Outward Foreign Direct Investments Patterns of Italian Firms in the EU ETS*

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Abstract

We consider the role played by the EU Emission Trading System (EU ETS) as a possible driver of outward Foreign Direct Investments (FDI) for Italian manufacturing firms. Using a panel dataset of about 22,000 firms covering the first two phases of the EU ETS and the pre-EU ETS period, we measure the patterns of FDI towards countries not covered by EU ETS.

Results show that the EU ETS had a weak effect on the number of new subsidiaries abroad (extensive margin), while it had a larger impact on production taking place in foreign subsidiaries (intensive margin), especially in trade-intensive sectors.

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I. Introduction

In the last few years the European Emission Trading Scheme (EU ETS) has attracted much attention among scholars and policy-makers as it represents the central policy instrument adopted by the EU to mitigate climate change. The capacity of the EU to unilaterally develop the first transboundary system of emission trading has made the EU ETS a prototype for several other ETSs that are rapidly spreading around the world (Ellerman, 2010; ICAP, 2016).

However, the lack of an internationally coordinated environmental policy has raised increasing concerns about the potential competitiveness losses deriving from such a stringent unilateral environmental regulation. It has been argued that in the presence of global externalities, such as the ones generated by CO_2 emissions, unilateral environmental interventions may end up being not environmentally effective while generating negative socio-economic consequences in terms of job losses.

Some European production sectors are regarded as particularly vulnerable to the risk of carbon leakage, i.e. the delocalisation of production (and corresponding carbon emissions) of involved industries towards geographical areas with laxer environmental regulations. This issue has been recognised by the European Commission that exempted from the auctioning of emission allowances those sectors more exposed to the risk of leakage, at least for the second commitment period of the EU ETS (2013-2020).

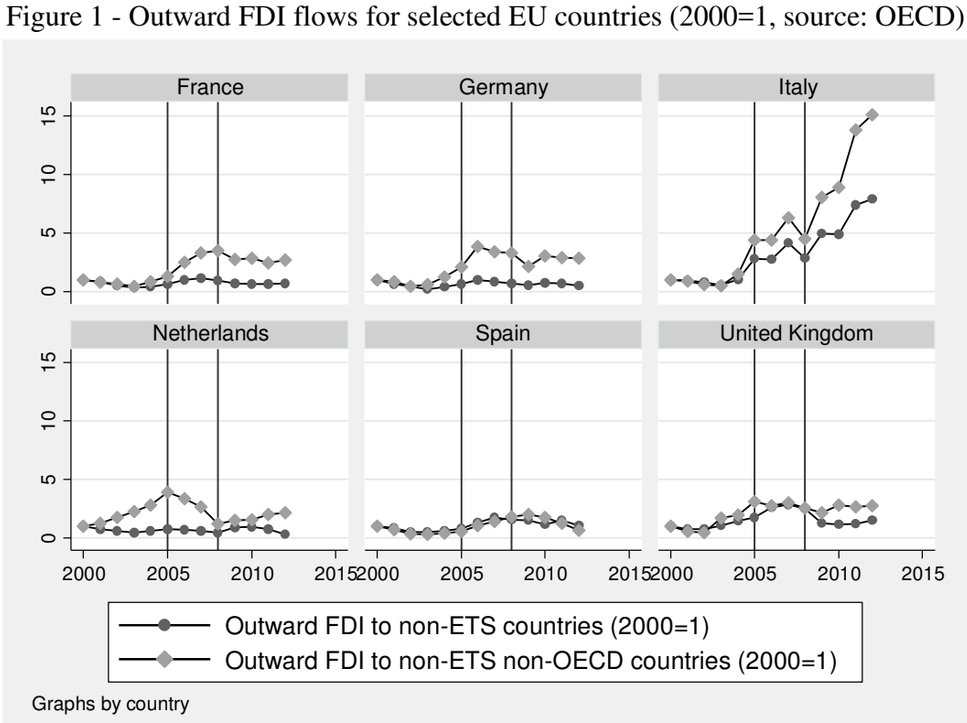
Surprisingly enough, however, this debate on the risks of carbon leakage lacks empirical evidence so far on whether the EU ETS can actually induce European firms to change their location, moving their production towards countries that are not subject to the EU ETS to avoid the need to comply with the regulation and the related costs. Our paper aims at closing this gap providing empirical evidence on this relevant issue.

The relocation risks caused by unilateral environmental regulation are the object of a long-standing and extensive theoretical and empirical literature (e.g. Hoel, 1991; Dean, 1992; Lucas et al., 1992; Motta and Thisse, 1994). One can distinguish two main research strands in this field: one on the so-called Pollution Haven Hypothesis (PHH) and the other on the Pollution Haven Effect (PHE). The former hypothesis argues that domestic regulatory stringency may trigger outward flows of FDI, while the latter claims that regulatory stringency 'at home' may negatively affect exports or inward flows of FDI. Both hypotheses have been investigated by several authors, mainly with respect to outward FDI from developed to developing countries, reaching contrasting results (see,

among the others, Hanna, 2010; Wagner and Timmins, 2009; Eskeland and Harrison, 2003). Although different types of environmental policies have been considered to assess the validity of the PHH, the role played by the EU ETS as a firm-level driver of outward FDI has not been examined so far, mainly due to the lack of available data.

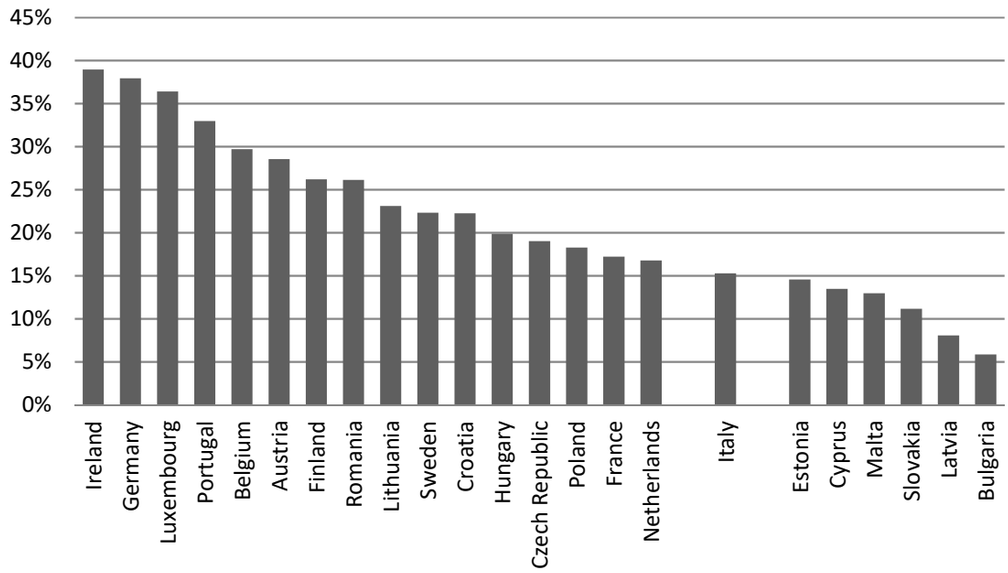
To overcome this limitation of the existing studies, the present paper contributes to the literature by providing an empirical investigation about the potential carbon leakage effects of the EU ETS for firms operating in Italy, one of the major countries subject to this regulation.[1] In our opinion, the Italian case is particularly interesting for several reasons: (i) Italy is one of the main emitters within the EU ETS, showing an active role within the EU ETS trade network (Borghesi and Flori, 2016); (ii) Italy has shown a fast increase in outward FDI in the last few years, particularly towards non-ETS non-OECD countries, above the average increase of other EU ETS countries (see Figure 1); (iii) Italy lags behind in terms of eco-innovation with respect to the other main EU economies, as confirmed by the comparison reported in Figure 2. Therefore, the implementation of the EU ETS might induce those Italian firms that are "at the margin" to relocate their production in non-EU ETS regions rather than to change their production activities (as in more technologically advanced countries).

Figure 1 - Outward FDI flows for selected EU countries (2000=1, source: OECD)



[1] For the period 2005-2012, Italian EU-ETS plants accounted for 9.5 percent of total EU-ETS plants, received 10 percent of overall emission allowances and have contributed to 10.3 percent of total CO_2 emissions.

Figure 2 - Share of manufacturing firms that introduced innovations that reduced their CO_2 footprint for selected EU countries (Community Innovation Survey 2006-2008, source: Eurostat)



In this paper we use administrative data on Italian manufacturing firms to identify the impact of the EU ETS on outward FDI employing matching techniques based on propensity score to construct a proper counterfactual. From the analysis performed in the paper, the first two phases of the EU ETS turn out to have a twofold effect on the FDI of Italian firms: they have a positive but weak effect on the number of new subsidiaries abroad (extensive margin), also when considering sectors exposed to carbon leakage, while they have a larger effect on the production occurring in foreign subsidiaries (intensive margin), especially in trade intensive sectors. This seems to suggest that Italian firms might have reacted to the EU ETS increasing their activities in existing foreign subsidiaries more than investing abroad through new subsidiaries.

To examine the issue described above, the paper is organized as follows. Section II provides a detailed description of the EU ETS. Section III reviews the related literature, devoting particular attention, within the vast PHH literature, to studies that are more specifically related to the EU ETS. Section IV describes the data and the empirical strategy adopted in the paper. Section V discusses the results of our empirical analysis. Section VI draws some concluding remarks that emerge from the analysis.

II. The EU ETS

The EU ETS was introduced by the Directive 2003/87/EC[2] as the pillar of the European climate change mitigation policy to reach the Kyoto targets and comply with other current and future regional or international targets. It is a cap-and-trade scheme for CO_2 in which emissions permits

[2] Amended by the Directives 2004/101/EC, 2008/101/EC and 2009/29/EC and by the Regulation 219/2009.

are allocated to the participants at the beginning of each period, either for free (grandfathering) or auctioned. At the end of each period participants are required to return an amount of emission permits corresponding to the actual amount of verified emissions. In the meantime, permits can be transferred between participants at a price per ton of CO_2 that, in equilibrium, should be equal to the marginal abatement cost, leading to efficient distribution of abatement across participants.[3] This type of regulation was set in place with a double objective: reducing the overall abatement costs of carbon emissions as well as providing the economic incentives to induce firms to develop low carbon technologies (Calel and Dechezleprêtre, 2016).

Three main periods can be identified. The period 2005-2007, in which the system was set up, represented a pilot phase (*Phase I*). The first commitment period (2008-2012, *Phase II*), leading to the Kyoto commitment period (2012), extended the scope of the scheme to aviation (2012). Finally, the second commitment period (2013-2020, *Phase III*) introduced a single EU-wide cap for total emissions and a rising use of auctioning in the allocation of the permits, with some exception for selected sectors.

The EU ETS covers now all EU28 countries plus Norway, Iceland and Lichtenstein. Being characterised by substantial sunk and fixed costs (including administrative and monitoring costs for participants and governments), the Commission decided to include in the scheme only the biggest emitters of CO_2. These emitters are identified by their sector of operation (or type of activity) and by the size of the plant in terms of production capacity. The scheme currently covers about 11,000 plants in Europe that contribute to around 45 percent of overall European GHG emissions[4]. The sectors and thresholds are reported in the Annex I of the Directive and have been amended twice since 2003.

The possible carbon leakage effect, that is, the phenomenon for which firms may relocate part of the production (and the corresponding CO_2 emissions) in countries where regulation is not in place, may hinder the policy environmental effectiveness of the regulation. The practice of exempting specific sectors from existing regulations is not uncommon: as Martin et al. (2014b) recall, since the introduction of carbon taxes back in the '90s, most of the countries involved granted some sort of exemptions to energy intensive firms to avoid their relocation.

[3] Within the EU ETS, the penalty for non-complying (i.e. not being able to return a sufficient number of emission permits at the end of the compliance period) was set equal to 40 euros per ton in the pilot phase (2005-2007) and to 100 euros per ton in the first commitment period (2008-2012).

[4] http://ec.europa.eu/clima/policies/ets/index_en.htm, last accessed: March 15, 2018.

In this light, a major amendment to the Directive concerned the differentiation of the allocation scheme across sectors for the second EU ETS commitment period (2013-2020) according to the criteria described in the new Articles 10 *bis* and 10 *ter* (Directive 2009/29/EC) to reduce the risk of leakage. The Decision of the European Commission 2010/2/EU provided a list of 4-digit NACE sectors for which permits could be grandfathered rather than auctioned also in the second commitment period (2013-2020) due to potentially relevant risks of off-shoring of these production activities caused by the EU ETS. Three main criteria were included in the amendment to identify the list of sectors to be exempted from auctioning. The first is a 'trade-based' criterion according to which industries (4-digit NACE) having a non-EU trade intensity (import plus export over domestic production) greater than 30% are exempted from auctioning (trade criterion). The second refers to those industries that are expected to experience additional (direct and indirect) costs because of the implementation of the ETS Directive greater than 30% of their gross value added (emission criterion). The third criterion involves industries having at the same time moderate trade intensity and implementation costs (trade intensity greater than 10% and ETS-related costs greater than 5% of gross value added).[5] This list was subsequently further amended to extend the exemption to other sectors.[6]

No exemption was in place in the period considered in our analysis. This means that we do not examine whether the exemption was successful in limiting the risk of carbon leakage, but rather whether outward FDI to unregulated countries were growing in these sectors due to the EU ETS even before the introduction of auctioning, so that their exemption from auctioning was ultimately justified.

The incentive to relocation deriving from the EU ETS can differ remarkably across regulated entities. In principle, the most efficient ones (i.e. those with low abatement costs) should have no incentive to offshore production since they can manage to sell their permits and thus gain from emission trading. The same applies to firms that receive allowances for free through grandfathering, at least as long as they are over-allocated (i.e. emit less than the permits at disposal).[7] However, even regulated entities that receive permits for free might consider moving

[5] A fourth criterion refers to a qualitative assessment (Art. 10bis.17) of the likely impact of the EU ETS on production costs, investments and profit margins. All these criteria are thoroughly discussed in the following document: http://ec.europa.eu/clima/policies/ets/cap/leakage/documentation_en.htm

[6] Decision of the European Commission 2012/498/EU.

[7] To reduce overallocation the Directive 2009/29/EC introduced an ex-post allocation adjustment in the following cases: if annual output falls below 50%, 25% or 10% of the historical level, the amount of already allocated allowances is reduced by 50%, 75% and 100%, respectively. Before the introduction of these rules, firms received more free permits, therefore they had a lower incentive to offshore. It could be argued that free allocations do not change

abroad if they expect that allocated allowances will progressively decrease over time, as planned by the EU. Moreover, to properly assess the costs imposed by the EU ETS on regulated firms one should consider not only the costs of purchasing emission allowances but also the organizational changes faced by the firms to adapt to the EU ETS such as the creation of firms' units specifically devoted to the ETS, as well as the monitoring, reporting and verification costs related to the ETS (Jaraitė et al., 2010; Joas and Flachsland, 2016). As pointed out by previous studies (Borghesi et al., 2015), the additional costs in terms of bureaucracy and human resources required by the EU ETS may be perceived as particularly burdensome especially in countries like Italy that already has a high number of administrative regulations, leading firms that have little profit margins to move abroad towards countries that do not have such a regulation.

Figure 3 - Allocation in the EU ETS (Italian manufacturing establishments in the EU ETS)

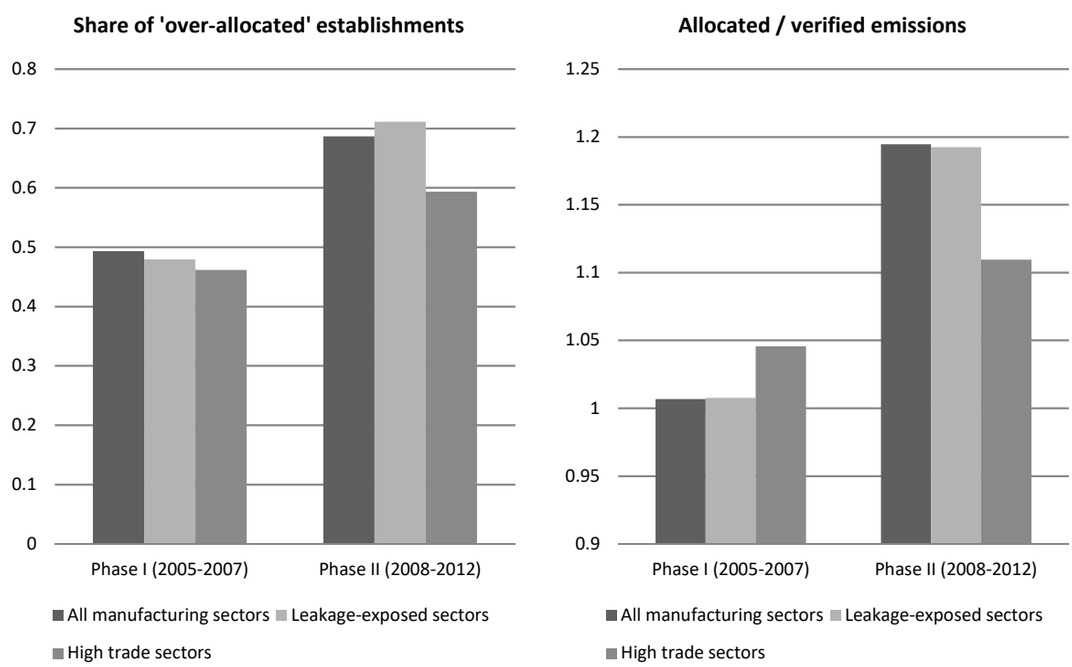


Figure 3 provides an overview of the Italian ETS firms in the manufacturing sector comparing allocated allowances and verified emissions by different sectors. Large differences emerge across the sectors at risk of carbon leakage and therefore exempted from the auctioning of allowances: in particular, in high-trade sectors the share of over-allocated installations was systematically lower than in all manufacturing sectors as well as in the other leakage-exposed sectors.

incentives to offshore at the margin (since they imply an opportunity cost), therefore the allocation method (grandfathering or auctioning) does not affect operational decisions in the short run. However, the allocation method may affect investment decisions (like those concerning offshoring) in the long run. The interested reader may refer to Flues and van Dender (2017) for an in-depth discussion of this aspect.

III. Literature review

Our paper relates to the literature on two separate but intertwined strands of research: on the one hand the literature on the drivers of FDI and in particular on the so-called Pollution Haven Hypothesis (PHH), on the other hand the literature that examines the economic impact of the EU ETS.

Many studies have examined the determinants of FDI (see, e.g. Faeth, 2009 and Blonigen and Piger, 2014 for exhaustive surveys on this issue). The literature has found that a combination of ownership and location advantages (e.g. technology intensity, firm size, productivity, market size, transport costs and trade barriers) as well as policy variables (e.g. fiscal and financial incentives) contribute to explain FDI. Therefore, firms' variables and specific characteristics of the home/host countries are often adopted to identify the firms that are more likely to delocalize their production. While a consensus has not been reached on the use and measurement of the different explanatory variables, there exists a large consensus in the literature on the existence of a few key motivations driving investment decisions (Dunning, 1993), that can be broadly summarised in the following categories: a) resource seeking, i.e. the availability of abundant low price production factors such as cheap natural resources and inexpensive labour; b) market seeking, i.e. the possibility to access to host countries' markets for processed goods; c) efficiency seeking, i.e. seeking the efficiency in the use of resources through the rationalization of production and product/process specialization; d) strategic asset seeking, i.e. linking the company to foreign networks of created assets, such as technology, organizational capabilities and markets.

Within the literature on the resource seeking motivation, there is a long-lasting and heated debate on the PHH, which dates back to the early 1990s when some seminal contributions on this issue first appeared (e.g. Lucas et al., 1992; Copeland and Taylor, 1994; Markusen et al. 1993; Chichilnisky 1994; Motta and Thisse 1994).[8] The Pollution Haven Hypothesis (PHH) predicts that multinationals will shift their production to countries with laxer environmental standards and regulations. This claim has been investigated both from a theoretical and empirical point of view. Among the theoretical contributions in this field, many early studies (Baumol and Oates, 1975, 1988; Oates and Schwab, 1988; Hillman and Ursprung, 1992, 1993; Rauscher, 1995; Fredriksson, 1997, 1999; Cole et al., 2006) emphasised the existence of a possible comparative advantage of

[8] See Dean (1992, 2001), Jaffe et al. (1995), Copeland and Taylor (2004), Brunnermeier and Levinson (2004), Erdogan (2014) for surveys of the literatures on the PHH.

developing countries in producing pollution-intensive goods, thus attracting FDI from developed countries. This theoretical advantage, although intuitively appealing, has found little or no empirical support over the last three decades. On the contrary, most studies agree that environmental compliance costs are not a main concern that induces firms to relocate their production and that other factors generally have a more important influence on investment decisions (e.g. institutional and legal contexts, corruption, the technological gap, the level of human capital and the development of financial markets in the host economies, etc.). As Eskeland and Harrison (2003) have pointed out, the impact of environmental regulation on investment and output is theoretically ambiguous and can only be resolved through appropriate empirical analyses. However, even the empirical literature has reached ambiguous and sometimes conflicting results suggesting that the debate is far from over (Taylor, 2005).

In his survey of the literature, Erdogan (2014) emphasises that studies carried out until the beginning of the '90s did not find any relevant effect of environmental regulations on FDI (e.g. Dean, 1992; Levinson, 1996). In his opinion, the main reason is that the amount of FDI flows started to rise after that period. As the author shows, however, even later studies (performed after the 2000s) find no univocal results and highlight only a weak evidence of PHH. The high heterogeneity of results is probably due to the different types of proxies that have been used to account for the regulations and to the countries being analysed. However, Levinson (2008) argues that it might also reflect differences in the estimation approach. In this regard, he distinguishes the literature on the PHH between first-generation studies, largely based on cross-sectional analyses, and second-generation studies, that generally adopt a panel approach. While the former finds no evidence of PHH, a few studies among the latter tend to support the PHH. According to Millimet and Roy (2016), this difference in the results mainly depends on the way environmental regulation is treated in the analyses: most of the studies (that do not support the PHH) take environmental regulation as exogenous while in reality it may be correlated with unobserved determinants of the location choice. Using novel identification strategies to account for the possible endogeneity of environmental regulation, the authors find it to be negatively correlated with inward FDI.

The present paper intends to provide new evidence on the lively debate on the PHH by looking at a specific environmental regulation, the EU ETS, that is particularly relevant for several reasons: (i) in policy terms, it represents the first international carbon market and the prototype for all the others ETSs that have been rapidly spreading at the world level (ICAP, 2016), and (ii) from the

methodological viewpoint, the EU ETS can be viewed as an exogenous environmental regulation, therefore providing an interesting instrument to test the PHH that can help overcome the endogeneity issue described above.[9]

EU ETS and carbon leakage

Our paper contributes to the still growing literature on the impact of the EU ETS. As Martin et al. (2016) point out in their survey, most of the literature so far focused on three different though related impacts of the EU ETS: on technological innovation, emissions abatement and firms' economic performance.

With respect to other measures of competitiveness such as international trade or foreign direct investments (the object of our analysis) very scarce empirical evidence is present in the literature. Focusing on the impact of Phase I on EU15 countries, Costantini and Mazzanti (2012) estimate that at the sectoral level, the EU ETS acted as deterrent of exports in all industries except for medium-low technology industries. Reinaud (2008) focuses instead on imports of aluminium in the EU27 countries and finds no evidence of any structural break between the periods before and after the implementation of the EU ETS.

Most of the papers in this research strand do not examine the impact on foreign subsidiaries of EU ETS firms, as our paper does. A relevant exception in this sense is represented by Martin et al. (2014a). Using survey data on more than 700 firms spread over 6 countries, the authors propose an innovative measure of perceived risk of carbon leakage based on managers' interviews. Then, they analyse the correlation between this measure and the criteria adopted by the EU to exempt from permit auctions the sectors at risk of relocation, namely, carbon intensity and trade exposure, finding that the former criterion is highly correlated to carbon leakage perceived risk whereas the latter is not. This leads them to propose two main modifications of the current exemption criteria: (i) to consider a sector at risk of carbon leakage only if it is both trade intensive and carbon intensive and (ii) to adopt a more specific measure of trade intensity that focuses on trade with less developed countries rather than all non-EU countries.

The EU ETS exemption criteria is also the object of a companion paper by Martin et al. (2014b) in which the authors formalise the theoretical framework for efficient compensation of industries at risk of relocation. Their work shows that compensation should not go to firms that have the highest

[9] It could be argued that EU ETS may be partially endogenous due to different monitoring and enforcement efforts across participating countries. It is necessary, therefore, to account for the country's idiosyncratic features that may affect these aspects. We thank an anonymous reviewer for pointing this out.

propensity to relocate but rather to those that ensure the highest marginal improvement of the government's objective function. From the application of the proposed industry compensation scheme to the EU ETS, the authors conclude that the exemption criteria adopted by the EU lead to inefficient allocations.

More recently, Dechezleprêtre et al. (2015) examine the carbon leakage effect from the point of view of multinational firms using a sample of 1785 multinational companies over the period 2007-2014. The originality of their contribution is that of studying whether the EU ETS may influence the relocation of CO_2 emissions within a multinational firm, by comparing emissions in Europe and outside Europe by the same company. Their hypothesis is that since these firms operate across different countries they might escape compliance costs by shifting their production to less regulated jurisdictions. The authors, however, find no evidence of any carbon leakage effect in general, and the same applies with respect to those sectors deemed at risk of carbon leakage.

Similar results derive from Koch and Basse Mama (2016) who study the causal effects of the EU ETS on outward FDI of German multinationals. Using a difference-in-differences with bias-corrected matching estimator, the authors find that only a small subset of firms significantly increased their FDI out of Europe compared to a counterfactual scenario. Such firms, however, do not belong to the sectors at risk of relocation according to the EU criteria, but rather to sectors that are less-capital intensive and therefore more geographically mobile.

As emerges from this survey of the literature, most of the existing studies cast doubts on the possibility that the EU ETS may induce regulated firms to relocate their activity through FDI and on the validity of the exemption criteria adopted by the EU for sectors at risk of relocation.

The present paper differs from previous studies in this research area in several respects: (i) rather than using managers' surveys, it exploits administrative data on FDI (from AIDA, Bureau van Dijk) and environmental regulation (the Union Registry of the EU ETS); (ii) it examines both the extensive and intensive margins of FDI; and (iii) it finds a differentiated impact of the EU ETS on these two dimensions of FDI: Italian regulated firms (especially in trade-exposed sectors) reacted to the EU ETS by increasing the sales of their subsidiaries in non-EU ETS countries more than the number of subsidiaries.

IV. Empirical framework

Data and variables

Our empirical analysis is based on a set of administrative data. We retrieved information on balance sheet, profit and loss account, age, region and industry for a large balanced sample of about 22 thousand Italian manufacturing firms with at least 20 employees from the AIDA (Bureau van Dijk) database.[10] Following Martin et al (2014b), we focus on the manufacturing sector since it is largely mobile across countries as compared to other emission intensive sectors such as the mining and quarrying sector (in which firms need to locate close to the extraction site).[11]

As to the construction of the dependent variables, the AIDA database provides only the latest available information about proprietary structure and subsidiaries, with some lag. Given that in each release of the AIDA database information refers to several different years,[12] the assessment of the annual number of subsidiaries and of the value of these subsidiaries is rather problematic. We thus decided to measure the number of subsidiaries and the sales generated by these subsidiaries (weighted by the ownership share) for three time windows: 2002-2004 (pre-ETS), 2005-2007 (*Phase I*) and 2008-2010 (*Phase II*).[13] These variables refer both to the extensive margin (number of subsidiaries) and the intensive margin (sales of these subsidiaries) of outward FDI and proxy the stock of both brownfield and greenfield FDI. We selected only industrial subsidiaries and use 10 percent of ownership as the threshold to consider the participation as an actual subsidiary.[14] We split the count of subsidiaries and the corresponding sales according to the country of destination of the FDI. In particular, we identify foreign subsidiaries located in countries that are not subject to the EU ETS. It can happen, however, that a destination country outside the EU ETS is characterized by environmental regulations that are, on average, more stringent than home (i.e. Italian) regulations. Think, for instance, of environmental regulations in some OECD countries

[10] AIDA collects information on medium-big Italian corporations. Missing information about 4-digit Nace sector and employment for some of the firms in the AIDA database has been retrieved from the ASIA (Archivio Statistico delle Imprese Attive) database (National Institute of Statistics, Istat).

[11] Some sectors included in the manufacturing sector (e.g. cement production) might have low mobility due to high transportation costs. Cement producers, however, represent a very limited share of all Italian manufacturing firms and of the sample examined here (9 out of 283 ETS firms), therefore their role is unlikely to affect results emerging from the analysis.

[12] For instance, the AIDA release of March 2011 reports information on subsidiaries ranging from 2007 to 2011, 64 percent of which refers to 2009.

[13] We complement the partially missing information on sales of foreign subsidiaries in AIDA with the correspondent information as reported in the AMADEUS database (Bureau van Dijk) by linking the identifier of the subsidiary reported in AIDA with the firm identifier in AMADEUS.

[14] The 10 percent threshold is the one suggested by the OECD to identify a Direct Investment Enterprise, see https://stats.oecd.org/glossary/detail.asp?ID=622. As a robustness check, in the web Appendix D we report results obtained increasing the threshold to 20 percent of direct or indirect ownership.

outside the EU ETS that in many cases have their own ETS or other carbon pricing policies.[15] In this case, a firm would prefer to comply with the EU ETS at home rather than with more stringent environmental regulations abroad. For this reason, we also compute the number of foreign subsidiaries and the corresponding sales in non-EU ETS countries that do not belong to the OECD, implicitly assuming that environmental regulation in non-EU ETS non-OECD countries is systematically less stringent than in EU ETS and/or OECD countries.[16]

We identified Italian firms that own plants covered by the EU ETS by matching unique identifiers (when available) and firm names in the Union Registry of the EU ETS with the name and unique identifier in AIDA. We examine a total of 283 manufacturing firms with at least one plant subject to the EU ETS.[17]

In line with the discussion in the first part of the paper, we split our overall sample into various subsamples to account for the different risk of carbon leakage. The first sample includes the whole manufacturing sector ('*All sectors*'). The second sample includes only firms belonging to the subset of manufacturing sectors, defined at the 4-digit NACE level, that are deemed to be exposed to significant risk of carbon leakage according to any of the criteria discussed in section II ('*Leakage-exposed sectors*'). The third sample refers to firms within the latter group belonging to trade-intensive sectors as defined in section II ('*High-trade sectors*'). The last sample includes firms in manufacturing sectors that are either trade-intensive or jointly moderately trade intensive (the share between extra-EU trade - import and export - and EU production is larger than 10 percent) and moderately emission intensive (the supposed cost to comply with the EU ETS is larger than 5 percent of the sector's gross value added) ('*Medium-high trade sectors*').[18]

Descriptive statistics of our variables of interest are reported in Table A1 (Appendix A), separately for ETS and non-ETS firms.[19] As clearly emerges from the table, the group of ETS firms differs

[15] The countries that belong to the OECD but are not within the framework of the EU-ETS are: Australia, Canada, Chile, Israel, Japan, Korea, Mexico, New Zealand, Switzerland, Turkey and the US.

[16] As a robustness check, we also employ a more direct measure of environmental regulatory stringency from the World Economic Forum to identify low-stringency destination countries. See web Appendix D.

[17] Overall, these firms own 581 of the 757 Italian manufacturing EU-ETS plants (76.8 percent), that account for 90.1 percent of CO_2 emissions from Italian manufacturing EU-ETS plants over the period 2005-2012. The matching is done by using the unique identifier of firms. For those EU-ETS plants for which the unique identifier was not available in the ETS registry, we matched on the name of the firm. ETS plants that were not matched belong to firms that contain some missing values in our variables of interest or that are not in the AIDA database. If also these firms performed FDI, this implies that the results found in our analysis might actually underestimate the true FDI effect of the EU-ETS.

[18] We do not evaluate separately those EU-ETS firms that operate in sectors that are exempted only because emission intensive (expected cost of the EU ETS greater than 30 percent of sector's gross value added) as the sample size of the treatment group would have been too small (17 firms).

[19] To simplify the notation, in what follows we will denote with [non-]ETS firms (countries) the companies (countries) that are [not] subject to the EU ETS.

from the one of non-ETS firms in basically all respects, which calls for a strategy to identify a more suitable counterfactual group to investigate the impact of the ETS on outward FDI of Italian firms.

Empirical strategy

The identification of plants that have to comply with the EU ETS (i.e. assignment to treatment) is not random but depends on a series of plant's features, namely, its sector of operation and its production capacity (sector-specific). This makes the identification of a suitable control group problematic. Matching at the plant level is not possible, because if two plants operate in the same sector and are similar in size, they should be either (both) covered by the EU ETS or (both) exempted from it. As discussed by Calel and Dechezleprêtre (2016) in their analysis about ETS-induced clean patents, while no credible matching is possible between treated and non-treated ETS plants, when moving to company-level analysis a 'matching' approach turns out to be a suitable route. Indeed, the EU ETS regulation is implemented applying inclusion criteria to installations rather than companies. It follows that while regulated installations systematically differ from unregulated ones, ETS firms may be similar to non-ETS firms in all respects (e.g. available resources, input prices, market conditions, regulations), apart from the size of each installation.[20]

Table A2 in Appendix A shows the distribution of firms across industries, regions, size classes and EU ETS status for our sample of firms. Considering the whole sample, the share of firms that own plants subject to the EU ETS is quite low (1.27%). These firms tend to be concentrated in three main sectors: manufacturing of food products, beverages and tobacco, manufacturing of pulp, paper and paper products and manufacturing of other non-metallic mineral products, which jointly account for about 60 percent of EU ETS firms. As expected, big firms (more than 250 employees) tend to be over-represented: 11 percent of big firms own plants subject to the EU ETS, as compared to only 0.37 percent of small firms. Finally, when looking at the geographical distribution of the Italian EU ETS firms, no apparent difference emerges between North, Centre and South in relative terms (i.e. as a share of total firms in each macro-region). As we will discuss hereafter, EU ETS firms differ substantially from other manufacturing firms in many other respects, which motivates the need to identify a proper counterfactual by means of matching techniques.

[20] The EU-ETS treatment is assigned to plants based on a continuous measure of installed production capacity. However, we cannot exploit the discontinuity around the threshold and estimate the treatment effect with a regression discontinuity design as this would require knowing the exact value of the production capacity for each treated and untreated plant. This information, as well as any other good proxy for plant-level production capacity, is not available.

To account for and limit these systematic differences, we estimate the propensity score which represents the probability of being selected in the treatment group according to some firm's characteristics. The estimation of the propensity score needs to include those variables that are expected to be correlated with the probability of being selected as a treated unit and, at the same time, with the outcome variable. Among the determinants of treatment, we include a series of industry dummies (2-digit NACE rev 1.1) as only plants that operate in certain industries or use certain production processes are required to participate in the EU ETS. Another important determinant of the treatment status is given by the size of the plant, in terms of production capacity. As we have no information on plant-level (or firm-level) production capacity, we use three different proxy variables (all in log) to account for firm size: number of employees in 2002 (also squared to account for possible non-linearities), stock of fixed physical capital per employee in 2002 and value of total (fixed and current) assets in 2002. Moreover, we include age to control for the fact that older firms were already on the market (with a given production capacity) even before the EU ETS Directive was approved. To account for differences in firm's growth, we include the growth rate of firm-level employment between 2002 and 2004. From Table A1, we observe that sales of ETS firms were higher on average than those of non-ETS firms. This difference in levels might reflect different trends (e.g. demand shocks) in the countries where ETS and non-ETS firms were present before the implementation of the policy. To account for this aspect and make sure that it does not drive our results, we include among the covariates in the propensity score the average country-specific GDP growth rate over the years 2000-2010 (taken from World Bank data) weighted by the number of subsidiaries owned by the firm in each country in 2002-2004 (before the EU ETS was implemented). As Table A1 shows, ETS firms were actually located in more fast-growing host countries than non-ETS firms (the average growth rate of the host countries being 7 per cent versus 2 per cent). Finally, we include as further covariates in the estimation of the propensity score the count of subsidiaries in non-ETS countries as well as the count of subsidiaries in ETS countries over the period 2002-2004. In this way, we aim at balancing the pre-treatment level in the outcome variables. Results of the estimation of the propensity score are reported, split by sample, in Table 1.

In line with expectations, firm's assignment to the ETS is positively correlated with all the different dimensions of firm size: physical fixed capital stock per employee, total assets and employment (though the latter is not statistically significant). Results are similar across different samples in

terms of statistical significance. Conditional on sector and size, all the other variables (except firm size in medium-high trade intensive sectors) turn out to be statistically non-significant in explaining ETS assignment.

Table 1 - Propensity score

	All sectors	Leakage-exposed sectors	High-trade sectors	Medium-high trade sectors
Subs in ETS countries (2002-2004)	-0.275	-0.218	-0.397	-0.156
	(0.193)	(0.233)	(0.279)	(0.248)
Subs in non-ETS countries (2002-2004)	0.149	0.0644	0.151	0.146
	(0.166)	(0.205)	(0.286)	(0.222)
GDP growth 2000-2010 in host countries	-0.463	-0.408	-0.0459	-0.245
	(0.603)	(0.714)	(0.890)	(0.760)
Age	0.00257	-0.000619	0.000338	-0.00336
	(0.00175)	(0.00207)	(0.00337)	(0.00254)
log(Capital stock per employee) (2002)	0.460***	0.450***	0.460***	0.439***
	(0.0539)	(0.0617)	(0.0947)	(0.0695)
log(Assets) (2002)	0.150**	0.0905	0.378***	0.163**
	(0.0596)	(0.0673)	(0.123)	(0.0785)
log(Employment) (2002)	0.143	0.193	0.0161	0.203
	(0.185)	(0.225)	(0.368)	(0.258)
log(Employment) squared (2002)	0.0259	0.0256	0.0279	0.0216
	(0.0167)	(0.0205)	(0.0312)	(0.0231)
Growth empl 2002-2004	0.190	0.248	0.411*	0.286*
	(0.139)	(0.154)	(0.210)	(0.167)
Pseudo R sq	0.426	0.456	0.528	0.502
Chi sq	1289.4	1050.3	519.7	949.8
N	22144	11779	9178	10449
N of treated firms	283	235	87	189
N of unmatched treated firm	22	17	11	15

Probit estimator for the time window 2002-2004. Dependent variable: ETS dummy. Standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Sector dummies (2-digit NACE rev 1.1) are included.

In addition to considering the propensity score in matching treated firms to suitable control firms, we also force the latter to belong to the same sector (2-digit NACE) of the former.[21] Exact matching on the sector allows to compare treated and untreated firms that presumably operate in the same markets for their final good and their intermediate inputs, that are exposed to the same sector-specific environmental and non-environmental regulation and that have similar conditions in terms of openness to trade and FDI. Among the different possible matching algorithms, we employ the nearest neighbours (up to 10 neighbours) matching with caliper (5 percent) as our favourite approach (see also Marin et al. 2017).[22] Selecting more than one nearest neighbour increases the efficiency of the estimates (Caliendo and Kopeinig, 2008). Moreover, the fact of conditioning control firms to be within a certain 'radius' (i.e. the caliper) also excludes potential controls that are too different from our set of treated firms, thus reducing the bias. As reported in Table 1, this

[21] As a robustness check, reported in the web Appendix D, we also match on 3-digit NACE sectors. While this allows to match treated firms to control firms within more homogeneous and narrowly defined sectors, the drawback is that no suitable control firm can be found for a very large number of ETS firms within such sectors. More details are discussed in the web Appendix D. Results based on the exact matching on 3-digit NACE sectors generally confirm our baseline results, even though coefficients are less precisely estimated.

[22] In the web Appendix D results based on kernel matching are also reported as a further robustness check, which confirm our baseline results.

happens for a relatively small number of ETS firms (22 in the full sample), for which no suitable match was found within the caliper. Following the approach of Calel and Dechezleprêtre (2016), we excluded from the analysis those EU ETS firms for which no match was possible since even the nearest neighbour was too far (i.e. outside the caliper) in terms of propensity score.

Table 2 - Balancing of the matching (all sectors, 10 nearest neighbours with 5 percent caliper and exact matching on 2-digit NACE)

Matching variables	**Matched**	**Treated**	**Control**	**t-test**	**p-value**
Subs in ETS countries (2002-2004)	Unmatched	0.2544	0.0656	12.58	0.000
	Matched	0.2107	0.2472	-0.99	0.322
Subs in non-ETS countries (2002-2004)	Unmatched	0.2085	0.0422	13.56	0.000
	Matched	0.1647	0.2128	-1.40	0.161
GDP growth 2000-2010 in host countries	Unmatched	0.0715	0.0209	10.22	0.000
	Matched	0.0608	0.0710	-0.95	0.345
Age	Unmatched	29.343	21.403	9.23	0.000
	Matched	28.943	28.928	0.01	0.994
log(Capital stock per employee)	Unmatched	12.135	10.742	21.68	0.000
	Matched	12.095	12.021	1.05	0.296
log(Assets)	Unmatched	18.143	15.713	32.90	0.000
	Matched	17.916	17.950	-0.25	0.805
log(Employment)	Unmatched	5.372	3.848	32.19	0.000
	Matched	5.160	5.221	-0.53	0.595
Growth empl 2002-2004	Unmatched	-0.0002	-0.0183	1.11	0.268
	Matched	0.0015	0.0117	-0.44	0.659
Sample	**Ps R2**	**LR chi2**	**p>chi2**		
Unmatched	0.426	1289.42	0.000		
Matched	0.012	8.50	1.000		
Other variables	**Matched**	**Treated**	**Control**	**t-test**	**p-value**
log(Sales)	Unmatched	17.799	17.320	4.96	0.000
	Matched	17.799	17.866	-0.50	0.620
log(Value added per employee)	Unmatched	11.200	11.073	3.17	0.002
	Matched	11.200	11.208	-0.13	0.894
log(Wage)	Unmatched	10.562	10.498	2.20	0.028
	Matched	10.562	10.582	-0.51	0.613

As it is visible from Table 2, after matching EU ETS firms with similar firms in the same sector with no plant covered by the EU ETS, we obtain a much more credible counterfactual. EU ETS firms were significantly different from non-ETS, before matching, in all the dimensions considered here. They were significantly older (8 years), significantly bigger in terms of number of employees (3.6 times), total assets (10 times) and fixed physical capital per employee (3 times), and with more subsidiaries both in ETS and non-ETS countries.[23] Matching based on the propensity score allows selecting a sample of non-ETS firms to be used as counterfactual that is similar in all respects to the sample of ETS firms in the pre-treatment period. The comparison between ETS and matched non-ETS firms indicates that the two samples are, on average, not different in any dimension. As balancing of variables that are included in the estimation of the propensity score is somewhat tautological, we examine whether matching also allows to balance the average differences between treated and control firms for variables that were not included in the estimation of the propensity

[23] Results for the other three subsamples are reported in Tables C1, C2 and C3 in the web Appendix C and are not different from the ones discussed for the full sample.

score. In the bottom part of Table 2 we report results for sales, labour productivity (value added per employee) and average wage. Differences were statistically significant for all these variables before matching, but disappeared after matching. In addition to differences in the level of firm characteristics, it would be useful to evaluate differences in pre-treatment trends between treated and control groups in our dependent variables. As we cannot measure yearly variation in FDI and we cannot obtain pre-2002 information on this dimension, we examine differences in pre-treatment trends for selected variables that are expected to be correlated with outward FDI: firm sales, number of employees and value of fixed financial assets. Results are reported in Appendix B. Treated and matched untreated firms show similar (not statistically different) pre-treatment trends.

In the analysis that follows we run regressions on samples that only include treated and matched firms (weighted by their contribution to the control sample).[24] To examine the impact of the EU ETS on FDI we estimate the following 'difference-in-differences' equation:

$$FDI_{i,t} = \alpha ETS_i + \beta_t D_t + \gamma_t ETS_i D_t + X'_{i,t}\delta + \varepsilon_{i,t} \qquad (1)$$

where $FDI_{i,t}$ is our dependent variable, that is the number of foreign subsidiaries in non-ETS countries or the sales by these subsidiaries of firm i in period t, ETS_i is a time invariant dummy variable taking the value of 1 for those firms i with at least one facility covered by the EU ETS and 0 otherwise, D_t is a time dummy, $X'_{i,t}$ is a set of control variables and $\varepsilon_{i,t}$ is the error term. Our parameters of interest are γ_t, with t=2005-2007 for the assessment of the effect of the pilot phase of the EU ETS and t=2008-2010 for the effect of the first commitment period of the EU ETS.

As dependent variables we consider both the extensive margin (count of subsidiaries) and the intensive margin (sales of subsidiaries) of FDI. These two dimensions can provide complementary information: while the extensive margin accounts for the fixed set-up costs related to the acquisition or construction of a new plant, the intensive margin captures the variable costs related to the higher business activities taking place inside the affiliates. We introduce a set of control variables in levels as well as interacted with a linear trend in the difference-in-differences estimates to account for the effect of these variables on the trend of our dependent variables. As firm-level control variables we include firm-level average wage per employee (in log), labour productivity (value added per employee, in log), size (number of employees, in log) and capital intensity (physical fixed capital

[24] If a treated firm is matched with 10 non-treated firms (and these are not matched with other treated firms), then we assign a unitary weight to the treated firm and a 1/10 weight to each of the control firms. Similarly, if only 9 non-treated firms are matched (because the potential tenth firm is out of the interval as defined by the caliper), each of the untreated firms is weighted 1/9.

stock per employee). All these variables are included in the regression as proxy for firm-level determinants of FDI.[25]

Moreover, we account for the possibility that firms take their FDI-related decisions based on aspects that are external to the firm such as the business environment in the home country/region. We employ two distinct variables as proxies for the quality of the business environment. The first variable measures the efficiency of the Italian judicial system to settle business-related lawsuits. We measure this (in)efficiency as the average length (in days) to conclude a bankruptcy by the provincial (NUTS3) court (source: Istat).[26] The second variable is an index of corruption at the provincial (NUTS3) level developed by Nifo and Vecchione (2014).

We also account in a flexible way for region-specific characteristics and shocks by including time-specific region dummies (NUTS2). This flexible control for region-specific unobserved shocks is particularly important in our case as the last period of the analysis (2008-2010) coincides with the beginning of the recession, during which the Italian GDP experienced a substantial (though not homogeneous) decrease: between 2008 and 2009, GDP decreased on average by 3.6 percent, ranging from a drop of 1.2 percent for Trentino Alto Adige to a drop of 6.5 percent for Piemonte.

In theory, a multinational firm might react to the EU ETS by shifting production from its Italian subsidiaries to other subsidiaries located elsewhere and/or opening up new subsidiaries in non-ETS countries. Unfortunately, the data at disposal do not allow us to trace companies and see whether the head of group opened up a new subsidiary somewhere else. Therefore, the observed impact of the EU ETS on FDI might actually be underestimated. However, to account for this possibility, we include three dummy variables (and their interaction with the time trend) to distinguish where the head of group, if any, is located (Italy, other EU ETS country or non-ETS country). This allows to account for the possibility that firms belonging to (different types of) groups may have different levels and trends of outward FDI.[27]

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[25] Notice that the control variables used in the matching are used here to improve the precision of the estimates and adjust for residual imbalances. Furthermore, their introduction allows to capture the effect of these variables on the trend of the dependent variables.

[26] Italian provinces show a substantial degree of heterogeneity in this variable, with trials' length ranging between 1601 days and 5687 days.

[27] To make sure that our estimations capture actual offshoring and are not driven by FDI in other sectors, one should ideally restrict the analysis to subsidiaries operating in the same sector as their mother company. Unfortunately, this information is missing in AIDA and even using other datasets (Orbis and Amadeus) we could find it for only 15% of all subsidiaries. Focusing on this small subset, we observe that most subsidiaries belong to the same sector of the mother company. In particular, only 2.6% of the subsidiaries of ETS firms in non-ETS countries belong to sectors (at 2-digit level) that are different from the sector of the mother company (corresponding to 0.86% of the overall sales of the subsidiaries in non-ETS countries). Our database, moreover, includes only industrial subsidiaries of industrial firms, which are generally less prone to change sector as compared to, say, financial and commercial subsidiaries.

Finally, we include a dummy variable that indicates whether the firm already had a subsidiary in the pre-treatment period (2002-2004), to account for the pre-existing knowledge of foreign markets by the firm.

As our firm-level control variables (size, capital intensity, wages, productivity, part of group) are likely to be influenced themselves by the EU ETS (Martin et al., 2016), they were likely to be 'bad controls' in our equation as they would have incorporated some of the effects of the EU ETS on FDI (Angrist and Pischke, 2009). For this reason, we include in the regression our firm-level control variables measured in the pre-treatment time window, to account for systematic time-invariant differences in FDI across firms, as well as the interaction term between the pre-treatment value of the variable and a time trend to account for possible differences in the trend of FDI for different initial firm-level characteristics. We follow the same approach for the time-invariant variable that measures GDP growth in host countries.

Both our dependent variables, that is, the count of subsidiaries in non-ETS countries and the sales of subsidiaries in the same set of countries, take only non-negative values, with zero being a potential (and frequent) outcome.[28] To account for this possibility, we estimate equation (1) with the Poisson pseudo-maximum likelihood (PPML) estimator. As discussed in Santos Silva and Tenreyro (2006), the PPML estimator provides a natural way to deal with zero values of the dependent variable and consistently estimates the conditional mean of the dependent variable (that does not necessarily need to be a count variable) in presence of heteroskedasticity. Finally, we cluster standard errors at the firm level to allow for potential correlation of errors within the firm.[29]

V. Results

Before discussing the results of our econometric analysis, it is important to examine what was the relevance of foreign activity by ETS firms and the evolution of the number of subsidiaries and the corresponding sales in the period under consideration, compared to the firms that were selected as counterfactual.

[28] It could happen that some of the zeros of our dependent variables are missing values (incidental truncation) and not actual 'zeros'. This could give rise to a selection bias if the incidental truncation is not random. It should be noted, however, that as long as selection is governed by firm-specific time invariant firm characteristics, our difference-in-differences estimate is robust to selection bias.

[29] Although the precision is slightly reduced, similar results apply when we cluster standard errors on sector by time to account for shocks that hit all firms within a sector in a similar way (see correspondent results in the web Appendix D, Tables D11 and D12).

Figure 4 - Share of subsidiaries in non-ETS countries

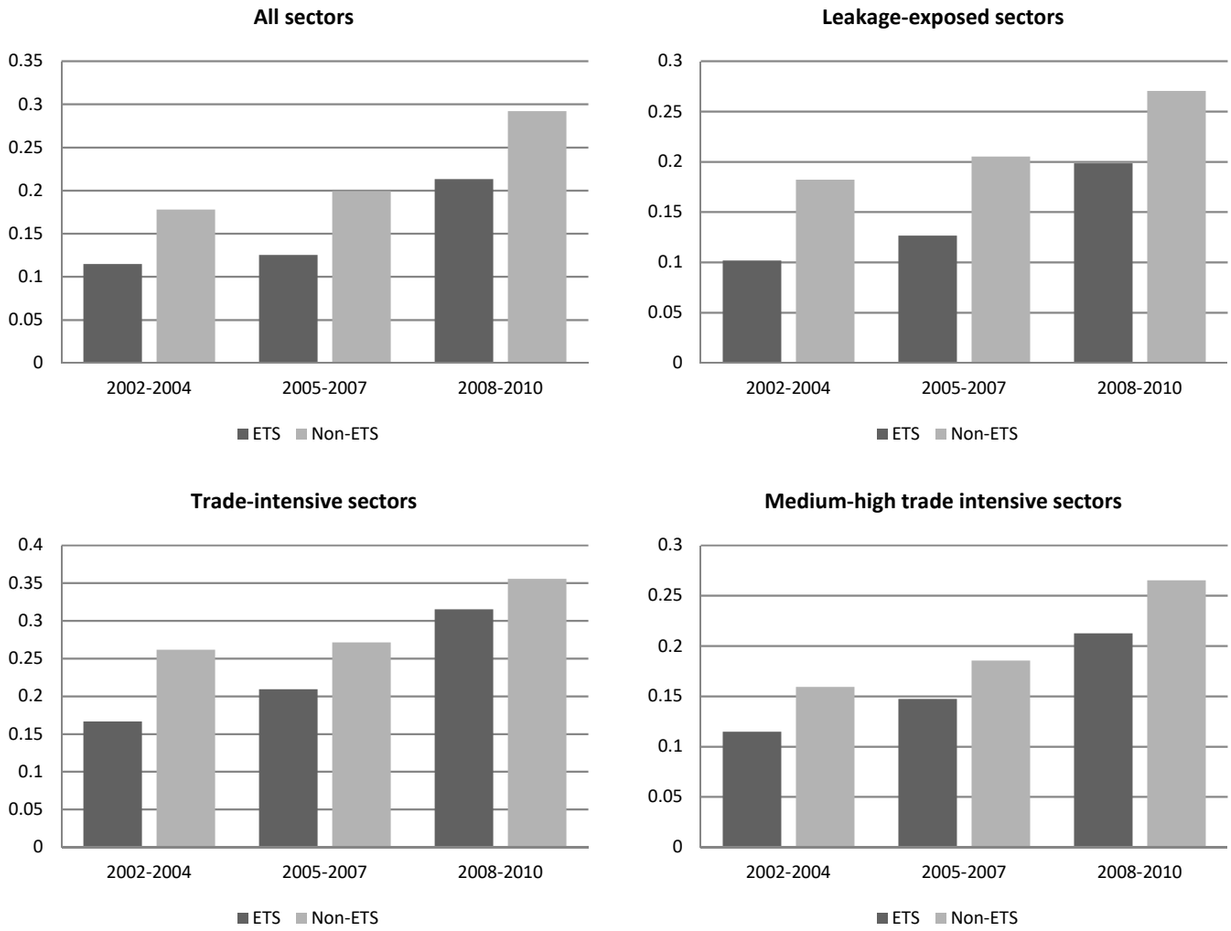

Figure 5 - Share of sales of subsidiaries in non-ETS countries

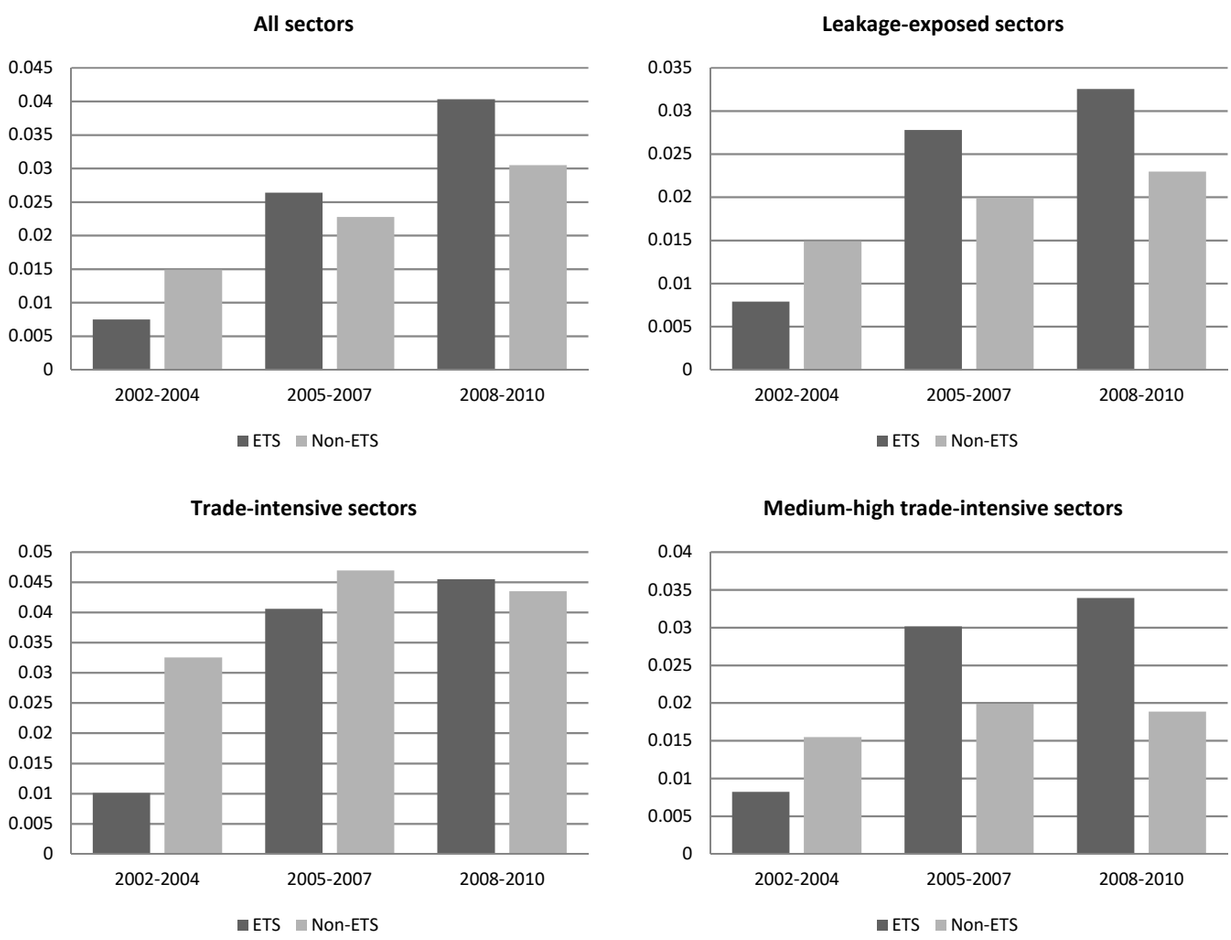

Figure 4 shows the share of subsidiaries in non-ETS countries over the total number of subsidiaries (including Italian subsidiaries and subsidiaries in EU ETS countries) for different samples. As the figure shows, ETS firms increased their subsidiaries outside the EU ETS over time in all the samples taken into account. However, a similar tendency applied to non-ETS firms so that we do not observe any clear-cut difference in trends between ETS and matched non-ETS firms. All in all, the difference between the two groups appears rather small, suggesting a limited contribution of the EU ETS to inducing firms to increase the number of subsidiaries in unregulated countries.

A second relevant insight is offered by Figure 5 in which we report the share of sales in subsidiaries located in non-ETS countries over the total sales of the firm.[30] In this way we can observe how the geographical distribution of Italian firms' production (proxied by their sales) evolved over time. The difference in trends between ETS and non-ETS matched firms is much larger in this case, with the share of sales in subsidiaries located in non-ETS countries growing much faster for ETS firms than for non-ETS firms, leading the former to overtake the latter from the beginning of Phase 1. This result emerges both when considering all manufacturing sectors together and the different categories of leakage exposed sectors. For example, in the manufacturing sector as a whole, the share of sales in non-ETS countries of ETS Italian firms grows from about 0.7 percent of the total sales in 2002-2004 to 4 percent in 2008-2010, while for non-ETS Italian firms the same measure increased only from 1.5 to 3 percent in the same period. Similar differences in trends can also be observed for leakage-exposed and trade-intensive sectors. The comparison of these results on the intensive margin with the ones of Figure 4 (extensive margin) suggests that EU ETS firms increased substantially the relative importance of production activities in foreign unregulated countries, with a preference for increasing production in existing foreign subsidiaries rather than increasing the number of subsidiaries. This is in line with expectations as the establishment of new subsidiaries abroad is characterized by high fixed and sunk costs (Helpman et al, 2004).

We present our estimates separately for the number of foreign subsidiaries (Tables 3 and 4) and for their sales (Tables 5 and 6). The explanatory variables of interest are the interaction terms between the treatment dummy (*ETS*) and the time dummies in which the EU ETS was in place (*Y2005_2007* and *Y2008_2010*). Overall, results appear to be quite consistent across the different samples and for the two phases of the EU-ETS.

[30] The latter is measured as the sum of the sales of the firm, the sales of the firm's subsidiaries located in Italy and the sales of the firm's subsidiary located abroad.

Table 3 - Results for the count of subsidiaries in non-ETS countries

Dep var: number of subsidiaries in non-ETS countries	(1) All sectors	(2) Leakage-exposed sectors	(3) High-trade sectors	(4) Medium-high trade sectors
Difference-in-differences estimates				
ETS	-0.719***	-0.860***	-0.696**	-0.724***
	(0.231)	(0.296)	(0.311)	(0.274)
ETS x Y2005_2007	0.405	0.477*	0.449	0.474*
	(0.247)	(0.279)	(0.306)	(0.273)
ETS x Y2008_2010	0.474**	0.557**	0.502*	0.404
	(0.236)	(0.274)	(0.292)	(0.280)
Control variables				
Subs in non-ETS countries (2002-2004)	2.364***	1.687***	1.661***	1.721***
	(0.280)	(0.378)	(0.396)	(0.451)
Firm belongs to a group based in non-ETS country (2002-2004)	0.879**	0.735	-0.351	-0.139
	(0.393)	(0.515)	(0.470)	(0.491)
Firm belongs to a group based in non-Italian ETS country (2002-2004)	0.514	0.573	0.726**	0.127
	(0.334)	(0.376)	(0.307)	(0.372)
Firm belongs to a group based in Italy (2002-2004)	-0.442*	-0.305	-0.486	-0.441*
	(0.230)	(0.272)	(0.305)	(0.264)
log(Employment, 2002-2004)	0.488***	0.511***	0.341*	0.477***
	(0.125)	(0.122)	(0.175)	(0.117)
log(Capital stock per employee, 2002-2004)	-0.320	-0.442*	-0.319	-0.678**
	(0.233)	(0.249)	(0.221)	(0.286)
log(Wages, 2002-2004)	0.916***	0.497	1.266***	0.621
	(0.355)	(0.469)	(0.430)	(0.384)
log(Value added per employee, 2002-2004)	-0.0743	0.781**	0.353	0.874**
	(0.352)	(0.349)	(0.489)	(0.365)
GDP growth 2000-2010 in host countries	3.918***	5.452***	3.371***	5.477***
	(0.868)	(1.045)	(1.061)	(1.170)
Length of bankruptcy process in the province (in 1000 days)	-0.0554	-0.0376	-0.110	-0.258
	(0.133)	(0.189)	(0.199)	(0.220)
Corruption index	-0.220	-1.200	0.152	-0.768
	(1.202)	(1.462)	(1.542)	(1.366)
Firm belongs to a group based in non-ETS country (2002-2004) x trend	-0.159	-0.0182	0.164	0.185
	(0.102)	(0.149)	(0.146)	(0.159)
Firm belongs to a group based in non-Italian ETS country (2002-2004) x trend	-0.304*	-0.467***	-0.630***	-0.302*
	(0.156)	(0.173)	(0.165)	(0.176)
Firm belongs to a group based in Italy (2002-2004) x trend	-0.0272	-0.0464	0.0137	0.0517
	(0.0858)	(0.0946)	(0.115)	(0.0974)
log(Employment, 2002-2004) x trend	0.00183	0.0315	0.0699	0.0220
	(0.0443)	(0.0488)	(0.0528)	(0.0638)
log(Capital stock per employee, 2002-2004) x trend	0.0465	-0.0395	-0.142	-0.000701
	(0.0893)	(0.0966)	(0.108)	(0.120)
log(Wages, 2002-2004) x trend	-0.466***	-0.380**	-0.627***	-0.262
	(0.126)	(0.177)	(0.155)	(0.163)
log(Value added per employee, 2002-2004) x trend	0.308***	0.122	0.366**	0.0366
	(0.117)	(0.135)	(0.182)	(0.144)
GDP growth 2000-2010 in host countries x trend	-0.222	-0.659*	-0.125	-0.739*
	(0.357)	(0.377)	(0.414)	(0.412)
N of matched treated firms	261	218	76	174
N of unmatched treated firms	22	17	11	15
N	4579	3441	1174	2464

Poisson estimator weighted by propensity score matching weight (10 nearest neighbour with 5 percent caliper and exact matching on 2-digit NACE). Standard errors clustered by firm in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables: time window dummies, year-specific region dummies (NUTS2).

Table 4 - Results for the count of subsidiaries in non-ETS non-OECD countries

Dep var: number of subsidiaries in non-ETS non-OECD countries	(1) All sectors	(2) Leakage-exposed sectors	(3) High-trade sectors	(4) Medium-high trade sectors
ETS x Y2005_2007	0.515*	0.768**	0.612*	0.663**
	(0.282)	(0.317)	(0.342)	(0.285)
ETS x Y2008_2010	0.481*	0.743**	0.434	0.564*
	(0.287)	(0.351)	(0.358)	(0.341)
N of matched treated firms	261	218	76	174
N of unmatched treated firms	22	17	11	15
N	4579	3441	1174	2464

Poisson estimator weighted by propensity score matching weight (10 nearest neighbour with 5 percent caliper and exact matching on 2-digit NACE). Standard errors clustered by firm in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables: Subs in non-ETS countries (2002-2004), Part of Italian group (2002-2004), Part of group based in non-Italian ETS country (2002-2004), Part of group based in non-ETS country (2002-2004), log(Employment, 2002-2004), log(Capital stock per employee, 2002-2004), log(Wages, 2002-2004), log(Value added per employee, 2002-2004), GDP growth 2000-2010 in host countries, Corruption index, Length of bankruptcy process in the province, Part of Italian group (2002-2004) x trend, Part of group based in non-Italian ETS countries (2002-2004) x trend, Part of group based in non-ETS country (2002-2004) x trend, log(Employment, 2002-2004) x trend, log(Capital stock per employee, 2002-2004) x trend, log(Wages, 2002-2004) x trend, log(Value added per employee, 2002-2004) x trend, GDP growth 2000-2010 in host countries x trend, ETS dummy, time window dummies, year-specific region dummies (NUTS2).

For the full sample of manufacturing firms (Column 1) we observe positive and significant impacts of the EU ETS on the count of subsidiaries located in non-ETS countries only for the second Phase (2008-2010). Italian ETS firms increased the number of subsidiaries in non-ETS countries on average by about 60.6 percent[31] in 2008-2010 with respect to 2002-2004. Column 2 shows results for firms belonging to industries identified by the European Commission as exposed to risks of leakage. Out of 283 treated firms, 235 (83 percent) belong to these sectors. In this case the treatment effect is positive and significant for both treatment periods (though only at 10 percent for 2005-2007) while the magnitude of the estimated effects is slightly larger than for the full sample. In Columns 3 and 4 we dig deeper into the 'leakage-exposed' sample and look at those sectors that were exempted from auctioning as being particularly trade intensive (i.e. trade intensity above 10 percent, see section III), no matter their emission intensity. Out of 283 ETS firms, 87 belong to high-trade intensive sectors (31 percent), while 189 belong to medium-high trade intensive sectors (67 percent). The effect of the ETS remains positive and of similar magnitude though significance decreases a bit. Overall, the impact of the EU ETS on the extensive margin of FDI is only weak. Even though the magnitude of the estimated effect may appear large, the high growth rate in foreign subsidiaries needs to be contrasted with the rather small number of subsidiaries in unregulated countries owned by Italian ETS firm before the EU ETS was in place.[32]

When looking at other regressors, we observe that the number of subsidiaries in non-ETS countries in the pre-treatment period has always a positive and highly significant effect in all specifications. This seems to confirm that investing abroad is partially a path dependent phenomenon as firms that have gained experience in doing FDI (incurring the sunk costs of multinational activity) are more likely to increase their presence abroad. Firm size (i.e. the number of employees) measured in the pre-treatment period has a positive and significant relationship with the count of subsidiaries in non-ETS countries. The initial level of capital intensity is negatively related to our dependent variable for the 'leakage exposed' sectors and the medium high-trade sectors, while a positive link between initial labour productivity and FDI towards non-ETS countries is found for the same sub-samples. Initial average wages are positively and significantly related to FDI in the aggregate sample, especially for the 'high-trade' sectors. These results are in line with the findings of the

[31] Given the use of a Poisson regression, the treatment effect is equal to E(Y|X=1) - E(Y|X=0) = e^{β} - 1. Therefore, the differential effect of the ETS is: $e^{0.474} - 1 = 0.606$.

[32] Back of the envelope calculations suggest that the estimated increase in the number of subsidiaries in non-ETS countries due to the EU ETS for the full sample of EU-ETS firms was 66 in Phase I and 80 in Phase II.

literature on the drivers of FDI: the firm-specific advantage that allows to overcome the liability of foreignness and invest abroad is positively correlated with firm size and productivity.[33]

Overall, the interaction terms between firm-level initial characteristics and the time trend are not statistically significant, suggesting that, after matching on the propensity score, firms with different initial features did not increase their FDI in different ways. Finally, we find a negative but non-significant relationship between outward FDI and the length of bankruptcy trials, as well as a negative and non-significant effect of the provincial corruption index.

As discussed above, we believe it is important to provide benchmark estimates for outward FDI towards the subset of non-EU ETS countries that do not belong to the OECD (Table 4). Firms that try to escape the ETS might want to locate in pollution havens (i.e. countries with low stringency of environmental regulation), typically non-OECD countries. Results for this subset of host countries are generally in line with our benchmark estimates of Table 3 even though the EU ETS effect turns out to be larger in magnitude and more precisely estimated, especially for leakage sectors and medium-high trade sectors in both ETS periods.

After the results on the extensive margin of FDI, we now look at how the ETS impacted the intensive margin of outward FDI towards non-ETS countries in terms of sales in these countries (Table 5). The interaction terms between the treatment dummy (*ETS*) and the time dummies (*Y2005_2007* and *Y2008_2010*) are positive and strongly significant in all subsamples and the magnitude of the coefficients is much larger than in the estimates on the count of subsidiaries. These results suggest that the barriers to FDI are difficult to overcome when the firm has to establish its presence abroad for the first time (i.e. opening a new subsidiary or acquiring an existing firm in the host country). However, when the firm decides to increase its sales in existing subsidiaries, the level of displacement caused by ETS is greater in relative terms. This effect remains evident also when considering firms that invest in non-ETS non-OECD countries (Table 6), even though coefficients appear to be less precisely estimated when considering the full sample.

[33] Similar results (omitted here for space reasons) hold true when accounting for import tariffs between Italy and the FDI host countries. Average import tariffs, in fact, were basically unchanged over the observation period, therefore trade barriers probably did not play a major role in affecting FDI.

Table 5 - Results for sales of subsidiaries in non-ETS countries

Dep var: sales of subsidiaries in non-ETS countries	(1) All sectors	(2) Leakage-exposed sectors	(3) High-trade sectors	(4) Medium-high trade sectors
Difference-in-differences estimates				
ETS	-0.924***	-1.025***	-1.106**	-0.885**
	(0.329)	(0.384)	(0.447)	(0.347)
ETS x Y2005_2007	1.140***	1.247***	1.412***	1.181***
	(0.349)	(0.402)	(0.413)	(0.362)
ETS x Y2008_2010	0.882**	1.379***	1.500***	1.232***
	(0.361)	(0.385)	(0.425)	(0.426)
Control variables				
Subs in non-ETS countries (2002-2004)	2.092***	0.462	0.826	1.002**
	(0.746)	(0.562)	(0.760)	(0.465)
Firm belongs to a group based in non-ETS country (2002-2004)	-0.133	0.0519	0.0113	-0.263
	(0.560)	(0.594)	(0.747)	(0.544)
Firm belongs to a group based in non-Italian ETS country (2002-2004)	-0.418	0.518	0.402	-0.319
	(0.526)	(0.682)	(0.580)	(0.778)
Firm belongs to a group based in Italy (2002-2004)	-1.116***	-0.830**	-0.853**	-1.320***
	(0.360)	(0.373)	(0.426)	(0.386)
log(Employment, 2002-2004)	1.029***	1.095***	0.925***	0.879***
	(0.206)	(0.281)	(0.338)	(0.298)
log(Capital stock per employee, 2002-2004)	-1.901***	-1.003**	-0.987***	-1.593***
	(0.715)	(0.402)	(0.362)	(0.550)
log(Wages, 2002-2004)	0.976*	0.772*	1.038*	0.915**
	(0.578)	(0.401)	(0.631)	(0.427)
log(Value added per employee, 2002-2004)	2.217*	1.977***	1.886**	1.727***
	(1.266)	(0.480)	(0.849)	(0.440)
GDP growth 2000-2010 in host countries	6.241***	8.199***	5.490**	8.098***
	(2.070)	(2.088)	(2.141)	(1.917)
Length of bankruptcy process in the province (in 1000 days)	-0.180	-0.430	-0.282	-0.999***
	(0.254)	(0.402)	(0.438)	(0.362)
Corruption index	-1.966	0.625	-0.380	0.113
	(2.091)	(2.139)	(2.030)	(1.877)
Firm belongs to a group based in non-ETS country (2002-2004) x trend	0.406*	0.0970	0.0541	0.0977
	(0.221)	(0.221)	(0.262)	(0.240)
Firm belongs to a group based in non-Italian ETS country (2002-2004) x trend	0.161	-0.765**	-0.868***	-0.459
	(0.333)	(0.307)	(0.292)	(0.321)
Firm belongs to a group based in Italy (2002-2004) x trend	0.220*	0.00185	0.0892	0.505***
	(0.131)	(0.204)	(0.173)	(0.177)
log(Employment, 2002-2004) x trend	-0.133	0.0313	0.121	0.120
	(0.0808)	(0.105)	(0.134)	(0.145)
log(Capital stock per employee, 2002-2004) x trend	0.489**	-0.144	-0.0899	-0.00309
	(0.235)	(0.170)	(0.188)	(0.222)
log(Wages, 2002-2004) x trend	-0.428*	-0.115	-0.674**	0.0236
	(0.247)	(0.248)	(0.269)	(0.260)
log(Value added per employee, 2002-2004) x trend	-0.166	-0.0165	0.363	0.0271
	(0.395)	(0.243)	(0.290)	(0.275)
GDP growth 2000-2010 in host countries x trend	-0.787	-1.188*	-0.401	-1.503**
	(0.691)	(0.685)	(0.642)	(0.722)
N of matched treated firms	261	218	76	174
N of unmatched treated firms	22	17	11	15
N	4579	3441	1174	2464

Poisson estimator weighted by propensity score matching weight (10 nearest neighbour with 5 percent caliper and exact matching on 2-digit NACE). Standard errors clustered by firm in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables: time window dummies, year-specific region dummies (NUTS2).

Table 6 - Results for sales of subsidiaries in non-ETS non-OECD countries

Dep var: sales of subsidiaries in non-ETS non-OECD countries	(1) All sectors	(2) Leakage-exposed sectors	(3) High-trade sectors	(4) Medium-high trade sectors
ETS x Y2005_2007	1.031***	0.999**	1.528***	0.713*
	(0.356)	(0.411)	(0.389)	(0.405)
ETS x Y2008_2010	0.429	1.097**	1.241**	0.963**
	(0.390)	(0.476)	(0.536)	(0.484)
N of matched treated firms	261	218	76	174
N of unmatched treated firms	22	17	11	15
N	4579	3441	1174	2464

Poisson estimator weighted by propensity score matching weight (10 nearest neighbour with 5 percent caliper and exact matching on 2-digit NACE). Standard errors clustered by firm in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Additional control variables: Subs in non-ETS countries (2002-2004), Part of Italian group (2002-2004), Part of group based in non-Italian ETS country (2002-2004), Part of group based in non-ETS country (2002-2004), log(Employment, 2002-2004), log(Capital stock per employee, 2002-2004), log(Wages, 2002-2004), log(Value added per employee, 2002-2004), GDP growth 2000-2010 in host countries, Corruption index, Length of bankruptcy process in the province, Part of Italian group (2002-2004) x trend, Part of group based in non-Italian ETS countries (2002-2004) x trend, Part of group based in non-ETS country (2002-2004) x trend, log(Employment, 2002-2004) x trend, log(Capital stock per employee, 2002-2004) x trend, log(Wages, 2002-2004) x trend, log(Value added per employee, 2002-2004) x trend, GDP growth 2000-2010 in host countries x trend, ETS dummy, time window dummies, year-specific region dummies (NUTS2).

These results, along with the ones on the extensive margin of FDI (count of subsidiaries), confirm what emerged from Figures 4 and 5: Italian regulated firms reacted to the introduction of the EU ETS mainly by increasing the production of existing subsidiaries in non-ETS countries more than through a substantial increase in the number of subsidiaries in these countries. The cost of starting a new subsidiary (or acquiring an existing one) in unregulated countries is probably too large to justify a generalized increase in the number of subsidiaries. Instead, regulated firms seem to go for a substantial displacement of production when it comes to exploit existing subsidiaries to reduce compliance costs of the EU ETS.

To assess the relative importance of the intensive and the extensive margin the following decomposition approach can be used. The impact of the ETS on the sales in non-ETS countries can be expressed as the combination of two components: (i) changes in the number of subsidiaries in non-ETS countries (extensive margin, denoted with *n*); and (ii) changes in the sales per subsidiary in non-ETS countries (intensive margin, labelled as *s*).

More specifically, by denoting with $T_t \equiv n_t s_t$ total firms' sales in non-ETS countries, the relative change in this variable due to the EU ETS ($\Delta T/T_{t-1}$) can be decomposed into the sum of the following terms:

$$\frac{\Delta T}{T_{t-1}} = \frac{n_t s_t - n_{t-1} s_{t-1}}{n_{t-1} s_{t-1}} = \frac{\Delta s}{s_{t-1}} + \frac{\Delta n}{n_{t-1}} + \frac{\Delta s}{s_{t-1}} \times \frac{\Delta n}{n_{t-1}} \qquad (2)$$

where $\frac{\Delta s}{s_{t-1}}$ is the impact of the EU ETS on the intensive margin, $\frac{\Delta n}{n_{t-1}}$ denotes its impact on the extensive margin and $\frac{\Delta s}{s_{t-1}} \times \frac{\Delta n}{n_{t-1}}$ is the interaction between the two effects (generally defined as covariance component). Based on the estimations of Tables 3 and 5, Table 7 reports the results for the impacts on both the intensive and the extensive margin and the relative ratio between the two effects. As the table shows, Italian firms reacted to the EU ETS by expanding production in foreign subsidiaries (intensive margin) as well as investing abroad through new subsidiaries (extensive margin). However, the intensive margin prevails over the extensive one in basically all the specifications taken into account (excluding for all sectors in Phase II). Indeed, the ratio between the intensive and the extensive margin is generally above one, and it gets particularly large in the case of high-trade sectors for which the intensive margin is more than twice the extensive margin as a share of the overall effect in both phases.

Table 7 – Decomposition of the overall effect between intensive margin, extensive margin and co-variance component

	All sectors	Leakage-exposed sectors	High-trade sectors	Medium-high trade sectors
		Phase I		
Relative contribution to the overall effect:				
Extensive margin	*23%*	*25%*	*18%*	*27%*
Intensive margin	*52%*	*47%*	*53%*	*46%*
Co-variance component	*25%*	*28%*	*29%*	*27%*
Ratio intensive/extensive margin	2.17	1.90	2.86	1.70
		Phase II		
Relative contribution to the overall effect:				
Extensive margin	*43%*	*25%*	*19%*	*21%*
Intensive margin	*35%*	*43%*	*49%*	*53%*
Co-variance component	*22%*	*32%*	*32%*	*26%*
Ratio intensive/extensive margin	0.83	1.71	2.63	2.59

Intensive margin, extensive margin and covariance component are defined in equation 2. Estimated coefficients refer to results for non-ETS subsidiaries (Panel A) of Tables 3 and 5.

VI. Conclusions

The issue of carbon leakage has become widely discussed in the lively debate about climate change as it represents a recurrent threat that can hinder the effectiveness of environmental regulation. As greenhouse gas emissions (including CO_2) are a global source of environmental externality, the possibility that some firms "escape" environmental regulation by relocating abroad can result in an overall weakening of the effectiveness of climate change mitigation policies. To examine this issue, our research deals with the role played by the EU ETS, the main policy instrument adopted by the EU in the last decade to address climate change mitigation. We have analysed whether the EU ETS may have influenced outward FDI of Italian firms towards countries that are not subject to this environmental regulation. The period we have analysed with data from the AIDA database ranges between 2002 and 2010. In the empirical analysis we considered three different ETS phases: the pre-treatment phase (2002-2004), the pilot phase (2005-2007) and the first half of the first commitment period (2008-2010). We first had to find a suitable counterfactual for our empirical analysis. We therefore employed the propensity score matching to identify a proper control group. After this step, we employed a difference-in-differences approach to estimate the impact of the EU ETS on both the extensive and intensive margin of outward FDI. We provide results according to the different criteria used to classify sectors at risk of carbon leakage. Our main findings suggest that the EU ETS had a positive but weak effect on the extensive margin as measured by the number of subsidiaries in non-EU ETS countries. The same result emerged when we focused on the sectors at risk of carbon-leakage and appeared to be higher when we restricted the analysis to subsidiaries in non-ETS non-OECD countries, particularly for trade-intensive sectors.

The impact of the EU ETS turned out to be much larger and significant when we looked at the intensive margin as measured by the sales of the subsidiaries in non-EU ETS countries. More precisely, the EU ETS had a positive impact on both the intensive and the extensive margin but the former turns out to be about twice the latter as a share of the overall effect. The larger effect on the intensive margin suggests that firms probably preferred to expand production in their own subsidiaries abroad more than opening up new ones. This result seems consistent with what one would expect given the deep recession that hit Italy in the second phase of the EU ETS, which probably led firms to exploit what they already had abroad more than facing the costs associated with new plants.

The positive effect of the EU ETS on the intensive margin is particularly evident in trade intensive sectors that are regarded at risk of delocalization. One possible reason is that firms belonging to sectors more exposed to trade have to remain competitive on both domestic and international markets to survive. Therefore, rather than sustaining higher compliance costs by continuing to produce at home, they may prefer to invest abroad in countries that are not subject to the EU ETS regulation.

In general, we can conclude that the first two phases of the EU ETS had a positive but small effect on the Italian FDI, which seems in line with the few recent studies conducted on this issue at the EU level (e.g. Dechezleprêtre et al., 2015; Koch and Basse Mama, 2016). This can probably be ascribed to the limited compliance costs of the environmental regulation, especially during the first commitment period when the permit price collapsed because of the crisis. Moreover, the rapid growth of cap-and-trade schemes (and of carbon pricing policies in general) at the world level may have hindered firms from delocalizing their production out of the EU ETS since similar environmental regulations are expected in many non-EU ETS countries in the future. Finally, as pointed out by previous studies on the Italian case (e.g. Borghesi et al., 2015), the initial uncertainty on the functioning of the scheme may have induced a "wait and see" strategy in many Italian firms.

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Appendix A - Sample description

Table A1 - Descriptive statistics

	Non-ETS firms (2002-2004)		ETS firms (2002-2004)	
	Mean	SD	Mean	SD
Leakage exposed sectors	0.55	0.50	0.83	0.38
Medium-high trade sectors	0.49	0.50	0.67	0.47
High trade sectors	0.44	0.50	0.30	0.46
Number of employees	75.80	207.40	746.36	2088.97
Total assets (mln euro)	18.71	94.06	334.71	874.19
Physical fixed capital stock (mln euro)	7.08	38.16	173.86	489.07
Sales (mln euro)	18.91	84.26	319.07	1148.66
Value added per employee (euro)	50065	37127	88828	59456
Wage per employee (euro)	31352	13180	42054	15950
Age	21.11	13.86	28.96	20.25
GDP growth (2000-2010) in host countries weighted by initial (2002-2004) count of subsidiaries	0.02	0.08	0.07	0.12
Firm belongs to a group based in non-ETS countries	0.01	0.10	0.06	0.23
Firm belongs to a group based in non-Italian ETS countries	0.02	0.15	0.17	0.37
Firm belongs to an Italian group	0.16	0.36	0.46	0.50
Count of subsidiaries in non-ETS countries	0.10	0.84	1.10	6.11
Count of subsidiaries in non-ETS non-OECD countries	0.05	0.51	0.52	2.97
Count of subsidiaries in ETS countries	0.15	1.06	2.07	11.76
Count of subsidiaries in Italy	0.33	1.47	2.70	6.35
Sales of subsidiaries in non-ETS countries (mln euro)	0.29	15.86	14.70	158.88
Sales of subsidiaries in non-ETS non-OECD countries (mln euro)	0.16	13.24	9.53	130.38
Sales of subsidiaries in ETS countries (mln euro)	34.11	705.67	623.80	3465.38
Sales of subsidiaries in Italy (mln euro)	3.08	32.85	79.81	313.41

Table A2 - Sample distribution across sectors, regions, size classes

Industry (NACE rev 1.1)	Total firms	of which ETS	Share ETS over tot firms
DA Food products, beverages and tobacco	1639	52	0.0317
DB-DC Textiles and textile products; Leather and leather products	2507	20	0.0080
DD Wood and wood products	661	2	0.0030
DE Pulp, paper and paper products; Publishing and printing	1340	70	0.0522
DF Coke, refined petroleum products, nuclear fuel	84	7	0.0833
DG Chemicals, chemical products and man-made fibers	998	26	0.0261
DH Rubber and plastic products	1549	9	0.0058
DI Other non-metallic mineral products	1378	49	0.0356
DJ Basic metals and fabricated metal products	4770	27	0.0057
DK Machinery and equipment n.e.c.	3527	9	0.0026
DL Electrical and optical equipment	1392	3	0.0022
DM Transport equipment	702	8	0.0114
DN Manufacturing n.e.c.	1683	1	0.0006
Region	Total firms	of which ETS	Share ETS
North	16630	187	0.0112
Centre	3256	54	0.0166
South	2344	42	0.0179
Size class	Total firms	of which ETS	Share ETS
20-49	13986	52	0.0037
50-249	7220	116	0.0161
250+	1024	115	0.1123
Total	22230	283	0.0127

Appendix B – Pre-treatment trends

While matching allows us to balance the level of observable features of treated and untreated firms, it could be the case that the two groups of firms, though similar 'in levels', were experiencing different trends in outward FDI even before the ETS was in place. In the absence of data on foreign subsidiaries prior to 2002 and due to the unreliability of year-by-year data on foreign subsidiaries, we cannot directly evaluate pre-treatment differences in trend in our set of dependent variables. As a proxy for outward FDI, we compare the trends in a series of variables that are expected to be correlated with FDI for the pre-treatment period 2000-2004. These include: total financial assets, average number of employees and sales. For each of these variables we estimate a simple fixed effect model on the sample of treated firms and matched untreated firms weighted with matching weights, including as covariates a series of year dummies and interaction terms between ETS treatment status and year dummies. We then jointly test the significance of the interaction term to examine whether the trends of treated and untreated firms were significantly different before the treatment. Results for these tests are reported in Table B1.

For all variables and samples, our estimates suggest that trends in variables that are expected to be correlated with outward FDI were not statistically different between ETS and matched non-ETS firms before the ETS was in place.

Table B1 - Pre-treatment common trends

	All sectors	Leakage-exposed sectors	High-trade sectors	Medium-high trade sectors
Sales (in log)				
F test of joint significance of ETS x year dummies	0.387	0.329	1.088	0.917
p-value	0.818	0.859	0.363	0.454
N	5275	3855	1290	2760
Number of employees (in log)				
F test of joint significance of ETS x year dummies	0.2	0.127	0.789	0.175
p-value	0.938	0.973	0.533	0.951
N	5235	3820	1275	2745
Stock of financial assets (in log)				
F test of joint significance of ETS x year dummies	1.496	0.172	0.866	0.462
p-value	0.201	0.953	0.485	0.763
N	4870	3540	1215	2515

Fixed effect estimator weighted by matching weights for the period 2000-2004. Year dummies included.