Leibniz Institute for Economic Research

Multinational corporations and the EU-ETS: Asset erosion and creeping deindustrialization?

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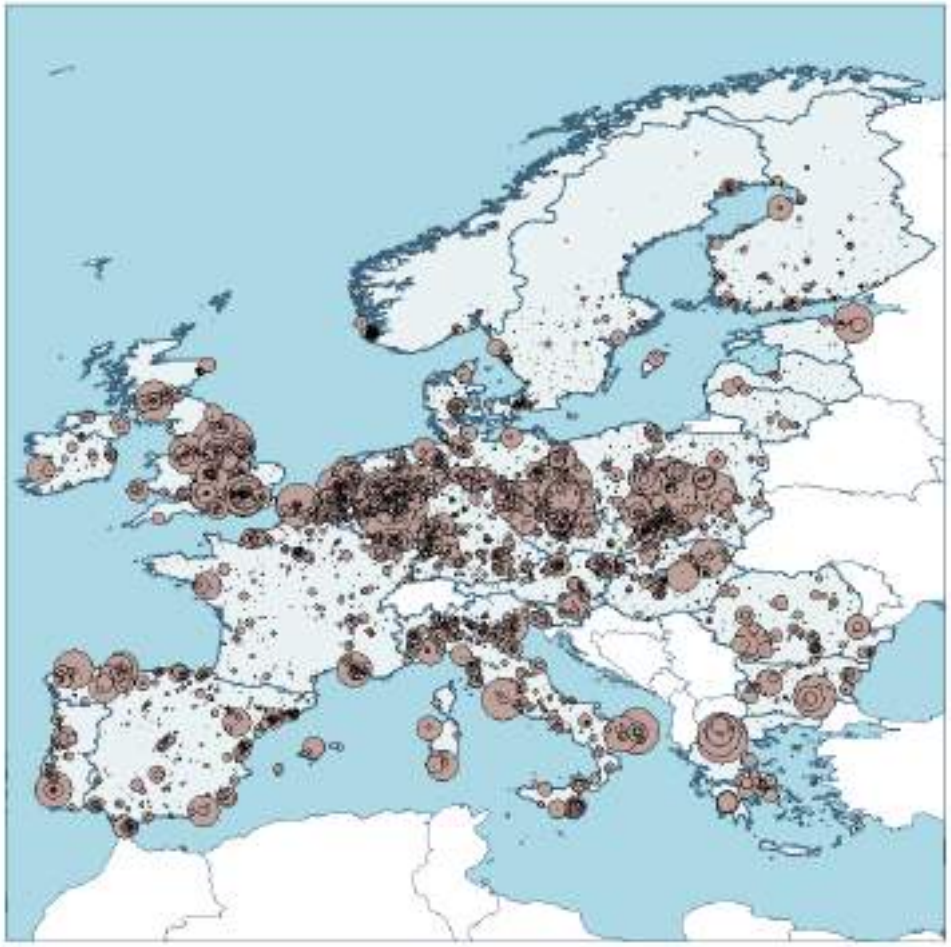
Agenda

1. Motivation
2. Data
3. Research Design
4. Results
5. Conclusion & Next steps

The EU ETS is Europe‘s flagship climate policy



- The EU Emissions Trading System (EU ETS) is the largest cap-and-trade system in the world, covering greenhouse gas (GHG) emissions in 31 countries
- Evidence on adaptive behavior by firms is crucial for regulators/policy makers, who face the threat of industrial relocation

Research questions

- Does the EU-ETS have an impact on regulated firm‘s behavior (at all)?
- Do MNEs react differently?

Specifically:

- Does the EU ETS cause an erosion of MNEs‘ fixed asset bases in the regulated countries?
- Is there evidence that suggests a “creeping deindustrialization” toward (established) subsidiaries in non EU ETS countries?

Research design

- Exploit installation level inclusion criteria to investigate causal impacts on asset bases
  - unconfoundedness (common trend), stable unit treatment value
- Stage I: Propensity score matching of treatment and control group based on pre-treatment characteristics
- Stage II: Difference-in-differences estimation

Preview of results (preliminary)

- *Regulated firms in general*

  Positive treatment effect of the EU ETS on tangible fixed assets, robust, but not for all samples

- *Multinational corporations*

  Negative interaction effect for MNEs without a functional link

Literature

EU-ETS impact assessment

- Calel and Dechezleprêtre (2016), Chan et. al (2013), Jaraite and di Maria (2016), Martin et al. (2016), Martin et al. (2014), Petrick and Wagner (2014), Wagner et al. (2014)

Carbon leakage and multinational business groups

- Dechezleprêtre et al. (2014), Koch and Basse Mama (2016), Borghesi et al. (2016)

Pollution havens

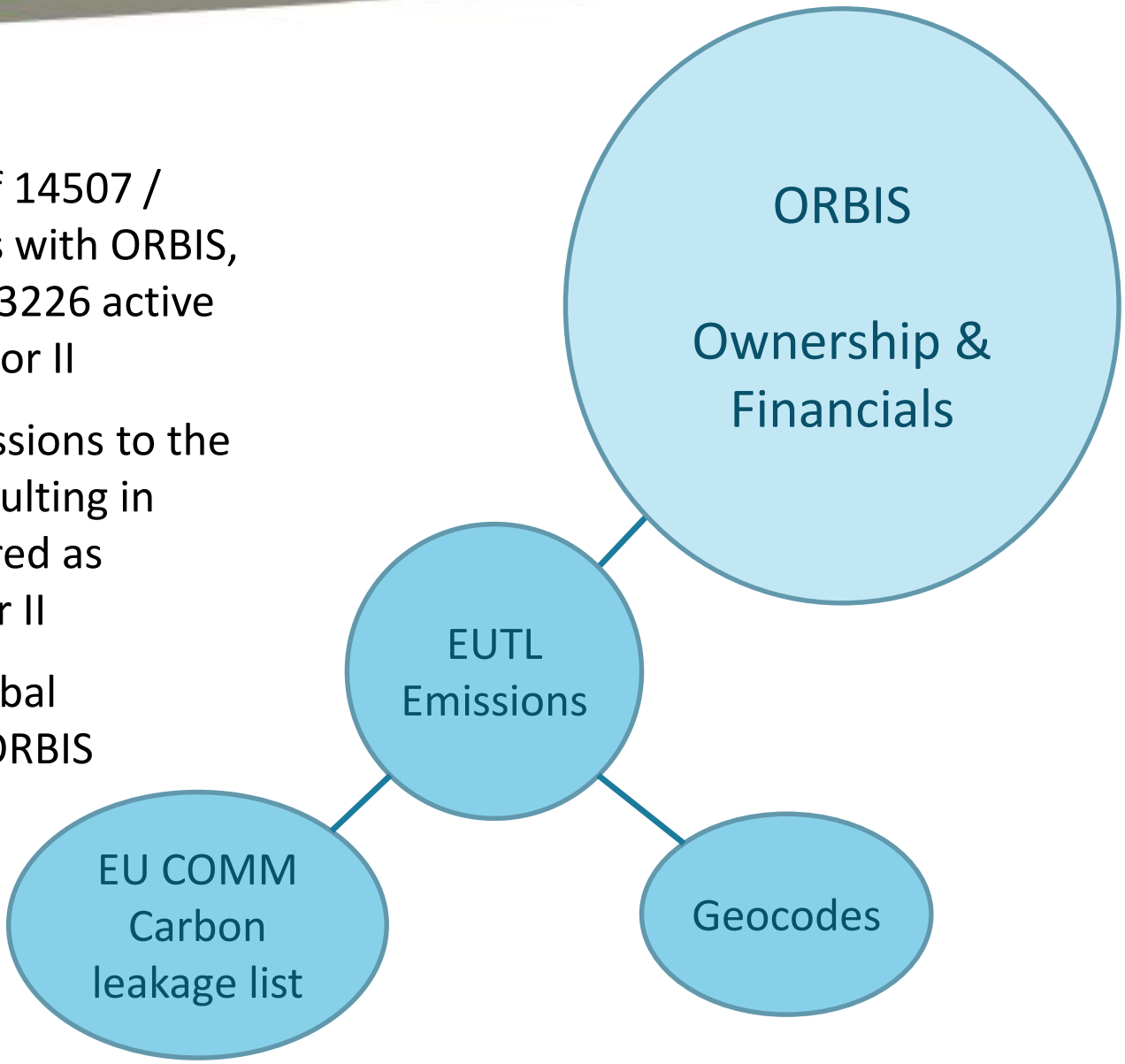
- Hanna (2010)

Structural features of business groups

- Vitali et al. (2011) The Network of Global Corporate Control, Altomonte and Rungi (2013) Business Groups as Hierarchies of Firms

Data structure

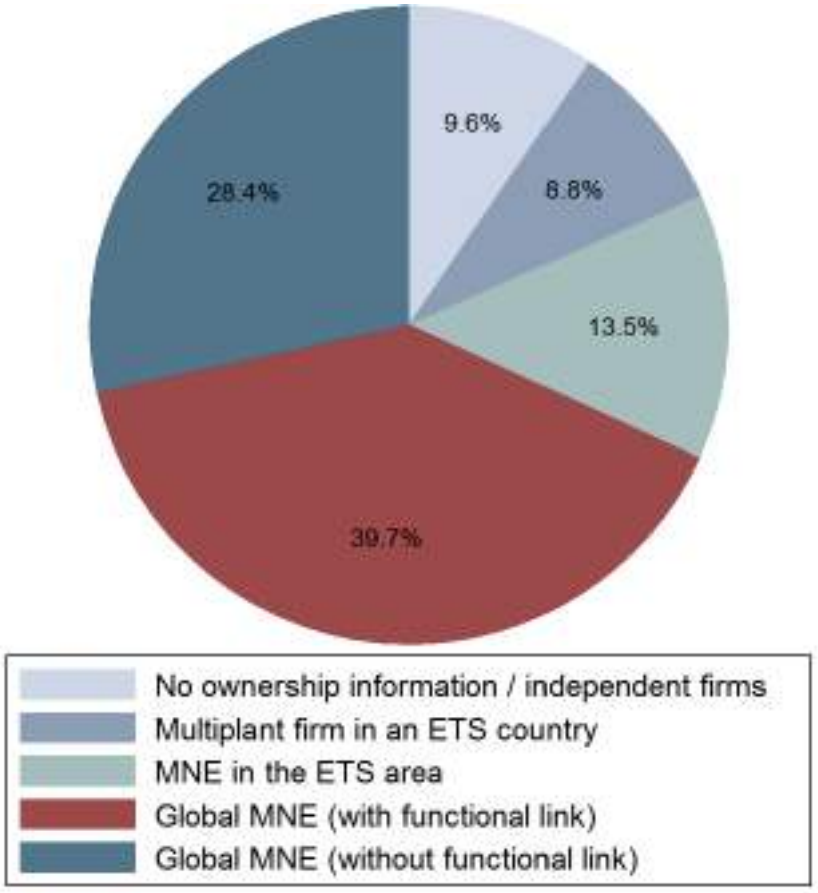
- Successful match of 14507 / 15043 ETS accounts with ORBIS, then reduction to 13226 active accounts in phase I or II
- Aggregation of emissions to the (first) firm level, resulting in 7279 firms considered as treated in phase I or II
- Identification of global ultimate owner in ORBIS (own definition)



Ownership algorithm

- Building upon Jaraite et al. (2013) we track top shareholders until we reach the end of a chain of control
- Ownership links have to be majority shares, joint ventures and controlling minority shares are excluded
- Global ultimate owner (GUO) have to be firms and have to control at least one subsidiary
- Firm structures can be identified in each year to test different structural assumptions

Verified emissions by firm type (2012)



Business Group Definitions

A) Global MNE

- Firm is part of a business group that consists of **multiple firms in both EU-ETS and non-EU-ETS countries** and at least one firm in the network has to be outside of the EU28+3

B) Global MNE with functional link

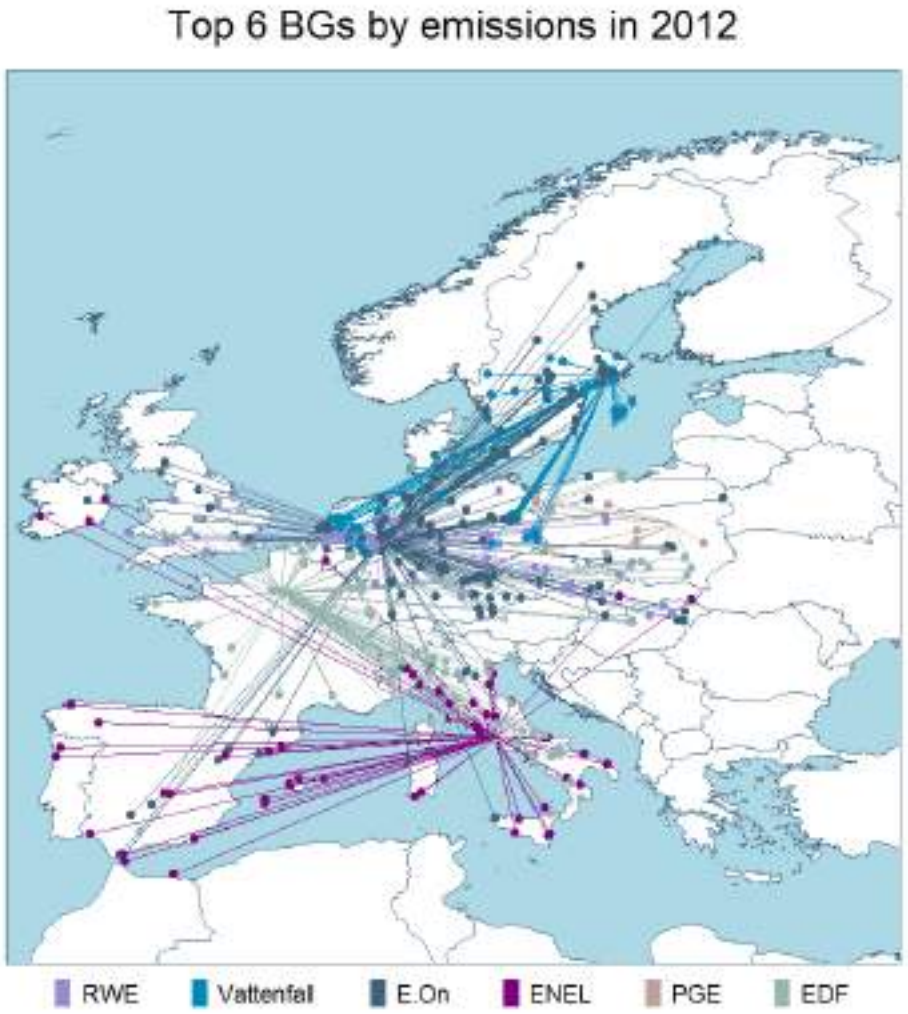
- Firm is part of a business (sub-)group that **operates within the same 2-digit NACE code**, consists of multiple firms in both EU-ETS non-EU-ETS countries and at least one firm in the functional network has to be outside of the EU28+3

C) Global MNE without functional link

- A) – C). Same as Global MNE, but we either have no information on sector similarity or we know that the firms are not active in similar sectors

Ownership structure

- ORBIS allows to track ownership of ETS accounts and identify business groups
- Group structures can be highly complex
- We identify firms that are part of multinational business groups and that have a (functionally equivalent, i.e. same sub-sector/industry) counterpart outside of the EU ETS area



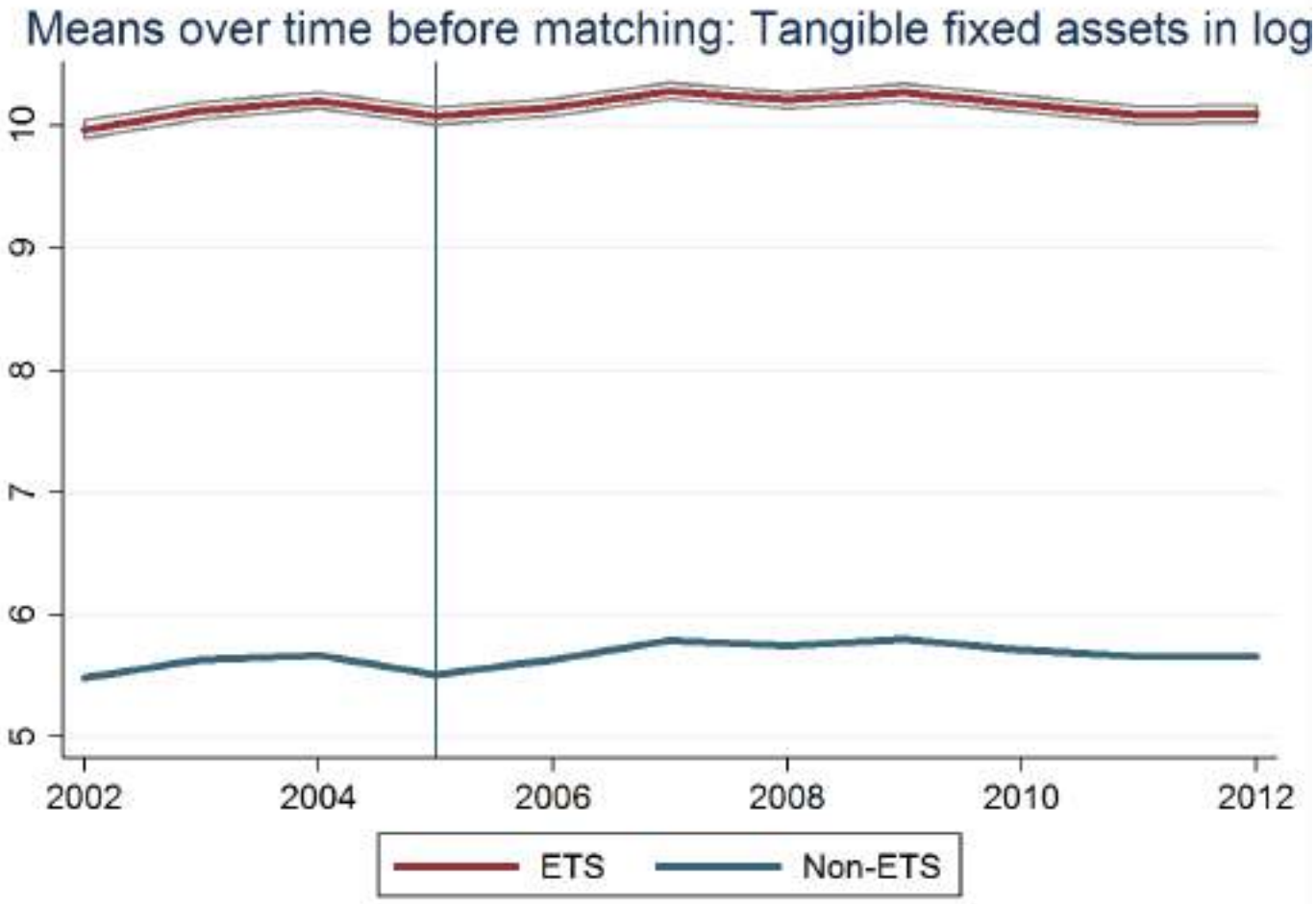
Summary statistics

- ORBIS pre-match

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) p25	(6) p50	(7) p75	(8) max
Total assets	13,497,404	33,448	1,370,056	0	933	2,415	6,037	1,416,132,580
Tangible fixed assets	13,079,039	4,725	142,930	0	38	231	1,232	112,801,797
Operating revenue	10,269,580	17,911	367,276	0	896	2,117	5,808	180,254,803
Number of employees	7,852,799	56	661	0	5	13	32	277,684
Investment ratio	11,527,596	.016	.19	-22	-.035	-.0003	.039	36
Tangible fixed asset ratio	13,071,929	.25	.28	0	.027	.14	.4	1
Profit ratio	9,744,471	-26	5,689	-6,990,853	.0057	.036	.095	2,734,182
Relative total asset ratio	750,813	.71	139	0	.0043	.035	.19	51,641
Date of incorporation	13,748,139	1,989	17	1,000	1,986	1,994	1,999	2,004

- N = number of observations
- Firms incorporated before 2005 in ETS countries and sectors
- Outliers excluded: Firms with jumps in the variables exceeding 99.9% of each period, implausible values (-5,61% of obs.)

Summary statistics



Stage I: „Design“

- Approach: “Control” via adequate “Choice” of comparison group
- Aim: improving overlap in covariate distributions before treatment between samples of treated and untreated firms
- Propensity score matching with 1-1 nearest neighbor and exact matching on the sector-country level
- Extensive matching on pre-treatment data (i.e., 2002-2004) to substantiate the common trend assumption
- Key covariates: total assets in logs, tangible fixed assets in logs, operating revenue in logs

Also matched on:

- Date of incorporation, investment ratio, profit ratio, tangible fixed asset ratio
- *First lags of* investment ratio, total assets in logs, tangible fixed assets in logs, operating revenue in logs, profit ratio, tangible fixed asset ratio
- *Second lags of* total assets in logs, tangible fixed assets in logs, operating revenue in logs, profit ratio, tangible fixed asset ratio

Matching details

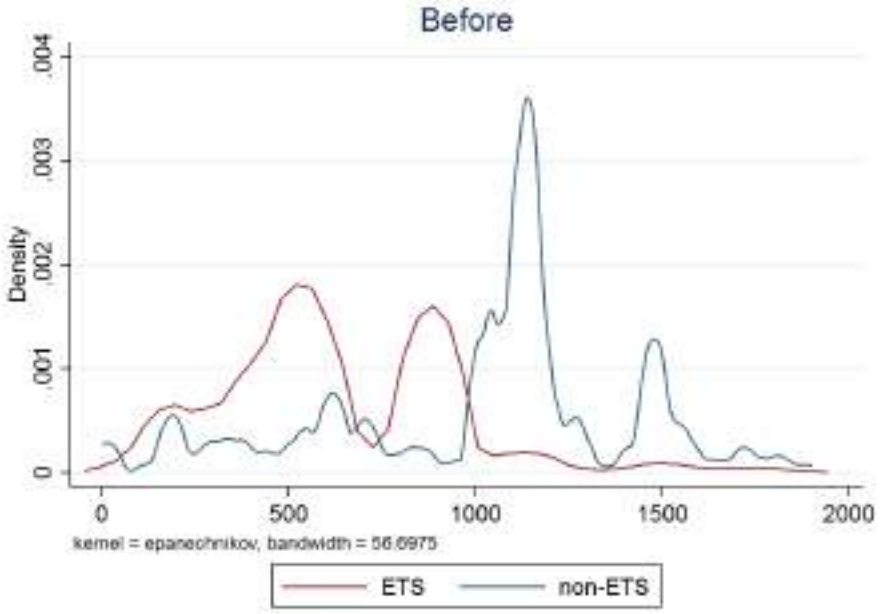
Variable	Unmatched / Matched	Mean Treated	Mean Control	%bias	%reduct |bias|	t-test t	t-test p>|t|	V(T)/ V(C)
g	U	632.2	1015.2	-106.1		-50.79	0.000	0.59*
	M	645.12	645.12	0.0	100.0	0.00	1.000	1.00
TOAS_IN	U	11.302	7.9063	189.7		116.75	0.000	1.64*
	M	10.908	10.858	2.7	98.6	0.92	0.355	0.96
TFAS_IN	U	10.298	5.8081	216.3		112.46	0.000	0.87*
	M	9.8735	9.892	-0.9	99.6	-0.34	0.733	0.95
OPRE_IN	U	11.138	8.1143	168.6		106.10	0.000	1.76*
	M	10.737	10.748	-0.6	99.6	-0.21	0.830	0.92*

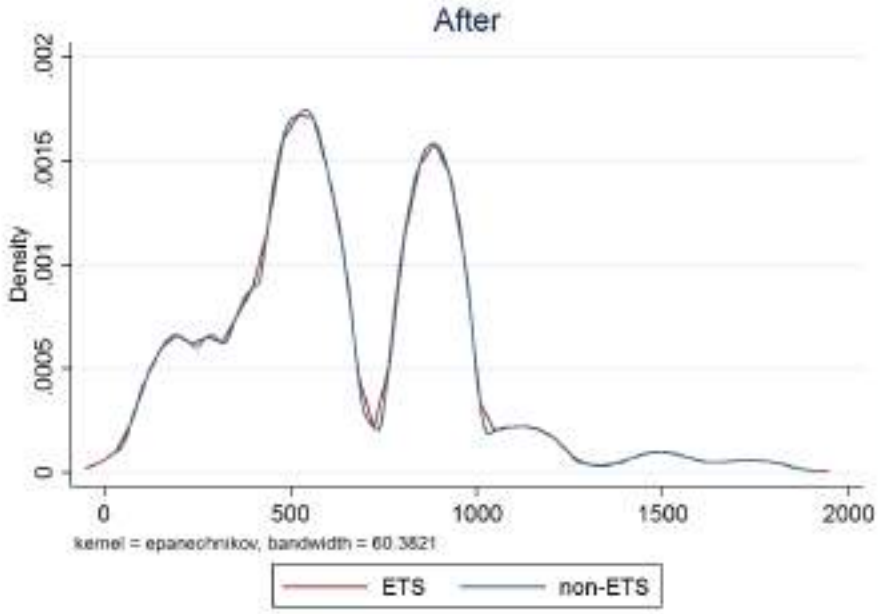
Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.374	13604.78	0.000	114.0	106.1	234.2*	0.89	79
Matched	0.006	39.83	0.003	2.0	1.0	18.1	1.30	42

* if B>25%, R outside [0.5; 2]

Summary statistics

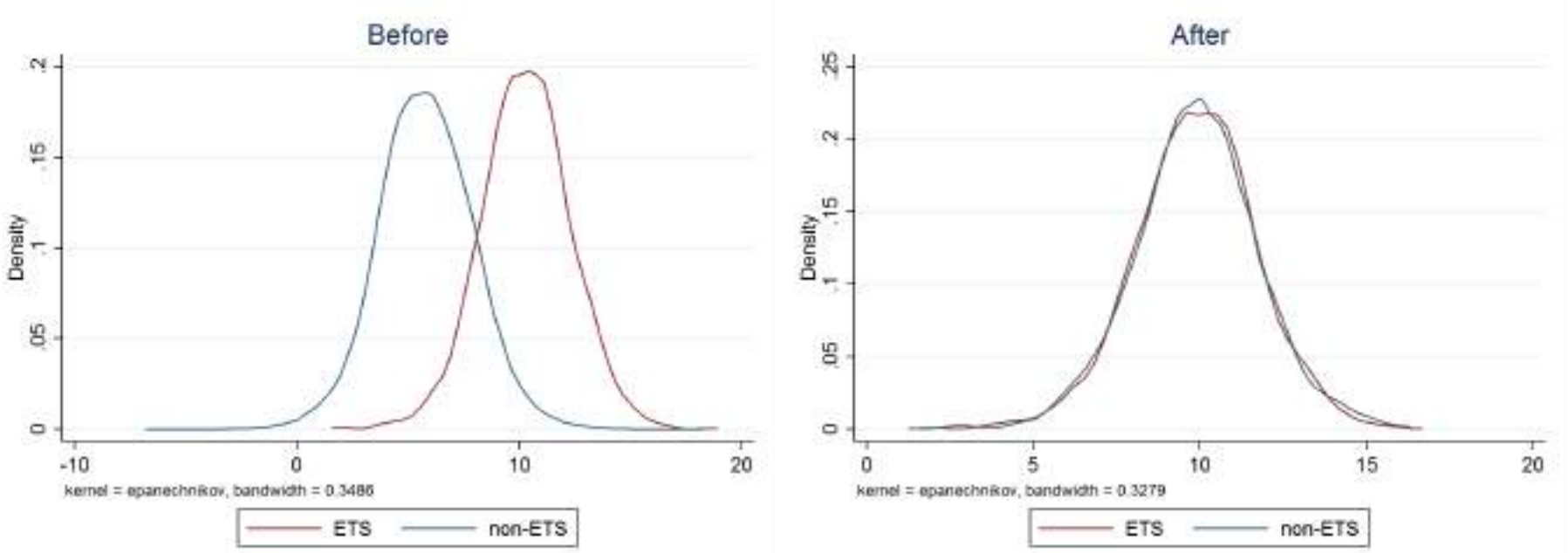
Country and sector combinations





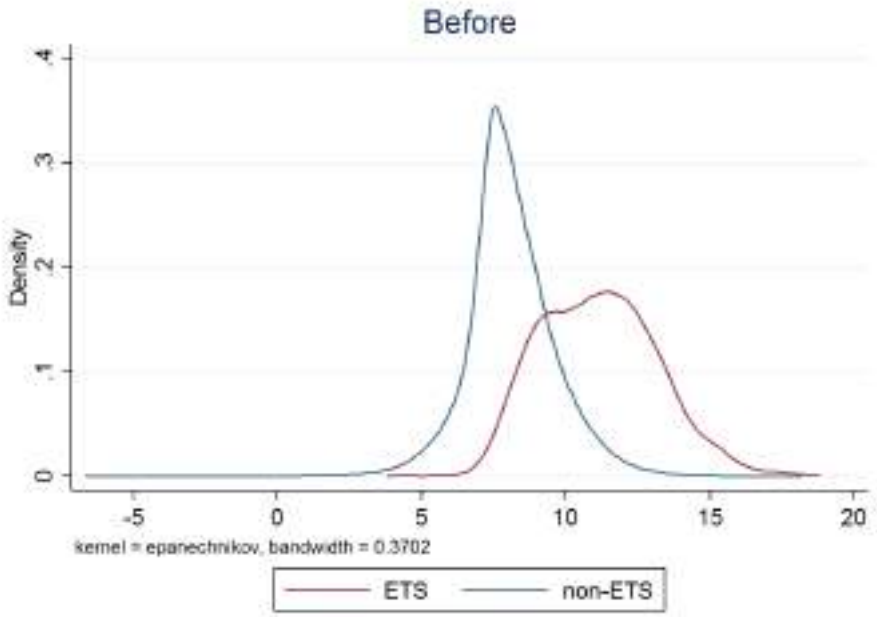
Summary statistics

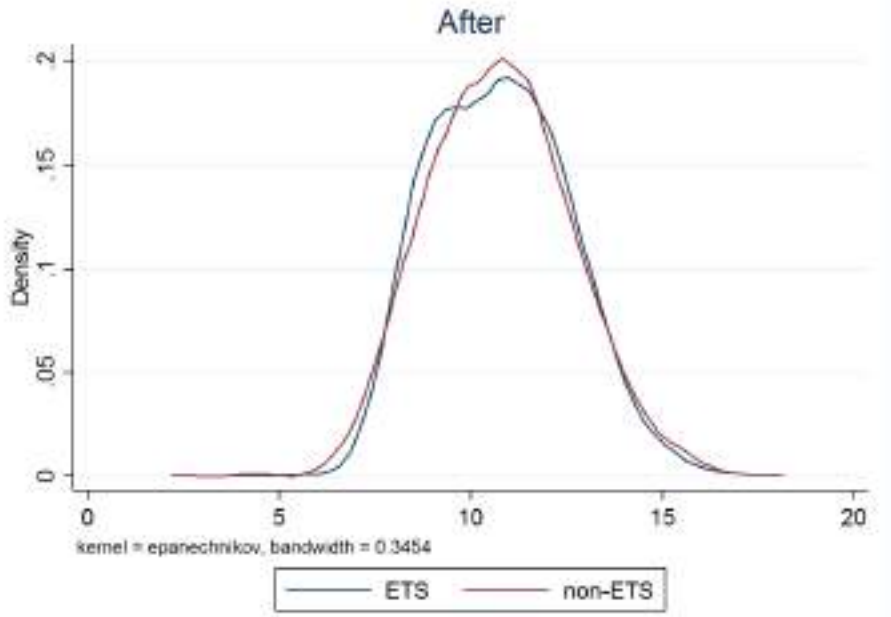
Tangible fixed assets in logs



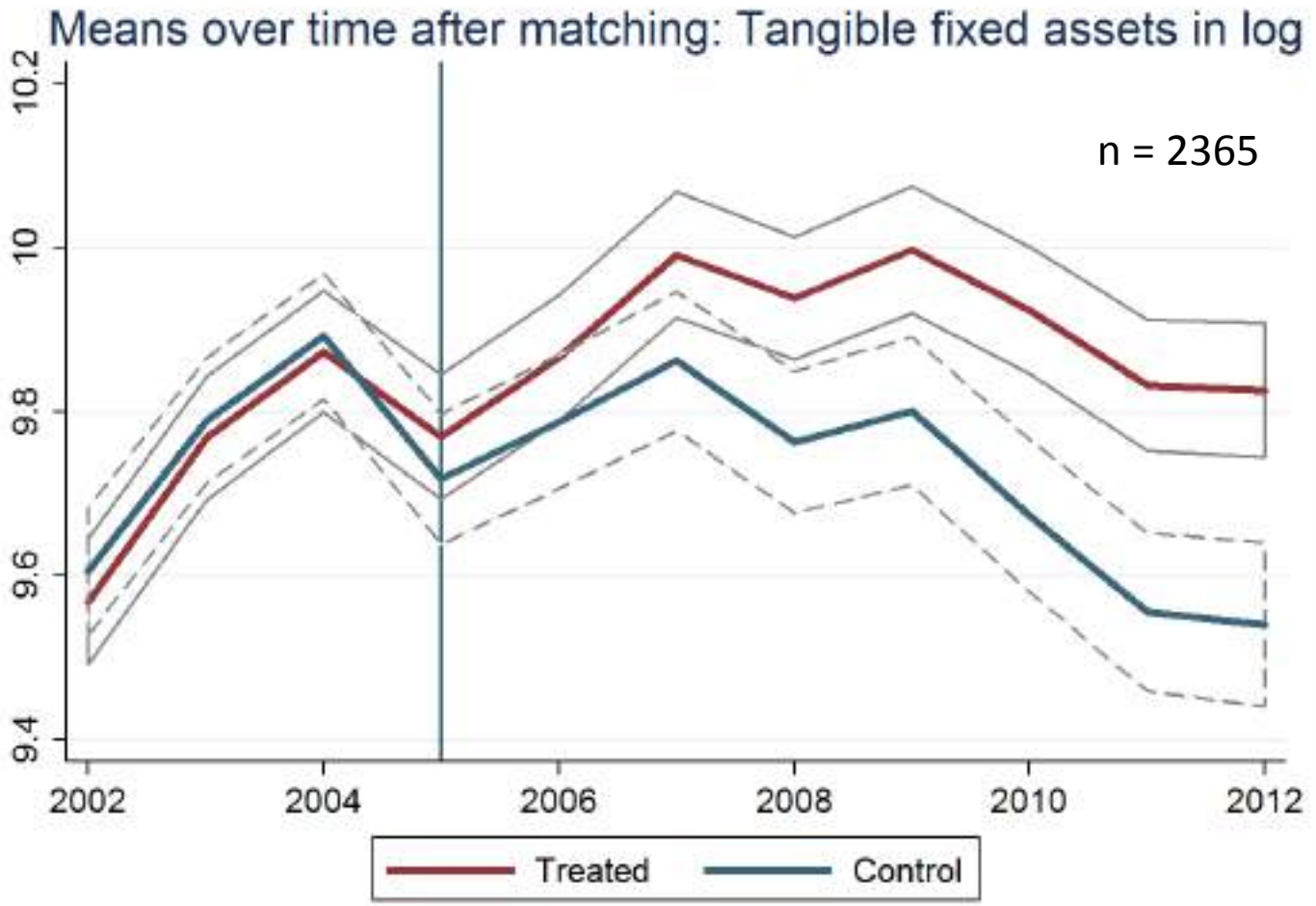
Summary statistics

Operating Revenue (Turnover) in logs





Summary statistics



Stage II: Causal analysis

- Pooled OLS estimation of a Difference-in-Differences (DiD) regression model with clustering of standard errors at level of individual firm
- Firm-level dummy variables to control for heterogeneous influences at firms, sub-sectors, countries, years etc.
- Interaction between treatment effect and indicator variables for firm structure enables detection of differential MNE effects (with vs. w/o link)
- Alternative definitions of treatment period (Phase I & II combined vs. only Phase II) allow for separate analyses of individual trading phases

$$TFAS_{i,t} = \alpha + \beta X_{i,t} + \gamma ETS_i + \lambda period_t + \varphi_1 MNE\_link_i + \varphi_2 MNE\_no\text{-}link_i$$
$$+ \delta treat_{i,t} + \phi_1 MNE\_link_i \times treat_{i,t} + \phi_2 MNE\_no\text{-}link_i \times treat_{i,t}$$
$$+ \tau T_t + \mu I_i + \varsigma C_i + \varepsilon_{i,t}$$

Stage II: Causal analysis

$$TFAS_{i,t} = \alpha + \beta X_{i,t} + \gamma ETS_i + \lambda period_t + \varphi_1 MNE\_link_i + \varphi_2 MNE\_no\text{-}link_i + \delta treat_{i,t} + \phi_1 MNE\_link_i \, x \, treat_{i,t} + \phi_2 MNE\_no\text{-}link_i \, x \, treat_{i,t} + \tau T_t + \mu I_i + \varsigma C_i + \varepsilon_{i,t}$$

$X_{i,t}$ – vector of firm-level financial covariates (i.e. TOAS, TFAS/TOAS, OPPL/OPRE)

ETS_i – dummy for EU ETS/non EU ETS firm | $period_t$ – period dummy (0 pre 2005, 1 from 2005)

MNE_link_i – MNE structure dummy (1 if global MNE with functional link outside EU ETS)

$MNE\_no\text{-}link_i$ – MNE structure dummy (1 if global MNE but w/o functional link)

$treat_{i,t} = ETS_i \times period_t$ – interaction of ETS and period indicator (1 for ETS firms in 2005 et seq.; 0 otherwise)

T_t – Year dummy | I_i – Industry dummy (Nace sub-sector) | C_i – Country dummy

4. Results – Tangible fixed assets

Table 1: Baseline effects (1)

	(1)	(2)	(3)
ETS treatment effect	0.133***	0.144***	0.143***
Global MNE and treated		−0.042	
Global MNE without functional link and treated			−0.092**
Global MNE with functional link and treated			0.001
Firms	2632	2632	2632

Significance levels: * p <0.10, ** p <0.05, *** p <0.01

Standard errors are clustered on the firm level.

Yearly fixed effects and firm-level fixed effects included.

- Global MNE defined as a firm belonging to a business group that is active both within the EU-ETS area and outside of it
- Functional link defined as an existing firm outside of the EU-ETS area that shares the same NACE two-digit code
- No „connected“ companies
- Outlier larger or smaller than 99.9% of our sample excluded
- Sample reduced to “survivors”, firms that have full coverage of tangible fixed assets and operating revenue from 2002-2012

4. Results – Tangible fixed assets (2)

Table 2: Baseline effects (2)

	(1)	(2)	(3)
ETS Phase I treatment	0.074***	0.078***	0.076***
ETS Phase II treatment	0.168***	0.188***	0.187***
Global MNE and treated (I)		−0.018	
Global MNE and treated (II)		−0.068	
Global MNE without functional link and treated (I)			−0.046
Global MNE without functional link and treated (II)			−0.127**
Global MNE with functional link and treated (I)			0.011
Global MNE with functional link and treated (II)			−0.018
Firms	2632	2632	2632

Significance levels: * p <0.10, ** p <0.05, *** p <0.01

Standard errors are clustered on the firm level.

Yearly fixed effects and firm-level fixed effects included.

- Model 1a – ETS Phase I & II effects
- No „connected“ companies
- Outlier larger or smaller than 99.9% of our sample excluded
- Sample reduced to “survivors”, firms that have full coverage of tangible fixed assets and operating revenue from 2002-2012

4. Results – Tangible fixed assets (3)

Table 3: Baseline effects (3)

	(1)	(2)	(3)
ETS Phase I treatment	0.074***	0.075***	0.073***
ETS Phase II treatment	0.168***	0.140***	0.152***
ETS Phase I underallocated		−0.005	0.013
ETS Phase II underallocated		0.152***	0.193***
Global MNE and treated (I)			0.004
Global MNE and treated (I), underallocated			−0.075
Global MNE and treated (II)			−0.042
Global MNE and treated (II), underallocated			−0.129
Firms	2632	2632	2632

Significance levels: * p <0.10, ** p <0.05, *** p <0.01

Standard errors are clustered on the firm level.

Yearly fixed effects and firm-level fixed effects included.

- Model 1b – ETS Phase I & II underallocation
- No „connected“ companies
- Outlier larger or smaller than 99.9% of our sample excluded
- Sample reduced to “survivors”, firms that have full coverage of tangible fixed assets and operating revenue from 2002-2012

4. Results – Tangible fixed assets (4)

Table 4: Effect heterogeneity (1)

	(1) Baseline	(2) Manufacturing	(3) CLL only	(4) Energy
ETS treatment effect	0.143***	0.136***	0.216***	0.129**
Global MNE without functional link and treated	−0.092**	−0.106***	−0.120***	−0.058
Global MNE with functional link and treated	0.001	−0.007	−0.009	−0.077
Firms	2632	1670	1174	580

Significance levels: * p <0.10, ** p <0.05, *** p <0.01

Standard errors are clustered on the firm level.

Yearly fixed effects and firm-level fixed effects included.

- Model 1
- No „connected“ companies
- Outlier larger or smaller than 99.9% of our sample excluded
- Sample reduced to “survivors”, firms that have full coverage of tangible fixed assets and operating revenue from 2002-2012

4. Results – Tangible fixed assets (5)

Table 5: Effect heterogeneity (2)

	(1) Baseline	(2) Manufacturing	(3) CLL only	(4) Energy
ETS Phase I treatment	0.076***	0.076***	0.122***	0.047
ETS Phase II treatment	0.187***	0.177***	0.278***	0.182**
Global MNE without functional link and treated (I)	−0.046	−0.068	−0.086*	0.054
Global MNE without functional link and treated (II)	−0.127**	−0.134***	−0.153***	−0.115
Global MNE with functional link and treated (I)	0.011	−0.027	−0.001	0.025
Global MNE with functional link and treated (II)	−0.018	−0.011	−0.033	−0.139
Firms	2632	1670	1174	580

Significance levels: * p <0.10, ** p <0.05, *** p <0.01

Standard errors are clustered on the firm level.

Yearly fixed effects and firm-level fixed effects included.

- Model 1a – ETS Phase I & II
- No „connected“ companies
- Outlier larger or smaller than 99.9% of our sample excluded
- Sample reduced to “survivors”, firms that have full coverage of tangible fixed assets and operating revenue from 2002-2012

4. Results – Tangible fixed assets (6)

Table 11: Baseline - sample comparison (1)

	(1) Baseline	(2) Baseline 2	(3) Baseline 3	(4) Baseline 4	(5) Baseline 5
ETS treatment effect	0.143***	0.153***	0.161***	0.148***	0.106***
Global MNE without functional link and treated	−0.092**	−0.096*	−0.058	−0.032	−0.021
Global MNE with functional link and treated	0.001	0.007	0.014	−0.002	−0.004
Firms	2632	1894	2846	4718	5684

Significance levels: * p <0.10, ** p <0.05, *** p <0.01

Standard errors are clustered on the firm level.

Yearly fixed effects and firm-level fixed effects included.

	(1) (Baseline)	(2) (Baseline 2)	(3) (Baseline 3)	(4) (Baseline 4)	(5) (Baseline 5)
Very large firms excluded	✓	✓			
Firms connected to the treatment group excluded	✓	✓	✓		
Firms with missing asset data excluded	✓	✓	✓		
Sector	All	All	All	All	All
NACE code	2-digit	3-digit	2-digit	2-digit	2-digit
Treatment group	1316	947	1423	2359	2842
Control group	1316	947	1423	2359	2842

4. Results – Tangible fixed assets (7)

Table 14: Manufacturing - sample comparison (1)

	(1) Manufacturing	(2) Manufacturing 2	(3) Manufacturing 3	(4) Manufacturing 4	(5) Manufacturing 5
ETS treatment effect	0.136***	0.185***	0.149***	0.158***	0.119***
Global MNE without functional link and treated	−0.106***	−0.136***	−0.095**	−0.066*	−0.052
Global MNE with functional link and treated	−0.007	−0.063	0.005	0.013	−0.002
Firms	1670	1052	1740	2868	3358

Significance levels: * p <0.10, ** p <0.05, *** p <0.01

Standard errors are clustered on the firm level.

Yearly fixed effects and firm-level fixed effects included.

	(1) (Manufacturing)	(2) (Manufacturing 2)	(3) (Manufacturing 3)	(4) (Manufacturing 4)	(5) (Manufacturing 5)
Very large firms excluded	✓	✓			
Firms connected to the treatment group excluded	✓	✓	✓		
Firms with missing asset data excluded	✓	✓	✓		
Sector	Manuf.	Manuf.	Manuf.	Manuf.	Manuf.
NACE code	2-digit	3-digit	2-digit	2-digit	2-digit
Treatment group	835	526	870	1434	1679
Control group	835	526	870	1434	1679

4. Results – Tangible fixed assets (8)

Table 15: Manufacturing - sample comparison (2)

	(1) Manufacturing	(2) Manufacturing 2	(3) Manufacturing 3	(4) Manufacturing 4	(5) Manufacturing 5
ETS Phase I treatment	0.076***	0.106***	0.082***	0.091***	0.035
ETS Phase II treatment	0.177***	0.238***	0.194***	0.210***	0.184***
Global MNE without functional link and treated (I)	−0.068	−0.058	−0.062	−0.046	−0.031
Global MNE without functional link and treated (II)	−0.134***	−0.183***	−0.122**	−0.090**	−0.081*
Global MNE with functional link and treated (I)	−0.027	−0.151***	−0.020	0.005	−0.006
Global MNE with functional link and treated (II)	−0.011	−0.046	0.004	0.003	−0.019
Firms	1670	1052	1740	2868	3358

Significance levels: * p <0.10, ** p <0.05, *** p <0.01

Standard errors are clustered on the firm level.

Yearly fixed effects and firm-level fixed effects included.

Conclusions

Preliminary evidence on regulated firms in general

- **Positive effects** on regulated firms‘ **tangible fixed assets**
- **Effect on assets** is so far **robust**
- ➢ *Asset effect*: Firms invest in adaption to a regulation they can’t evade?

Preliminary specific evidence on MNEs

- *global MNEs w/o functional link*: **negative, highly significant effect** on **tangible fixed assets**
- *global MNEs with functional link*: **no significant effect**

- ➢ *MNEs w/o link*: **Investing to establish functional links** outside of EU ETS?
- ➢ *MNEs with link*: **“Sit-and-wait strategy”** (capacity shifts possible if EU ETS becomes more biting)

Some ideas for next steps

- Further robustness checks to strengthen internal validity:
  - w.r.t. matching specifications
  - w.r.t. estimation models
- In-depth analyses of potential composition effects in ownership groups (i.e. different firms, treated and untreated, that belong to same GUO)
- If feasible (but looks rather unlikely after first rounds of data screening): in-depth analysis of spatial investment dynamics for the subset of MNEs that are covered by consolidated and unconsolidated accounts in ORBIS
- Research avenues to assess external validity:
  - analysis of trade flows in manufactured goods form regulated sectors?
  - analysis of emissions data once available

Many thanks for your attention!

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