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

Preliminary draft. Please do not quote

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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 henceforth).

In particular, we aim at assessing whether EU-ETS has any effect on the intensive and extensive margins of outward FDI patterns of Italian firms. Using a novel panel dataset of about 50,000 firms covering the first two phases of the EU-ETS (pilot phase and first commitment period) and the pre-EU-ETS period, we are able to observe the patterns of FDI by destination country of firms, distinguishing between those with plants covered by the EU-ETS and other firms. Results show that firms in the EU-ETS tend to increase their presence in countries not covered by the EU-ETS as well as in countries within the EU-ETS. Moreover, FDI patterns in sectors exempted by the auctioning in the current second commitment period of the EU-ETS, are generally greater than the ones observed for EU-ETS firms in other sectors.

Keywords: EU-ETS, FDI, carbon leakage

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1 Introduction

The theoretical starting point of the paper is represented by the fact that, when a multinational firm moves its production process to another country where the level of the environmental regulation is lower, we are considering the Pollution Haven Hypothesis (PHH) to occur. This phenomenon has been investigated by several authors both from a theoretical and empirical point of view, mainly with respect to outward FDI from developed countries (e.g. Hanna, 2010). Despite different types of environmental policies have been taken into consideration, the role played by the EU-ETS has not been examined so far as a outward FDI determinant. The EU-ETS is the central policy instrument introduced by the European Commission in order to mitigate the emergence of climate change. Due to its nature of unilateral policy instrument, the EU-ETS raised many concerns in terms of carbon leakage, i.e. the delocalization of production of involved industries towards environmental policy-free geographical areas. The issue of carbon leakage has been recognized by the Commission which 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. On the other hand, firms who are willing to become leader in the market for CO_2 allowances could expand their presence in countries covered by the EU-ETS (or other non-EU emission trading schemes) in order to employ their emission-abating (or energy efficient) technologies in a greater number of production plants, to try to manipulate the market for permits or for other strategic reasons.

Our paper contributes to the current literature by providing a theoretical and empirical investigation about the potential carbon leakage effects of the EU-ETS. We derive our set of testable hypotheses from the theoretical model and then we test them by using a novel panel dataset on the portfolio of subsidiaries of Italian firms. From our analysis we find confirmation that firms covered by the EU-ETS tend to offshore more than untreated firms, the effect being greater for firms in sectors more exposed to carbon leakage dynamics. These results are not significant in the pilot phase of the EU-ETS (2005-2007) while they turn out to be significant and robust in the first commitment period (2008-2012).

The paper is organized as follows. Section 2 reviews the relevant literature on the pollution haven hypothesis. Section 3 describes in detail the EU-ETS, the data we use and the empirical strategy. Section 4 discusses the results of our empirical analysis. Section 5 draws some conclusions.

2 Literature review

The PHH has been analyzed both from a theoretical and empirical point of view: in this respect, Markusen (1997) builds up a model which predicts the effect of environmental regulation on both local and multinational firms' location decisions. The findings point to a decrease in the number of multinational firms but, at the same time, an increase of domestic firms. Other papers have specifically focused on the FDI behaviour. Dijkstra et al. (2011), using a Cournot duopoly model, find that outward FDI may not necessarily be spurred by more stringent environmental regulation. A similar result is found by Sanna-Randaccio and Sestini (2012).

From an empirical point of view, early papers focused on the analyses of developed countries such as the US, even though mixed results have been found. In this respect, List and Co (2000) and Keller and Levinson (2002) both recognize that higher environmental regulation can cause a lower amount of FDI inflows into the US. Using US firm-level data and without controlling for host country regulation, they that firms that are already more regulated do not increase so much their investment abroad. Similarly, but using industry data, Wagner and Timmins (2009) examine whether the environmental regulations across several host countries affect the amount of outward FDI of German manufacturing industries over 1996 and 2003, finding a positive result for all six industries. However, not only developed countries are considered in the analyses. More recently, Manderson and Kneller (2012), by analyzing outward FDI from the UK, find that environmental regulations cannot be considered an important determinant of the internationalization process.

Chung (2014) analyzes South Korean FDI over 2000–2007. Their main finding is that polluting industries display a higher amount of FDI both at the extensive and intensive margin. The Chinese case is examined by Dean et al. (2009), who find that only equity joint ventures in highly-polluting industries coming from Hong Kong, Macao, and Taiwan are driven towards locations characterized by lower environmental standards. In the same way, one of the few studies that account for firm heterogeneity is by Javorcik and Wei (2004) who analyze the investment choices of multinational firms that decide to locate across Eastern Europe and the former Soviet Union. Although some empirical evidence that FDI are negatively correlated with tight standards, their results are not robust to other proxies for environmental stringency.

A step further, is made by Naughton (2014), who considers the role played by both the home and the host country regulation on the bilateral FDI flows of 28 OECD countries. He finds that stricter host country regulation contributes to decrease the amount of FDI.

3 Empirical framework

3.1 The EU-ETS

The EU-ETS was introduced by the Directive 2003/87/EC[1] as the pillar of the European climate change mitigation policy to reach the Kyoto targets and for the following targets to be set at the regional or international level. The EU-ETS is a cap-and-trade scheme for CO_2 in which emissions permits are allocated to the participants at the beginning of each period, either for free (grandfathering) or auctioned. The participants are then required to return an amount of emission permits corresponding to the actual amount of emissions. In the meanwhile, permits can be transferred between the participants at a price per ton of CO_2 that, in equilibrium, should be equal to the marginal cost of abatement, leading to efficient distribution of abatement across participants. The penalty for non-complying was set to 40 euros per ton in the pilot phase (2005-2007) and to 100 euros per ton in the first commitment period (2008-2012).

[1] Emended by the Directives 2004/101/EC and 2008/101/EC, the Regulation 219/2009 and the Directive 2009/29/EC.

The period 2005-2007 was a pilot phase, in which the system was set up. The first commitment period (2008-2012), leading to the Kyoto commitment period (2012), extended the scope of the scheme to aviation (2012). Finally, the second commitment period (2013-2020) 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 all EU countries plus Norway, Iceland and Lichtenstein. Being characterized by substantial sunk and fixed costs (including administrative costs for participants and governments), the Commission decided to include in the scheme only the bigger emitters of CO2. These emitters are identified by their sector of operation (or type of activity) and by the size of the facility in terms of production capacity. The scheme currently covers about 11,000 facilities in Europe that contribute to about 45 percent of overall European GHG emissions[2]. The sectors and thresholds are reported in the Annex I of the Directive and have been emended two times since 2003[3]. All in all, firms covered by the EU-ETS tend to be big firms in specific sectors. This makes the identification of a suitable counterfactual problematic. Matching at the facility level, for example, is not possible, because if firms are similar in terms of sector of operation and size, they should be both either covered by the EU-ETS or exempted from it.

One major amendment concerned the differentiation of the allocation scheme across sectors for the second commitment period of the EU-ETS, with 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 which are deemed to be exposed to a significant risk of carbon leakage*'. The decisions includes a list of 4-digit sectors[4] for which permits will be grandfathered also in the second commitment period of the EU-ETS (in which allocation has been partially done by auctioning permits) due to potentially relevant risks of offshoring of these production

[2] http://ec.europa.eu/clima/policies/ets/index_en.htm

[3] The Directive of 2003 refers to the following activities (with corresponding capacity thresholds – Annex I of the Directive 2003/87/EC): Combustion installations with a rated thermal input exceeding 20 MW (except hazardous or municipal waste installations); Mineral oil refineries; Coke ovens; Production and processing of ferrous metals; Metal ore (including sulphide ore) roasting or sintering installations; Installations for the production of pig iron or steel (primary or secondary fusion), including continuous casting, with a capacity exceeding 2,5 tonnes per hour; Installations for the production of cement clinker in rotary kilns with a production capacity exceeding 500 tonnes per day or lime in rotary kilns with a production capacity exceeding 50 tonnes per day or in other furnaces with a production capacity exceeding 50 tonnes per day; Installations for the manufacture of glass including glass fibre with a melting capacity exceeding 20 tonnes per day; Installations for the manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain, with a production capacity exceeding 75 tonnes per day, and/or with a kiln capacity exceeding 4 m3 and with a setting density per kiln exceeding 300 kg/m3; Industrial plants for the production of (a) pulp from timber or other fibrous materials (b) paper and board with a production capacity exceeding 20 tonnes per day. The list has been further extended to other sectors (refer to the consolidated version of the Directive 2003/87/EC).

[4] The decision identifies the following 4-digit Nace rev. 1.1 sectors:1010, 1430, 1597, 1711, 1810, 2310, 2413, 2414, 2415, 2417, 2710, 2731, 2742, 2744, 2745, 2931, 1562, 1583, 1595, 1592, 2112, 2320, 2611, 2613, 2630, 2721, 2743, 2651, 2652, 1110, 1310, 1320, 1411, 1422, 1450, 1520, 1541, 1591, 1593, 1712, 1713, 1714, 1715, 1716, 1717, 1721, 1722, 1723, 1724, 1725, 1740, 1751, 1752, 1753, 1754, 1760, 1771, 1772, 1821, 1822, 1823, 1824, 1830, 1911, 1920, 1930, 2010, 2052, 2111, 2124, 2215, 2330, 2412, 2420, 2441, 2442, 2452, 2463, 2464, 2465, 2466, 2470, 2511, 2615, 2621, 2622, 2623, 2624, 2625, 2626, 2681, 2722, 2741, 2861, 2862, 2874, 2875, 2911, 2912, 2913, 2914, 2921, 2923, 2924, 2932, 2941, 2942, 2943, 2951, 2952, 2953, 2954, 2955, 2956, 2960, 2971, 3001, 3002, 3110, 3120, 3130, 3140, 3150, 3162, 3210, 3220, 3230, 3310, 3320, 3340, 3350, 3511, 3512, 3530, 3541, 3542, 3543, 3550, 3621, 3622, 3630, 3640, 3650, 3661, 3662, 3663, 1730, 2020, 2416, 2751, 2753.

activities due to the EU-ETS. These sectors have been identified through qualitative and quantitative analysis on the importance of potential carbon leakage and, to some extent, through a political negotiation. This list has been further emended to add other sectors with the decisions of the European Commission 2012/498/EU[5] and 2014/9/EU[6]. This characterization of the policy is particularly relevant for our case, especially because no exemption was in place in the period we consider.

3.2 Data sources

Our empirical analysis is based on a set of administrative data. We retrieved information on balance sheet, profit and loss account, region (NUTS2) and industry (Nace rev. 1.1, 4-digit) for a large sample (about 190,000) of Italian firms from the AIDA (Bureau van Dijk) database. Data refer to three different releases, in order to minimize missing values: March 2009, August 2012 and January 2013. For the moment we just use information about the number of employees and the book value (total assets) of the firm.

In each edition of the AIDA database, information about proprietary structure and subsidiaries refers to the latest available information, with some lags. For example, most of the information in the release of February 2007 refers to the year 2004. In order to reconstruct the whole history of our firms in terms of number and composition of their subsidiary firms, we used seven releases of the AIDA database[7]. However, given that in each release information refers to several different years, the assessment of the annual number of subsidiaries is rather problematic. We thus decide to measure the number of subsidiaries for three time windows: 2002-2004 (pre-ETS), 2005-2007 (pilot phase of the ETS) and 2008-2010 (first commitment period of the EU-ETS). In order to have predetermined control variables, they are measured in the first year of each time window (number of employees and book value).

We selected only industrial subsidiaries (excluding financial and other types of subsidiaries) and use 10 percent of ownership as the threshold to consider the participation as an actual subsidiary. We then split the count of foreign subsidiaries according to the country of destination of the FDI. In particular, we identify foreign subsidiaries in countries not covered by the EU-ETS[8] and in countries not belonging to the OECD[9]. One possible drawback of this approach is that we cannot measure the actual size and relevance of these subsidiaries in terms of monetary value (total assets, turnover) or number of employees.

As an additional control, we also include the number of Italian subsidiaries. The variable is built following the same procedure as for foreign subsidiaries.

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[5] The decision adds the following 4-digit Nace sector: 2614.

[6] The decision adds the following 4-digit Nace sectors: 2653, 2662.

[7] February 2007, May 2008, March 2009, March 2010, March 2011, August 2012, January 2013.

[8] Countries adhering to the EU-ETS are: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Latvia, Lichtenstein, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the UK.

[9] OECD countries are: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, UK and US.

It is possible that for some firms information about the presence and composition of subsidiaries is not available because of data collection strategies. This means that some of the zeros we observe in the number of subsidiaries are, however, a missing values. This incidental truncation could create some selection bias. Our empirical strategy also aims at correcting such biases.

Finally, we identified Italian firms with facilities covered by the EU-ETS by matching unique identifiers (when available) and firm names in the Community Independent Transaction Log with the name and identifier in AIDA. We identified a total of 390 firms with at least one facility subjected to the EU-ETS. For the moment, we do not consider whether firms entered the EU-ETS after 2005 or whether they exited the scheme during the considered period.

Our operative sample includes a sample of firms in AIDA (Bureau van Dijk) observed in the years 2002, 2005 and 2008 and amounts to about 50,000 firms. We retain only those forms for which we have no missing value in our variables of interest, ending up with 296 EU-ETS firms out of 390 matched EU-ETS firms. Firms belong both to industrial sectors and to service sectors. The criterion for including the firm was that, within the same cell characterized by size (1-49 employees, 50-249 employees and 250 or more employees) and sector (2-digit Nace rev 1.1), at least one firm was subjected to the EU-ETS[10]. The rational is to exclude those firms which are likely to be bad counterfactual for EU-ETS firms. This reduces the number of firms to about 50,000 As a robustness check (available upon request), we excluded all those sectors at 4-digit for which no EU-ETS firm was observed.

Table 1 shows the distribution of firms cross size classes and EU-ETS status. As expected, most of the firms covered by the EU-ETS are big firms while small firms are under-represented. Table 2 shows the share of firms with foreign subsidiaries by year and EU-ETS status while Table 3 reports the average number of foreign subsidiaries, that is our main dependent variable. EU-ETS firms were characterized by a much more intense foreign activity than non-EU-ETS firms even before the EU-ETS. On average, about one quarter of EU-ETS firms had a foreign subsidiary while only about 2.7 percent of non-EU-ETS firms had a foreign subsidiary in 2002-2004. Most of this difference is likely to be explained by the different firm size distribution between EU-ETS and non-EU-ETS firms, with bigger firms being more likely to have foreign subsidiaries. The number of foreign subsidiaries increases in time both for EU-ETS and non-EU-ETS firms, as well as the probability of having foreign subsidiaries.

3.3 Empirical strategy

The selection of facilities into the EU-ETS is not random but depends on a series of observable characteristics of the facility, that is its size (sector-specific) and its sector of operation. This specific set of selection rules limits the possibility of using a matching estimator to identify a proper static counterfactual, given that non-treated facilities in the same sector and with the same size should be treated as well. This problem could be alleviated, however, when using the firm rather than the facility as the unit of analysis, because firms could be similar in terms of their economic dimensions (size, profitability, etc) but they could differ in terms of features of their facilities.

[10] The potential sample of firms was of about 90,000 firms. Results on the full sample, not substantially different from the ones based on the selected sample, are available upon request.

Our choice, however, is to exploit the panel dimension of our dataset by using a difference-in-differences approach, as described in equation 1:

$$FDI_{i,t} = \alpha \times ETS_i + \beta_t \times D_t + \gamma_t \times ETS_i \times D_t + \sum_j \delta^j \times X_{i,t}^j + \varepsilon_{i,t} \quad (1)$$

where:

- $FDI_{i,t}$ is our dependent variable, that is the number of foreign subsidiaries by 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 facilities covered by the EU-ETS and 0 otherwise;
- D_t is a time dummy;
- $X_{i,t}^j$ is a set of control variables;
- $\varepsilon_{i,t}$ is the error term.

Our parameter of interest is γ_t, with *t*=2005 for the assessment of the effect of the pilot phase of the EU-ETS and *t*=2008 for the effect of the first commitment period of the EU-ETS. However, to control for unobserved fixed effect, we substitute $\alpha \times ETS_i$ with a firm-specific fixed effect (α_i), as in equation 2:

$$FDI_{i,t} = \alpha_i + \beta_t \times D_t + \gamma_t \times ETS_i \times D_t + \sum_j \delta^j \times X_{i,t}^j + \varepsilon_{i,t} \quad (2)$$

A final concern regards the possibility that some of the zeros of our dependent variables are, actually, missing value (incidental truncation) as discussed in the description of the data. This could give rise to a selection bias if the incidental truncation is not random. To correct for that problem, we also employ a Heckman sample selection model to specification in equation 1.

4 Results

Our baseline results are reported in Table 4, in which the dependent variable is the count of foreign subsidiaries. We employ a fixed effect model. For each dependent variable, we report both a simple difference-in-difference estimate and an estimate in which we add firm size and the number of domestic subsidiaries[11] as additional controls[12]. Our estimates suggest that firms with plants covered by the EU-ETS have increased their number of foreign subsidiaries substantially more than other firms, both in the pilot phase of the EU-ETS (ETS x D2005) and in the first commitment period (ETS x D2008). This evidence is important both when considering all destination countries and when considering destination countries not covered by the EU-ETS

[11] The number of domestic subsidiaries is measured with two variables. First, we have a dummy variable that equals one for those observations with no domestic subsidiaries and zero otherwise. Second, we take the log of the number of domestic subsidiaries and substitute log(0) with zero, given. By doing that, the effect for firms with no domestic subsidiaries will be captured by the dummy, while the extensive margin will be capture by the log of domestic subsidiaries.

[12] Results remain unchanged when adding other controls such as the intensity of both physical and intangible capital, labour productivity and the stock of total and environmental patents.

(columns 3 and 4) and non-OECD destination countries (column 5 and 6). Results are robust to the inclusion of controls. The magnitude of the effect is also relevant: the additional number of foreign subsidiaries ranges between 30 (total foreign subsidiaries in 2005) and 68 (non-EU-ETS subsidiaries in 2008) percent of the average number of subsidiaries in EU-ETS firms.

As a robustness check, we deal with two possible issues that could characterize the estimates of Table 4. First, as explained in section 4.1, our strategy to measure the number of foreign subsidiaries is likely to be characterized by incidental truncation. In case this incidental truncation is not random, our baseline estimates would be characterized by a selection bias. Second, given that the distribution of our dependent variable is very skewed, we take the log of the number of foreign subsidiaries as our dependent variable. By doing that, all zeros could be either actually zeros or missing observations (incidental truncation). Our specification is now a standard difference-in-differences, with a dummy for EU-ETS firms, further interacted with time dummies.

In the selection equation of our Heckman sample selection model, we use three variables as exclusion restriction: the log of domestic subsidiaries, a dummy for firms without any domestic subsidiary and the log of total assets. These variable should be correlated with the probability of observing at least one foreign subsidiary.

While our baseline specification has no further control, for each dependent variable we add a second specification in which we include size (log of employees) as an additional control together with region (NUTS2) and sector (2-digit Nace rev. 1.1) dummies.

Results for the sample selection model are reported in Table 5. Results remain qualitatively unchanged: EU-ETS firms increased their presence abroad as measured by the number of foreign subsidiaries. However, the effect turns out to be positive and significant only for the first commitment period of the EU-ETS. Here coefficients should be interpreted as follows: EU-ETS firms increased their number of foreign subsidiaries by about 30 percent compared to non-EU-ETS firms when considering total foreign subsidiaries and foreign subsidiaries in non-EU-ETS countries. The effect was even bigger in magnitude (about 45 percent) when considering non-OECD countries as the destination of the FDI. The correlation between the error terms of the selection equation and of the second stage equation is always negative, with great magnitude and strongly significant, suggesting the presence of a selection bias. Looking at the selection equation, we observe that the EU-ETS has a generally negative effect on the probability of having subsidiaries abroad (extensive margin), the effect being weakly significant for non-EU-ETS outward FDI and stronger for aggregate FDI and non-OECD FDI. This result may depend on the presence of sunk costs of doing FDI, that cannot be borne by firms already constrained by unavoidable sunk costs related to the EU-ETS.

4.1 Differential effect for firms in sectors more exposed to carbon leakage

We follow the same approach when assessing the extent to which the effect of the EU-ETS on outward FDI differs for those sectors classified by the European Commission as the ones more exposed to carbon leakage. Results for the fixed effect specifications are reported in Table 6 while results for the sample selection model are reported in Table 7. We observe that the positive effect of the EU-ETS on outward FDI tends to be generally bigger for those EU-ETS firms that belong to those sectors identified as more exposed to leakage than for EU-ETS firms in other sectors. The

differential effect is statistically insignificant, even though big in magnitude, in the fixed effect estimates, while it is strongly significant in the Heckman sample selection model for non-EU-ETS and non-OECD outward FDI. In particular, in these two cases, the inclusion of a differential effect for sectors exposed to leakage has the consequence of reducing substantially the effect found for EU-ETS firms in others sectors, that turns out to be statistically insignificant. This evidence seems to suggest that EU-ETS firms belonging to these sectors were actually relatively more exposed to carbon leakage pressures than EU-ETS firms in other sectors, even before the exemption from auction for these sectors was enacted in 2013.

5 Conclusions

In this paper we have analyzed what happen to FDI outflows when host countries are covered by ETS. The empirical analysis, which is relative to both the intensive and extensive margin of FDI, has been carried out with respect to the Italian case, considering three different ETS phase: the pre-commitment phase (2003-2005), the pilot phase (2005-2007) and, finally, the first commitment period (2008-2012). Our empirical approach has been that of considering a difference-in-difference approach and Heckman selection approach to control for possible selection bias. Our main findings suggest that the number of foreign affiliates abroad has increased for firms covered by the EU-ETS. In particular, when considering the sectors that are more exposed to carbon leakage, we find that the positive effects coming from EU-ETS on outward FDI are even bigger.

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Table 1 - Firms by size class and EU-ETS status

Size class (02-04)	Non-EU-ETS	EU-ETS	Share EU-ETS
1-49	43,298	77	0.0018
50-249	5,943	110	0.0182
250+	909	109	0.1071
Total	50,150	296	0.0059

Table 2 - Share of firms with foreign subsidiaries by year and EU-ETS status

Year	Non-EU-ETS	EU-ETS	Total
	Tot foreign		
2002-2004	0.027	0.251	0.029
2005-2007	0.035	0.302	0.037
2008-2010	0.064	0.318	0.065
Total	0.042	0.290	0.044
	No EU-ETS		
2002-2004	0.016	0.169	0.017
2005-2007	0.018	0.190	0.019
2008-2010	0.037	0.240	0.038
Total	0.024	0.200	0.025
	No OECD		
2002-2004	0.011	0.119	0.012
2005-2007	0.015	0.153	0.016
2008-2010	0.034	0.176	0.035
Total	0.020	0.149	0.021

Table 3 – Number of foreign subsidiaries by year and EU-ETS status

Year	Non-EU-ETS	EU-ETS	Total
	Tot foreign		
2002-2004	0.07	1.41	0.07
2005-2007	0.13	2.31	0.14
2008-2010	0.24	3.97	0.27
Total	0.15	2.56	0.16
	No EU-ETS		
2002-2004	0.03	0.45	0.03
2005-2007	0.06	1.06	0.06
2008-2010	0.12	1.92	0.13
Total	0.07	1.14	0.08
	No OECD		
2002-2004	0.02	0.32	0.02
2005-2007	0.04	0.80	0.05
2008-2010	0.09	1.39	0.10
Total	0.05	0.83	0.06

Table 4 – Baseline estimates (dependent variable: count of foreign subsidiaries)

	All foreign	All foreign	No EU-ETS	No EU-ETS	No OECD	No OECD
D2005	0.0646***	0.0459***	0.0306***	0.0201***	0.0249***	0.0168***
	(0.00416)	(0.00426)	(0.00264)	(0.00257)	(0.00208)	(0.00212)
D2008	0.179***	0.160***	0.0909***	0.0805***	0.0745***	0.0663***
	(0.00848)	(0.00920)	(0.00562)	(0.00576)	(0.00446)	(0.00471)
ETS x D2005	0.834***	0.676**	0.580***	0.491***	0.456***	0.386***
	(0.305)	(0.305)	(0.174)	(0.172)	(0.148)	(0.147)
ETS x D2008	2.390**	2.264**	1.380**	1.309**	1.004**	0.947**
	(0.941)	(0.933)	(0.540)	(0.535)	(0.420)	(0.416)
log(Subs_IT)		0.610***		0.343***		0.271***
		(0.0721)		(0.0532)		(0.0422)
No subs IT		0.192***		0.111***		0.0859***
		(0.0276)		(0.0194)		(0.0157)
log(Empl)		-0.0145		-0.00756		-0.00854
		(0.0221)		(0.0126)		(0.0116)
R sq	0.0110	0.0223	0.00854	0.0181	0.00794	0.0173
F	115.9	96.63	68.59	65.73	72.59	71.37
N	151014	151014	151014	151014	151014	151014

Fixed effect model. Robust standard error in parenthesis. * p<0.1, ** p<0.05, *** p<0.01.

Table 5 – Sample selection model (dependent variable: log of foreign subsidiaries)

Heckman model	All foreign	All foreign	No EU-ETS	No EU-ETS	No OECD	No OECD
ETS	0.00511	-0.000640	-0.151	-0.201*	-0.0287	-0.0177
	(0.104)	(0.103)	(0.112)	(0.113)	(0.124)	(0.128)
D2005	0.294***	0.289***	0.459***	0.457***	0.393***	0.383***
	(0.0291)	(0.0286)	(0.0358)	(0.0352)	(0.0376)	(0.0375)
D2008	0.186***	0.179***	0.221***	0.197***	0.162***	0.122***
	(0.0262)	(0.0270)	(0.0312)	(0.0323)	(0.0331)	(0.0352)
ETS x D2005	0.0631	0.0873	0.110	0.102	0.102	0.0833
	(0.141)	(0.138)	(0.155)	(0.153)	(0.166)	(0.167)
ETS x D2008	0.300**	0.320**	0.300**	0.314**	0.443***	0.454***
	(0.139)	(0.136)	(0.147)	(0.146)	(0.161)	(0.162)
log(Empl)		0.0189*		0.00153		-0.0161
		(0.0107)		(0.0132)		(0.0134)
Selection eq						
ETS	-0.136	-0.0445	-0.170*	-0.0589	-0.191*	-0.111
	(0.0937)	(0.0983)	(0.101)	(0.106)	(0.111)	(0.117)
D2005	0.0797***	0.0968***	-0.0300	-0.0271	0.0680**	0.0783***
	(0.0202)	(0.0215)	(0.0254)	(0.0271)	(0.0269)	(0.0286)
D2008	0.360***	0.449***	0.317***	0.400***	0.409***	0.482***
	(0.0185)	(0.0197)	(0.0225)	(0.0240)	(0.0241)	(0.0256)
ETS x D2005	-0.0428	-0.0717	-0.00602	-0.0507	-0.0249	-0.0614
	(0.130)	(0.135)	(0.141)	(0.148)	(0.152)	(0.159)
ETS x D2008	-0.291**	-0.392***	-0.134	-0.237*	-0.264*	-0.344**
	(0.128)	(0.134)	(0.136)	(0.142)	(0.148)	(0.155)
log(assets)	0.447***	0.354***	0.433***	0.347***	0.385***	0.322***
	(0.00551)	(0.00793)	(0.00680)	(0.00984)	(0.00690)	(0.0101)
log(Subs_IT)	0.145***	0.270***	0.103***	0.216***	0.146***	0.247***
	(0.0117)	(0.0126)	(0.0133)	(0.0145)	(0.0137)	(0.0150)
No subs IT	-0.372***	-0.318***	-0.366***	-0.298***	-0.312***	-0.245***
	(0.0166)	(0.0176)	(0.0207)	(0.0220)	(0.0217)	(0.0230)
log(Empl)		0.0923***		0.0881***		0.0651***
		(0.00858)		(0.0105)		(0.0107)
Industry dummies	No	Yes	No	Yes	No	Yes
Regional dummies	No	Yes	No	Yes	No	Yes
Rho	-0.735	-0.756	-0.695	-0.734	-0.687	-0.725
Lambda	-0.720	-0.721	-0.609	-0.640	-0.564	-0.597
Sigma	0.979	0.954	0.877	0.872	0.822	0.824
N	151014	151014	151014	151014	151014	151014

Heckman sample selection model (ML estimator). Standard errors clustered by firms in parenthesis. * p<0.1, ** p<0.05, *** p<0.01

Table 6 – Differential effect for sectors exposed to leakage (dependent variable: count of foreign subsidiaries)

	All foreign	All foreign	No EU-ETS	No EU-ETS	No OECD	No OECD
D2005	0.0396***	0.0224***	0.0179***	0.00823***	0.0156***	0.00835***
	(0.00363)	(0.00381)	(0.00238)	(0.00236)	(0.00187)	(0.00195)
D2008	0.120***	0.0960***	0.0589***	0.0460***	0.0519***	0.0421***
	(0.00767)	(0.00773)	(0.00543)	(0.00530)	(0.00439)	(0.00435)
ETS x D2005	0.593	0.459	0.495*	0.420	0.360	0.301
	(0.442)	(0.443)	(0.259)	(0.259)	(0.264)	(0.265)
ETS x D2008	0.752**	0.604*	0.394**	0.311*	0.205	0.139
	(0.349)	(0.345)	(0.175)	(0.172)	(0.128)	(0.128)
D_leak x D2005	0.278***	0.237***	0.142***	0.119***	0.103***	0.0846***
	(0.0281)	(0.0277)	(0.0169)	(0.0169)	(0.0134)	(0.0135)
D_leak x D2008	0.663***	0.654***	0.358***	0.353***	0.253***	0.248***
	(0.0535)	(0.0519)	(0.0301)	(0.0294)	(0.0224)	(0.0216)
ETS x	0.162	0.157	0.0195	0.0166	0.0712	0.0695
D_leak x D2005	(0.606)	(0.603)	(0.348)	(0.346)	(0.316)	(0.315)
ETS x	2.151	2.194	1.329	1.354	1.109	1.129
D_leak x D2008	(1.577)	(1.571)	(0.901)	(0.898)	(0.699)	(0.697)
log(Subs_IT)		0.609***		0.344***		0.271***
		(0.0724)		(0.0533)		(0.0423)
No subs IT		0.181***		0.105***		0.0818***
		(0.0278)		(0.0195)		(0.0158)
log(Empl)		0.00617		0.00363		-0.000654
		(0.0217)		(0.0124)		(0.0114)
R sq	0.0183	0.0297	0.0147	0.0243	0.0132	0.0226
F	62.31	63.54	42.87	43.74	45.01	47.92
N	151014	151014	151014	151014	151014	151014

Fixed effect model. Robust standard error in parenthesis. * p<0.1, ** p<0.05, *** p<0.01.

Table 7 - Sample selection model (dependent variable: log of foreign subsidiaries)

Heckman model	All foreign	All foreign	No EU-ETS	No EU-ETS	No OECD	No OECD
ETS	0.0947	0.0328	-0.0780	-0.174	0.0371	0.0112
	(0.104)	(0.103)	(0.113)	(0.113)	(0.125)	(0.127)
D2005	0.281***	0.284***	0.458***	0.464***	0.336***	0.332***
	(0.0387)	(0.0380)	(0.0503)	(0.0493)	(0.0519)	(0.0513)
D2008	0.135***	0.147***	0.171***	0.164***	0.0906**	0.0648
	(0.0344)	(0.0349)	(0.0428)	(0.0435)	(0.0454)	(0.0468)
ETS x D2005	0.155	0.229	0.180	0.173	0.161	0.135
	(0.192)	(0.188)	(0.210)	(0.208)	(0.227)	(0.228)
ETS x D2008	0.267	0.348*	-0.0533	-0.00793	0.176	0.171
	(0.187)	(0.183)	(0.190)	(0.189)	(0.209)	(0.210)
ETS x D_leak	-0.257***	-0.163***	-0.263***	-0.177***	-0.299***	-0.190***
	(0.0443)	(0.0465)	(0.0525)	(0.0558)	(0.0570)	(0.0607)
D_leak x D2005	0.0139	0.0107	-0.0131	-0.0183	0.101	0.106
	(0.0585)	(0.0570)	(0.0710)	(0.0696)	(0.0749)	(0.0740)
D_leak x D2008	0.0916*	0.0884*	0.0579	0.0711	0.0964	0.118*
	(0.0533)	(0.0522)	(0.0620)	(0.0612)	(0.0660)	(0.0655)
ETS x	-0.138	-0.218	-0.105	-0.111	-0.101	-0.103
D_leak x D2005	(0.201)	(0.198)	(0.223)	(0.223)	(0.235)	(0.237)
ETS x	0.0258	-0.0806	0.566***	0.494**	0.427**	0.415*
D_leak x D2008	(0.194)	(0.191)	(0.196)	(0.196)	(0.213)	(0.215)
log(Empl)		0.0256**		0.00998		-0.0110
		(0.0106)		(0.0131)		(0.0134)
Selection eq						
ETS	-0.249***	-0.101	-0.263***	-0.102	-0.277**	-0.151
	(0.0934)	(0.0982)	(0.101)	(0.106)	(0.111)	(0.117)
D2005	0.0970***	0.112***	-0.0401	-0.0374	0.0993***	0.110***
	(0.0250)	(0.0264)	(0.0332)	(0.0348)	(0.0345)	(0.0361)
D2008	0.413***	0.479***	0.358***	0.413***	0.454***	0.503***
	(0.0226)	(0.0238)	(0.0286)	(0.0300)	(0.0307)	(0.0321)
ETS x D2005	0.124	0.0722	0.232	0.171	0.128	0.109
	(0.173)	(0.182)	(0.189)	(0.200)	(0.203)	(0.215)
ETS x D2008	-0.189	-0.333*	0.0960	-0.000596	-0.102	-0.171
	(0.170)	(0.178)	(0.177)	(0.188)	(0.193)	(0.204)
log(assets)	0.607***	0.311***	0.604***	0.313***	0.560***	0.271***
	(0.0319)	(0.0370)	(0.0378)	(0.0438)	(0.0415)	(0.0477)
log(Subs_IT)	-0.0225	-0.0393	0.0355	0.0281	-0.0647	-0.0826
	(0.0436)	(0.0454)	(0.0528)	(0.0549)	(0.0563)	(0.0584)
No subs IT	-0.0647	-0.0859**	-0.00974	-0.0245	-0.0294	-0.0410
	(0.0407)	(0.0424)	(0.0474)	(0.0493)	(0.0508)	(0.0528)
ETS x D_leak	-0.287	-0.229	-0.417**	-0.369*	-0.247	-0.237
	(0.186)	(0.195)	(0.204)	(0.217)	(0.216)	(0.229)
D_leak x D2005	-0.184	-0.0589	-0.436**	-0.371*	-0.306	-0.263
	(0.181)	(0.191)	(0.188)	(0.200)	(0.203)	(0.215)
D_leak x D2008	0.400***	0.353***	0.384***	0.346***	0.341***	0.321***
	(0.00572)	(0.00795)	(0.00711)	(0.00988)	(0.00722)	(0.0101)
ETS x	0.193***	0.276***	0.160***	0.224***	0.194***	0.253***
D_leak x D2005	(0.0119)	(0.0127)	(0.0136)	(0.0146)	(0.0141)	(0.0151)
ETS x	-0.352***	-0.315***	-0.336***	-0.294***	-0.286***	-0.243***
D_leak x D2008	(0.0169)	(0.0177)	(0.0211)	(0.0221)	(0.0220)	(0.0230)
log(Empl)		0.0788***		0.0717***		0.0531***
		(0.00868)		(0.0106)		(0.0109)
Industry dummies	No	Yes	No	Yes	No	Yes
Regional dummies	No	Yes	No	Yes	No	Yes
Rho	-0.742	-0.754	-0.709	-0.732	-0.700	-0.724
Lambda	-0.730	-0.718	-0.627	-0.636	-0.582	-0.596
Sigma	0.983	0.952	0.884	0.869	0.831	0.823
N	151014	151014	151014	151014	151014	151014

Heckman sample selection model (ML estimator). Standard errors clustered by firms in parenthesis. * p<0.1, ** p<0.05, *** p<0.01