OFFSHORING.* In column 1, environmental stringency is represented only by *PACE*; in Column 2 we use only the *ETS* dummy; in Column 3 we include both of them, and in Column 4 we include *ETS* and $\Delta PACE$.

< Table 4 >

Looking at firm-level covariates across the four columns, we observe that the likelihood to offshore production is unambiguously higher for large firms, confirming that going international requires higher human and financial capabilities. Results point also to the fact that offshoring is part of a broader international strategy of the firm, including both being part of an international business group and exporting. As far as variables capturing the potential role of the market, just *TRADEMARK* is significant. As far as the other firm-level variables are considered, capturing the firm innovation's capabilities (*R&D BUDGET* and *R&D COOP*), its attitude toward environmental issues (*ENV STANDARD* and *ENV INNO*) they are not significant if not weakly.

Looking at industry-level variables measuring for the role of policy stringency, we find that the average marginal effects of both *PACE* and *ETS* are positive and statistically significant, although not particularly strong in magnitude. All the rest being equal, we find that a one standard deviation increase in pollution abatement expenditures is related to an average 0.08% increase in the probability to offshore production. For ETS, we find that being part of an industry subject to the EU-ETS is related to an average 6% increase in offshoring production. Significant but modest in magnitude is also the effect of Δ*PACE* on OFFSHORING, with an average marginal effect of 0.0004. When looking at the goodness of fit statistics, we also note that a model including both measures of environmental stringency (as that in Column 3) is preferable than a model with only one variable. Therefore, in the remaining Tables, we only show the results of a model where *PACE* and *ETS* are simultaneously included. The same models are also estimated by replacing *PACE* with Δ*PACE* as a regressor, and we always find similar results.

Table 5 shows the estimation results of Equation 1 when offshoring is realized through FDI (Columns 1-3) and through IO (Columns 4-6) respectively.

< Table 5 >

From the first column we note that the likelihood to engage in outward FDI is higher for large firms, for firms being part of a foreign-owned group, for firms also engaged in exporting activities, for firms registering a trademark and so engaged in establishing a market reputation through branding and firms equipped with proper ICT. Interestingly, the effect of *PACE* is positive and statistically significant, although at 10% and modest in strength, whereas the average effects of *ULC* and *ETS* are not significantly different from zero.

The second and third columns distinguish between FDI in the North and FDI in the South. We find that, while the average marginal effect of *FOREIGN GROUP* is always positive and statistically significant, those of firm size, export, trademarks, ICT, and environmental standards certification hold significant only when FDI are directed to the South. What drives FDI to the North, instead, seems to be related to the international business networks to which the firm belongs and to the adoption of B2C strategies. Moreover, proximity also matters: the marginal effects of the dummies for being located in the North West and in the North East are positive and highly significant, which can explain the choice of Northern Italian firms to relocate production to closer Northern European countries. Interestingly, we observe that, while the average marginal effect of *PACE* is positive and significant only in the FDI SOUTH case, *ETS* is never statistically significant. This latter result may have a twofold explanation. On the one hand, it can be that the adaptation costs implied by the ETS are not so high to push firms to engage in FDI. On the other, it can be that ETS industries are those where the risk of carbon leakage is lower.

The fourth column in Table 5 shows the factors related to the propensity to subcontract production to foreign suppliers. Differently from the FDI case, size and ICT are not relevant: technologies allowing a better interaction among different units and an integration with suppliers is beneficial when firms go abroad through direct investments, whereas it is not easy to implement in the contexts of international outsourcing. As for FDI, instead, being part of a foreign-owned group, being an exporter and having registered a trademark are factors related to a higher likelihood to IO. We also find that firms with an environmental standard certification are less likely to outsource, which is coherent with the fact that such certifications requires often firms to be responsible of the environmental impacts also of their supply chain, which is easier managed when activities are closer (both geographically and culturally) to the headquarters. Interestingly, the contrary held in the context of FDIs: when going to the South having environmental certifications may be necessary to keep the reputation.

Going to industry-level covariates, now we find that unit labor cost significantly affects IO as well as both our environmental stringency proxies. In particular, looking at the fifth and sixth columns, we note that such a positive correlation holds for the IO SOUTH case, whereas for firms outsourcing in the North environmental protection does not represent a relevant driver. In line with the Pollution Haven Hypothesis, a more stringent environmental regulation may induce firms to transfer production abroad, especially in less developed areas where environmental standards are laxer or where consumers' attention towards environmental issues is lower.

Two novel pieces of evidence arise from these estimates. First, different environmental regulation instruments may have different effects on the global sourcing strategies of firms. While pollution abatement costs are always associated to a higher likelihood to offshore production, EU-ETS is only related to IO strategies, but not with FDI. Second, when a more stringent environmental regulation is related to a higher recourse to offshoring, this occurs in less developed countries. Moreover, other firm-level strategies matter in driving this decision: among them, other internationalization strategies, as well as market strategies and scale efficiency seem to be of particular relevance.
Table 6 reports robustness checks from the bivariate probit estimates.

< Table 6 >

From the first column, we see that the general propensity to exclusively engage in FDI is affected by firm-level strategies and attributes, like foreign group membership, trademarks and ICT. The second column shows that the general propensity to exclusively engage in IO is related to both firm-level strategies (like exports and environmental standards) and industry-related variables, like labour cost and environmental regulation. Interestingly, only *PACE* is related to a higher joint probability of FDI and IO, as can be seen in the third column.
Finally, Table 7 shows a further robustness check, where we use the bivariate probit model to jointly estimate the probability to offshore production to the South, either through FDI or through IO. For simplicity, we only report the marginal effects related to the industry-level covariates.

< Table 7 >

When going to the South only by FDI, environmental regulation does not have any relevant effect now. We conclude that results from Table 5, third column, are sensitive to the fact that firms can simultaneously engage in IO strategies. Instead, results from the second column confirm that both *PACE* and *ETS* are significantly related to the likelihood to source production to foreign suppliers. The last column shows that firms committed on both sourcing modes are also those subject to more stringent environmental stringency, although only *PACE* is statistically significant.

5. Conclusions

The relationship between environmental policy and the subsequent trade patterns are a hot issue in the current policy agenda. Of particular concern is the risk that targeting climate change mitigation at home may induce a global transfer of production activities across countries, raising carbon leakage and environmental dumping phenomena. Not only, but regulating the environmental policy may also have important consequences on domestic labour market dynamics and may constitute a tool for countries for attracting foreign investments (Copeland, 2008; Millimet and Roy, 2012). Policy implication related to this issue are extremely relevant.

In this paper we investigate whether a more stringent environmental regulation may push firms to offshore production when considering for other strategy aspects of the firms. Using a novel dataset on Italian manufacturing firms, we estimate the effect of pollution abatement costs and assignment into industries subject to EU-ETS regulation on the likelihood to offshore production, either through FDI or through subcontracting abroad to a foreign supplier. To give account of the PHH, we distinguish between offshoring in less developed countries and offshoring in developed countries, the latter being characterized by a more stringent environmental regulation. We also control for firm-level attributes and strategies that can be related to the international sourcing choices.

Our univariate and bivariate probit estimates show that environmental policy is related to firm upstream internationalization strategies. In particular, we find that a more stringent regulation, reflected in higher private investments for reducing pollution, is related to a higher likelihood to transfer production to the South, especially through subcontracting abroad, although the effect is not particularly strong. Less significant or robust are the effects on FDI to the South, probably because this sourcing strategy entails more settlement and transport or logistics costs than outsourcing. Instead, we do not find any relation between environmental policy and offshoring to the North: this seems more driven by market strategies operated at the firm level. Indeed, firm's resources and strategy (both regarding its attitude toward environmental issues and its relationship with the market) may be more relevant in explaining such strategies than environmental policy pressures.

These results are in line with the PHH and complement recent evidence (Martin et al., 2014) on the role of environmental stringency on the risk of carbon leakage. We provide further evidence on the need to distinguish among different sourcing strategies, as they entail different costs and opportunities and to complement industry level variables on policy pressures with other variables capturing the firm's strategy.

Finally, it is worth noting that our empirical analysis suffers from some limitations.

First, our dataset does not cover all the manufacturing sectors in Italy, thus limiting the generalizability of our results. Second, we can only use environmental stringency variables at the industry level. Third, the cross-sectional nature of our data does not allow a proper treatment of endogeneity. Although the problem should be mitigated by the fact that our unit of analysis is the firm, and not the industry, it can be that higher propensity to offshore dirty production stages of a single firm reduces the total amount of emissions of the industry. Such a reverse causality issue could be mitigated with the use of proper external instruments, which should be related to environmental stringency but not with offshoring (see Millimet and Roy, 2012 for a review)[3].

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[3] Such a problem should be less relevant when we estimate our model on the sub-sample of micro and small firms only. Unreported etimates of Equation 1 on this sub-sample confirm the previous results.

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Tables and Figures

Table 1. Industry, size and geographic distribution of firms in the sample

Industry (ATECO 2007)	N	%
13. Textile	45	6.58
14. Wearing apparel	41	5.99
15. Leather and related products	34	4.97
16. Wood	22	3.22
17. Paper	21	3.07
22. Rubber and plastics	58	8.48
23. Non-metallic mineral products	53	7.75
25. Fabricated metal products	157	22.95
26. Computer and electronics	28	4.09
27. Electric and domestic apparel	38	5.56
28. Machinery and equipment	97	14.18
29. Motor vehicles	16	2.34
30. Other transport goods	13	1.90
31. Furniture	61	8.92
Size	N	%
Micro: 1-9	71	10.38
Small: 10-49	362	52.92
Medium: 50-249	211	30.85
Large: 250+	40	5.85
Geography	N	%
North West	250	36.55
North East	289	42.25
Centre	107	15.64
South	38	5.56

Table 2. Summary statistics: dependent variables

Variable	Description	Mean	S.d.	Min	Max
OFFSHORING	Dummy=1 if the firm contracts out (all or some) production stages to foreign suppliers, either through FDI or through IO	0.244	0.430	0	1
IO	Dummy=1 if the firm subcontracts (all or some) production stages to foreign suppliers	0.171	0.377	0	1
IO|OFFSHORING==1	Dummy = 1 if the firm subcontracts (all or some) production stages to foreign suppliers, conditional on OFFSHORING=1	0.701	0.459	0	1
IO_NORTH	Dummy=1 if the firm externalizes (all or some) production stages to foreign suppliers located in developed countries (North)	0.111	0.314	0	1
IO_NORTH|IO=1	Dummy=1 if the firm externalizes (all or some) production stages to foreign suppliers located in developed countries (North), conditional on FORSUP=1	0.590	0.494	0	1
IO_SOUTH	Dummy=1 if the firm externalizes (all or some) production stages to foreign suppliers located in developing or transition countries (South)	0.114	0.318	0	1
IO_SOUTH|IO=1	Dummy=1 if the firm externalizes (all or some) production stages to foreign suppliers located in developing or transition countries (South) , conditional on FORSUP=1	0.607	0.491	0	1
FDI	Dummy=1 if the firm owns production facilities in foreign countries	0.126	0.332	0	1
FDI| OFFSHORING = 1	Dummy = 1 if the firm subcontracts (all or some) production stages to foreign suppliers, conditional on OFFSHORING=1	0.515	0.501	0	1
FDI_NORTH	Dummy=1 if the firm owns production facilities in developed foreign countries (North)	0.054	0.226	0	1
FDI_NORTH|FDI=1	Dummy=1 if the firm owns production facilities in developed foreign countries (North), conditional on FDI=1	0.430	0.498	0	1
FDI_SOUTH	Dummy=1 if the firm owns production facilities in developing foreign countries (South)	0.088	0.283	0	1
FDI_SOUTH|FDI=1	Dummy=1 if the firm owns production facilities in developing foreign countries (South), conditional on FDI=1	0.698	0.462	0	1

Notes: NORTH includes Europe-15 countries, USA/Canada and Japan; SOUTH includes East Europe, East Asia, Africa, Latin America and other countries.

Table 3. Summary statistics: firm-specific and industry-specific covariates

Variable	Description	Mean	S.d.	Min	Max
Firm-level covariates					
MICRO	Size: 0-9 employees	0.104	0.305	0	1
SMALL	Size: 10-49 employees	0.529	0.500	0	1
MEDIUM	Size: 50-249 employees	0.308	0.462	0	1
LARGE	Size: 250+ employees	0.058	0.235	0	1
NORTH WEST	Piedmont, Lombardy and Liguria	0.423	0.494	0	1
NORTH EAST	Veneto, Friuli Venezia Giulia, Trentino Alto Adige and Emilia Romagna	0.365	0.482	0	1
CENTRE	Tuscany, Lazio, Marche and Umbria	0.156	0.364	0	1
SOUTH	Campania, Abruzzo, Molise, Apulia, Basilicata, Calabria, Sardinia and Sicily	0.056	0.229	0	1
LOW_TECH	Dummy = 1 if the firm belongs to a low or medium-low tech industry (OECD)	0.401	0.490	0	1
FOREIGN GROUP	Dummy = 1 if the firm belongs to a business group led by a foreign company or if at least one of the members of the group is located in a foreign country	0.181	0.386	0	1
B2C	Dummy = 1 if the main customer of the firm is a commercial activity or a final consumer (Business to Consumer)	0.415	0.493	0	1
TRADEMARKS	Dummy = 1 if the firm registered a trademark	0.430	0.495	0	1
EXPORT	Dummy = 1 if the firm exports in foreign markets	0.743	0.437	0	1
ENV_STANDARD	Dummy = 1 if the firm obtained an environmental standard certification	0.224	0.417	0	1
ENVINNO	Dummy = 1 if the firm introduced an environmental innovation (product or process)	0.411	0.492	0	1
R&D_BUDGET	R&D financial budget (% of turnover)	0.020	0.051	0	0.45
R&D_COOP	Dummy=1 if the firm cooperates in R&D with external subjects (universities, scientific parks, research centers, firms…)	0.263	0.441	0	1
ICT	Dummy=1 if the firm adopts the following ICT facilities: videoconference, extranet for suppliers, extranet for logistics, Supply Chain Management solutions	0.453	0.498	0	1
Industry-level covariates					
ULC	Labour cost per capita, average 2008-2010	25961	3581.4	19570	31202
$PACE_{2008\text{-}10}$	Private environmental investments, % on total gross fixed investments, average 2008-2010 (2-digit)	0.009	0.004	0	0.016
$\Delta PACE_{2010/08}$	PACE2010/PACE2008	61.44	237.2	0.5	1000
ETS	Dummy Emissions Trading System (4 digit)	0.287	0.453	0	1

Table 4. Environmental regulatory stringency and offshoring: probit estimates

	(1)	(2)	(3)	(4)
Small	-0.019	-0.015	-0.015	-0.014
	(0.044)	(0.044)	(0.044)	(0.044)
Medium	0.065	0.063	0.072	0.073
	(0.050)	(0.051)	(0.050)	(0.050)
Large	0.209***	0.203***	0.210***	0.212***
	(0.072)	(0.077)	(0.071)	(0.071)
Low Tech	-0.057	-0.026	-0.073**	-0.064*
	(0.037)	(0.037)	(0.034)	(0.033)
Foreign group	0.104**	0.115***	0.101***	0.100**
	(0.043)	(0.043)	(0.043)	(0.042)
Export	0.124***	0.118***	0.125***	0.124***
	(0.042)	(0.043)	(0.042)	(0.042)
B2C	0.016	0.020	0.019	0.020
	(0.048)	(0.051)	(0.046)	(0.046)
Trademarks	0.113***	0.136***	0.111***	0.110***
	(0.030)	(0.027)	(0.029)	(0.029)
Env standard	-0.049	-0.062*	-0.046	-0.044
	(0.035)	(0.036)	(0.035)	(0.035)
Env Inno	0.010	-0.023	0.012	0.013
	(0.032)	(0.031)	(0.031)	(0.031)
R&D budget	0.281	0.311	0.220	0.218
	(0.266)	(0.266)	(0.268)	(0.268)
R&D Coop	0.039	0.047	0.036	0.036
	(0.026)	(0.030)	(0.029)	(0.029)
ICT	0.046	0.068*	0.051	0.050
	(0.029)	(0.035)	(0.033)	(0.033)
$ULC_{2008\text{-}10}$	0.031	-0.006	0.034	0.035*
	(0.022)	(0.022)	(0.021)	(0.021)
$PACE_{2008\text{-}10}$	0.086***		0.086***	
	(0.017)		(0.017)	
$\Delta PACE_{2010/08}$				0.0004***
				(0.0000)
ETS		0.067*	0.064*	0.066**
		(0.040)	(0.034)	(0.033)
Area dummies	Yes	Yes	Yes	Yes
N	684	684	684	684
Pseudo R^2	0.261	0.226	0.266	0.269
% Corr. Class.	80.70	79.53	81.14	80.70
HL test	0.839	0.095	0.563	0.545
AIC	599.73	626.91	598.07	596.05

Notes: cluster-robust (at 4 digit industry level) standard errors in parentheses. Cells report average marginal effects. All the estimates include also a constant term. $ULC_{2008\text{-}10}$ and $PACE_{2008\text{-}10}$ are standardized.
*** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Table 5. Environmental stringency, FDI and international outsourcing: probit estimates

	FDI	FDI NORTH	FDI SOUTH	IO	IO NORTH	IO SOUTH
Small	-0.040	-0.030	0.030	-0.015	-0.008	0.048
	(0.043)	(0.029)	(0.047)	(0.064)	(0.052)	(0.045)
Medium	-0.012	-0.012	0.032	0.040	0.049	0.074
	(0.043)	(0.027)	(0.052)	(0.072)	(0.056)	(0.051)
Large	0.105*	0.043	0.104*	0.054	0.048	0.146**
	(0.058)	(0.037)	(0.060)	(0.093)	(0.096)	(0.063)
Low Tech	-0.033	0.000	-0.049*	-0.077**	-0.026	-0.049*
	(0.025)	(0.015)	(0.025)	(0.035)	(0.037)	(0.029)
Foreign ownership	0.073***	0.045**	0.042**	0.088***	0.067***	0.057***
	(0.026)	(0.019)	(0.021)	(0.028)	(0.027)	(0.027)
Export	0.060*	0.029	0.061*	0.156***	0.133***	0.113***
	(0.036)	(0.025)	(0.034)	(0.039)	(0.037)	(0.037)
B2C	0.010	0.047**	0.008	0.062	0.094**	0.042
	(0.036)	(0.021)	(0.033)	(0.045)	(0.040)	(0.033)
Trademarks	0.075***	0.035	0.038**	0.064**	0.021	0.043*
	(0.025)	(0.023)	(0.018)	(0.032)	(0.026)	(0.026)
Env standard	0.029	0.011	0.049**	-0.067**	-0.055**	-0.010
	(0.024)	(0.014)	(0.018)	(0.026)	(0.025)	(0.029)
Env Inno	0.031	0.026	0.017	-0.004	-0.004	-0.003
	(0.025)	(0.018)	(0.020)	(0.031)	(0.023)	(0.026)
R&D budget	-0.114	-0.023	-0.096	0.153	0.044	0.037
	(0.197)	(0.096)	(0.162)	(0.225)	(0.166)	(0.205)
R&D Coop	0.032	0.012	0.015	-0.017	-0.004	-0.041**
	(0.024)	(0.019)	(0.022)	(0.027)	(0.022)	(0.024)
ICT	0.050**	-0.003	0.066***	0.029	-0.010	0.025
	(0.023)	(0.014)	(0.020)	(0.030)	(0.025)	(0.018)
$ULC_{2008\text{-}10}$	-0.006	0.014	0.005	0.037*	0.048***	0.023*
	(0.013)	(0.009)	(0.011)	(0.021)	(0.015)	(0.015)
$PACE_{2008\text{-}10}$	0.020*	0.011	0.025*	0.074***	0.009	0.061***
	(0.011)	(0.009)	(0.015)	(0.016)	(0.016)	(0.012)
ETS	0.000	-0.011	0.009	0.081**	0.019	0.090***
	(0.023)	(0.020)	(0.022)	(0.032)	(0.023)	(0.026)
Area dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	684	684	684	684	684	684
Pseudo R^2	0.253	0.269	0.250	0.208	0.210	0.237
% Corr. Class.	88.16	94.88	91.23	84.21	88.16	89.91
HL test	0.944	0.961	0.978	0.821	0.999	0.737

Notes cluster-robust (at 4 digit industry level) standard errors in parentheses. Cells report average marginal effects. All the estimates include also a constant term. $ULC_{2008\text{-}10}$ and $PACE_{2008\text{-}10}$ are standardized.
*** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Table 6. Environmental stringency, FDI and IO: bivariate probit estimates

	Pr(FDI=1 I IO=0)	Pr(IO=1 I FDI=0)	Pr(FDI=1 & IO=1)
Foreign group	0.043*	0.062	0.033**
	(0.025)	(0.040)	(0.016)
Export	0.021	0.093***	0.022***
	(0.020)	(0.021)	(0.007)
B2C	-0.005	0.056	0.009
	(0.020)	(0.048)	(0.013)
Trademarks	0.050**	0.037	0.025**
	(0.020)	(0.028)	(0.008)
Env standard	0.029	0.054***	-0.004
	(0.022)	(0.018)	(0.005)
Env Inno	0.023	-0.011	0.005
	(0.018)	(0.021)	(0.007)
R&D budget	-0.071	0.140	-0.004
	(0.143)	(0.210)	(0.042)
R&D Coop	0.025	-0.018	0.004
	(0.020)	(0.020)	(0.006)
ICT	0.030*	0.016	0.013*
	(0.015)	(0.023)	(0.007)
$ULC_{2008-10}$	-0.007	0.032*	-0.004
	(0.009)	(0.017)	(0.004)
$PACE_{2008-10}$	0.006	0.058***	0.013***
	(0.009)	(0.013)	(0.004)
ETS	-0.010	0.074**	0.010
	(0.015)	(0.033)	(0.007)
Area dummies	Yes	Yes	Yes
Size dummies	Yes	Yes	Yes
Low tech dummy	Yes	Yes	Yes
ρ=0.322***			

Notes cluster-robust (at 4 digit industry level) standard errors in parentheses. Cells report average marginal effects. All the estimates include also a constant term. $ULC_{2008-10}$ and $PACE_{2008-10}$ are standardized.
*** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Table 7. Environmental stringency, FDI and IO to the South: bivariate probit estimates

	Pr(FDI SOUTH=1 I IO SOUTH=0)	Pr(IO SOUTH =1 I FDI SOUTH =0)	Pr(FDI SOUTH =1 & IO SOUTH =1)
$ULC_{2008-10}$	0.001	0.018	0.002
	(0.004)	(0.012)	(0.002)
$PACE_{2008-10}$	0.006	0.045***	0.006**
	(0.005)	(0.010)	(0.002)
ETS	-0.002	0.084**	0.006
	(0.008)	(0.029)	(0.004)
Area dummies	Yes	Yes	Yes
Size dummies	Yes	Yes	Yes
Low Tech	Yes	Yes	Yes
ρ=0.375***			

Notes cluster-robust (at 4 digit industry level) standard errors in parentheses. Cells report average marginal effects. All the estimates include also a constant term. $ULC_{2008-10}$ and $PACE_{2008-10}$ are standardized.
*** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Figure 1. Distribution of FDI and IO by area of destination