

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

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GCET Conference 2014
Copenhagen, September 2014

Background

- ▶ Increasing **concerns** about the potential **losses** of **competitiveness** caused by stringent **unilateral** environmental **regulations**
 - ▶ **Social** and **economic** issues
 - ▶ **Environmental** issues ⇒ in presence of **global externalities** (e.g. CO2 emissions), leakage affects the **effectiveness** of the **environmental policy**
- ▶ **Pollution haven hypothesis** (PHH) and **pollution have effect** (PHE) (Scott Taylor, 2004; Dean et al, 2009)
 - ▶ PHE ⇒ regulatory **stringency** 'at home' negatively affects export or inward flows of **FDIs**
 - ▶ PHH ⇒ **relative domestic regulatory stringency** triggers outward flows of **FDIs** ⇒ **international data** are needed

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 - ▶ **PHH** ⇒ **relative** domestic regulatory **stringency** triggers **outward** flows of **FDIs** ⇒ **international data** are needed

Literature review

- ▶ **Extensive** theoretical and empirical literature on the assessment of the **PHE** and the **PHH** due to environmental regulation
 - ▶ **List and Co (2000)** and **Keller and Levinson (2002)** ⇒ **US states** with more **strict** environmental **regulation** receive **less FDI**s (PHE)
 - ▶ **Manderson and Kneller (2012 ERE)** find **no evidence** of **PHH** for **UK** multinationals (analyzing **outward FDI**s)
 - ▶ **Chung (2014 JDE)** finds **evidence** of **PHH** for **Korean** firms ⇒ firms in **polluting industries** tend to **invest more** in **countries** with **laxer** environmental **regulations**
- ▶ Many recent contributions also focused on the potential **carbon-leakage** effects driven by the **EU-ETS**
 - ▶ **Martin et al (2014 AER)** and **Martin et al (2014 EcolEc)** ⇒ very detailed **assessment** of the **decision** to **exempt** some sectors from **auctioning** (more on that in the following slides)
 - ▶ They find that the '**emission intensity**' criterion tends to **prevail** on the '**subject to foreign competition**' criterion ⇒ **job losses** and **competitiveness** issues mostly related to potential **foreign competition**
 - ▶ **No direct** assessment of the effect on **outward FDI**s

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 - ▶ **No direct assessment** of the effect on outward **FDI**s

Research questions

1. Evaluate whether the **EU-ETS** was characterized by **carbon leakage** effects for **Italian** firms in terms of greater **outward FDI** flows for **treated** firms
2. Assess whether firms in **sectors exempted from auctioning** in the second commitment period were the ones **relatively more interested** by **leakage** in the **pilot** phase and in the **first commitment** period, thus **justifying** their **exemption** from auctioning

The EU-ETS

- ▶ **Main features of the EU-ETS (Directive 2003/87/EC):**
 - ▶ **Main regulatory instrument** for climate change **mitigation** in the EU
 - ▶ About **11,000 installations** in **31 countries** in 2014, **45 percent** of **GHG** emissions
 - ▶ **Cap-and-trade, grandfathering** in the pilot phase (2005-2007) and in the first commitment period (2008-2012), **increasing** share of **auctioning** from 2013
 - ▶ The EU-ETS covers **installations** in the **power** and **heat generation** sector, in **energy-intensive manufacturing** sectors and (from 2012) aircrafts used for **civil aviation**
 - ▶ Minimum **threshold** of installed **capacity** for **specific sectors**
- ▶ Decision (2010/2/EU of the EC) to **exempt specific sectors** from **auctioning**:
 - ▶ To **increase** the **environmental effectiveness** of the EU-ETS
 - ▶ To **reduce** potential **losses of competitiveness** for more exposed sectors
 - ▶ **Complex** combination of **qualitative** and **quantitative** criteria
 - ▶ **Narrow definition** of sectors (4-digit Nace)
- ▶ **Example:** 26.11 Manufacturing of flat glass is exempted; 26.12 Shaping and processing of flat glass is not exempted

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Data sources

- ▶ **Balance sheet** information and other information (sector, address, age, etc) from the **AIDA** (Bureau van Dijk) database ⇒ **various releases** to minimize missing observations
- ▶ Control variables observed in year **2002, 2005** and **2008**
- ▶ **Balanced** panel of about **90,000** firms
- ▶ **EU-ETS** firms identified by matching OHA in the **EU Transaction Log**
- ▶ **Operative** sample of **50,000** firms ⇒ we **excluded** firms in **sector** (2-digit) and **size**-classes with no treated firms

Number of subsidiaries

- ▶ In **each release** of the **AIDA** database, information about **proprietary structure** and **subsidiaries** refers to the **latest** available information (**firm-specific**) with some lags
- ▶ We used **seven** different **releases** of AIDA and counted the number of subsidiaries by country for **three** different **time windows** ⇒ 2002-2004, 2005-2007, 2008-2010
- ▶ **Sparse** information on the **value** (assets, sales, employees) of the subsidiaries
- ▶ Subsidiaries ⇒ **ownership** (direct and indirect) greater than **10 percent**
- ▶ **No possibility** to assess whether no information means **no subsidiaries** or **missing** information ⇒ possible problems of **incidental truncation** and **sample selection**

Difference-in-differences approach

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

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where:

- ▶ $FDI_{i,t}$ 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;
- ▶ α_i is the firm **fixed effect**;
- ▶ D_t is a **time dummy**;
- ▶ $X_{i,t}^j$ is a set of **control variables**;
- ▶ $\varepsilon_{i,t}$ is the **error** term.

Econometric issues: sample selection

- ▶ **No mean** to assess whether no information on subsidiaries means **zero** subsidiaries or **missing** information
- ▶ If **missing** information is **not random**, sample **selection bias** arises
- ▶ **Heckman ML sample selection model** can correct for sample selection
- ▶ We estimate our **Diff-in-Diff** with the **Heckman ML** model, using the **log of foreign subsidiaries** as dependent variable and assuming missing values for all zeros in the dependent variable
- ▶ **Joint** evaluation of **intensive** and **extensive** margins
- ▶ **Exclusion restrictions** \Rightarrow dummy for **Italian subsidiaries**, log of Italian subsidiaries, log of **total assets**

Descriptive statistics

Table : Firms by size class and EU-ETS status

Size class (2002-2004)	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 : 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 : 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*** (0.00416)	0.0459*** (0.00426)	0.0306*** (0.00264)	0.0201*** (0.00257)	0.0249*** (0.00208)	0.0168*** (0.00212)
D2008	0.179*** (0.00848)	0.160*** (0.00920)	0.0909*** (0.00562)	0.0805*** (0.00576)	0.0745*** (0.00446)	0.0663*** (0.00471)
ETS x D2005	0.834*** (0.305)	0.676** (0.305)	0.580*** (0.174)	0.491*** (0.172)	0.456*** (0.148)	0.386*** (0.147)
ETS x D2008	2.390** (0.941)	2.264** (0.933)	1.380** (0.540)	1.309** (0.535)	1.004** (0.420)	0.947** (0.416)
log(Subs.IT)		0.610*** (0.0721)		0.343*** (0.0532)		0.271*** (0.0422)
No subs IT		0.192*** (0.0276)		0.111*** (0.0194)		0.0859*** (0.0157)
log(Empl)		-0.0145 (0.0221)		-0.00756 (0.0126)		-0.00854 (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.

- ▶ EU-ETS firms experience a **relatively more rapid increase in foreign subsidiaries** than other firms
- ▶ Results hold when considering **any foreign subsidiaries** (i.e. including countries in the EU-ETS), **non-ETS** and **non-OECD** countries
- ▶ Results are **significant** for both the **pilot phase** and the **first commitment period**

Table : 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 (0.104)	-0.000640 (0.103)	-0.151 (0.112)	-0.201* (0.113)	-0.0287 (0.124)	-0.0177 (0.128)
D2005	0.294*** (0.0291)	0.289*** (0.0286)	0.459*** (0.0358)	0.457*** (0.0352)	0.393*** (0.0376)	0.383*** (0.0375)
D2008	0.186*** (0.0262)	0.179*** (0.0270)	0.221*** (0.0312)	0.197*** (0.0323)	0.162*** (0.0331)	0.122*** (0.0352)
ETS × D2005	0.0631 (0.141)	0.0873 (0.138)	0.110 (0.155)	0.102 (0.153)	0.102 (0.166)	0.0833 (0.167)
ETS × D2008	0.300** (0.139)	0.320** (0.136)	0.300** (0.147)	0.314** (0.146)	0.443*** (0.161)	0.454*** (0.162)
log(Empl)		0.0189* (0.0107)		0.00153 (0.0132)		-0.0161 (0.0134)
Selection eq	(omitted)					
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.

- ▶ **Selection bias** is present (negative and strongly significant ρ)
- ▶ The **effect** of the EU-ETS is now **insignificant** for the **pilot** phase but strongly **significant** for the **first commitment period**
- ▶ The **magnitude** of the effect (here 'normalized' by using the log) is **greater** for **non-OECD** countries than for **non-ETS** or **any foreign** country

Table : 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*** (0.00363)	0.0224*** (0.00381)	0.0179*** (0.00238)	0.00823*** (0.00236)	0.0156*** (0.00187)	0.00835*** (0.00195)
D2008	0.120*** (0.00767)	0.0960*** (0.00773)	0.0589*** (0.00543)	0.0460*** (0.00530)	0.0519*** (0.00439)	0.0421*** (0.00435)
ETS x D2005	0.593 (0.442)	0.459 (0.443)	0.495* (0.259)	0.420 (0.259)	0.360 (0.264)	0.301 (0.265)
ETS x D2008	0.752** (0.349)	0.604* (0.345)	0.394** (0.175)	0.311* (0.172)	0.205 (0.128)	0.139 (0.128)
D_leak x D2005	0.278*** (0.0281)	0.237*** (0.0277)	0.142*** (0.0169)	0.119*** (0.0169)	0.103*** (0.0134)	0.0846*** (0.0135)
D_leak x D2008	0.663*** (0.0535)	0.654*** (0.0519)	0.358*** (0.0301)	0.353*** (0.0294)	0.253*** (0.0224)	0.248*** (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*** (0.0724)		0.344*** (0.0533)		0.271*** (0.0423)
No subs IT		0.181*** (0.0278)		0.105*** (0.0195)		0.0818*** (0.0158)
log(Empl)		0.00617 (0.0217)		0.00363 (0.0124)		-0.000654 (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.

- ▶ **Big (but insignificant) differential effect** for ETS firms in sectors more exposed to leakage

Table : 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 (0.104)	0.0328 (0.103)	-0.0780 (0.113)	-0.174 (0.113)	0.0371 (0.125)	0.0112 (0.127)
D2005	0.281*** (0.0387)	0.284*** (0.0380)	0.458*** (0.0503)	0.464*** (0.0493)	0.336*** (0.0519)	0.332*** (0.0513)
D2008	0.135*** (0.0344)	0.147*** (0.0349)	0.171*** (0.0428)	0.164*** (0.0435)	0.0906** (0.0454)	0.0648 (0.0468)
ETS x D2005	0.155 (0.192)	0.229 (0.188)	0.180 (0.210)	0.173 (0.208)	0.161 (0.227)	0.135 (0.228)
ETS x D2008	0.267 (0.187)	0.348* (0.183)	-0.0533 (0.190)	-0.00793 (0.189)	0.176 (0.209)	0.171 (0.210)
ETS x D.leak	-0.257*** (0.0443)	-0.163*** (0.0465)	-0.263*** (0.0525)	-0.177*** (0.0558)	-0.299*** (0.0570)	-0.190*** (0.0607)
D.leak x D2005	0.0139 (0.0585)	0.0107 (0.0570)	-0.0131 (0.0710)	-0.0183 (0.0696)	0.101 (0.0749)	0.106 (0.0740)
D.leak x D2008	0.0916* (0.0533)	0.0884* (0.0522)	0.0579 (0.0620)	0.0711 (0.0612)	0.0964 (0.0660)	0.118* (0.0655)
ETS x D.leak x D2005	-0.138 (0.201)	-0.218 (0.198)	-0.105 (0.223)	-0.111 (0.223)	-0.101 (0.235)	-0.103 (0.237)
ETS x D.leak x D2008	0.0258 (0.194)	-0.0806 (0.191)	0.566*** (0.196)	0.494** (0.196)	0.427** (0.213)	0.415* (0.215)
log(Empl)		0.0256** (0.0106)		0.00998 (0.0131)		-0.0110 (0.0134)
Selection eq	(omitted)					
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
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.

- ▶ **Sectors** more exposed to **leakage** drive most of the overall effect, especially for **non-OECD** and **non-ETS** countries of destination

Conclusions

Summing up:

- ▶ **Firms** subject to the **EU-ETS** **increased** their number of foreign **affiliates** relatively **more** than other firms, **especially** in the first commitment period (**2008-2010**)
- ▶ Most of this effect is **driven** by EU-ETS firms that operate in **sectors** potentially more **exposed** to carbon **leakage** (as identified by the European Commission) ⇒ **justification** for the **exemption** from **auctioning**?
- ▶ Results tend to be **stronger** when considering subsidiaries in **countries not** covered by the **EU-ETS** or in **non-OECD** countries
- ▶ We observe some **selection bias**, but **results** are **robust** to the correction for such bias

Policy implications:

- ▶ **Exemption** for exposed sectors seems **appropriate** ⇒ Martin et al (2014) demonstrate that it is **not optimal**
- ▶ **Strong results** even in presence of **low and volatile carbon prices**

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THANK YOU FOR YOUR ATTENTION

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Table : Sample selection model (baseline) - selection equation

Selection eq	All foreign	All foreign	No EU-ETS	No EU-ETS	No OECD	No OECD
ETS	-0.136 (0.0937)	-0.0445 (0.0983)	-0.170* (0.101)	-0.0589 (0.106)	-0.191* (0.111)	-0.111 (0.117)
D2005	0.0797*** (0.0202)	0.0968*** (0.0215)	-0.0300 (0.0254)	-0.0271 (0.0271)	0.0680** (0.0269)	0.0783*** (0.0286)
D2008	0.360*** (0.0185)	0.449*** (0.0197)	0.317*** (0.0225)	0.400*** (0.0240)	0.409*** (0.0241)	0.482*** (0.0256)
ETS x D2005	-0.0428 (0.130)	-0.0717 (0.135)	-0.00602 (0.141)	-0.0507 (0.148)	-0.0249 (0.152)	-0.0614 (0.159)
ETS x D2008	-0.291** (0.128)	-0.392*** (0.134)	-0.134 (0.136)	-0.237* (0.142)	-0.264* (0.148)	-0.344** (0.155)
log(assets)	0.447*** (0.00551)	0.354*** (0.00793)	0.433*** (0.00680)	0.347*** (0.00984)	0.385*** (0.00690)	0.322*** (0.0101)
log(Subs_IT)	0.145*** (0.0117)	0.270*** (0.0126)	0.103*** (0.0133)	0.216*** (0.0145)	0.146*** (0.0137)	0.247*** (0.0150)
No subs IT	-0.372*** (0.0166)	-0.318*** (0.0176)	-0.366*** (0.0207)	-0.298*** (0.0220)	-0.312*** (0.0217)	-0.245*** (0.0230)
log(Empl)		0.0923*** (0.00858)		0.0881*** (0.0105)		0.0651*** (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
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Table : Sample selection model (sectors exposed to leakage) - selection equation

Selection equation	All foreign	All foreign	No EU-ETS	No EU-ETS	No OECD	No OECD
ETS	-0.249*** (0.0934)	-0.101 (0.0982)	-0.263*** (0.101)	-0.102 (0.106)	-0.277** (0.111)	-0.151 (0.117)
D2005	0.0970*** (0.0250)	0.112*** (0.0264)	-0.0401 (0.0332)	-0.0374 (0.0348)	0.0993*** (0.0345)	0.110*** (0.0361)
D2008	0.413*** (0.0226)	0.479*** (0.0238)	0.358*** (0.0286)	0.413*** (0.0300)	0.454*** (0.0307)	0.503*** (0.0321)
ETS x D2005	0.124 (0.173)	0.0722 (0.182)	0.232 (0.189)	0.171 (0.200)	0.128 (0.203)	0.109 (0.215)
ETS x D2008	-0.189 (0.170)	-0.333* (0.178)	0.0960 (0.177)	-0.000596 (0.188)	-0.102 (0.193)	-0.171 (0.204)
log(assets)	0.607*** (0.0319)	0.311*** (0.0370)	0.604*** (0.0378)	0.313*** (0.0438)	0.560*** (0.0415)	0.271*** (0.0477)
log(Subs.IT)	-0.0225 (0.0436)	-0.0393 (0.0454)	0.0355 (0.0528)	0.0281 (0.0549)	-0.0647 (0.0563)	-0.0826 (0.0584)
No subs IT	-0.0647 (0.0407)	-0.0859** (0.0424)	-0.00974 (0.0474)	-0.0245 (0.0493)	-0.0294 (0.0508)	-0.0410 (0.0528)
ETS x D.leak	-0.287 (0.186)	-0.229 (0.195)	-0.417** (0.204)	-0.369* (0.217)	-0.247 (0.216)	-0.237 (0.229)
D.leak x D2005	-0.184 (0.181)	-0.0589 (0.191)	-0.436** (0.188)	-0.371* (0.200)	-0.306 (0.203)	-0.263 (0.215)
D.leak x D2008	0.400*** (0.00572)	0.353*** (0.00795)	0.384*** (0.00711)	0.346*** (0.00988)	0.341*** (0.00722)	0.321*** (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*** (0.00868)		0.0717*** (0.0106)		0.0531*** (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.