The Effect of the EU Emissions Trading System on Climate Investments

Felix Rochlitz

University of Basel

felix.rochlitz@unibas.ch

07.07.25

Motivation

- EU ETS **reduced emissions** of regulated firms
- However, lack of robust evidence on **mechanisms** that led to emissions reductions (Colmer et al., 2024)
- **Empirical evidence on climate-investments** at the firm-level is "badly needed" (Teixidó et al., 2019)

Motivation

- EU ETS **reduced emissions** of regulated firms
- However, lack of robust evidence on **mechanisms** that led to emissions reductions (Colmer et al., 2024)
- **Empirical evidence on climate-investments** at the firm-level is "badly needed" (Teixidó et al., 2019)

Research Question:

Do firms increase spending on climate investments after EU ETS regulation?

In a nutshell

- **What?** Effect EU ETS $\rightarrow$ climate investments
- **Why?** Evidence on this mechanism needed

In a nutshell

- **What?** Effect EU ETS $\rightarrow$ climate investments
- **Why?** Evidence on this mechanism needed
- **Who?** Manufacturing firms that entered EU ETS in 2013

In a nutshell

- **What?** Effect EU ETS $\rightarrow$ climate investments
- **Why?** Evidence on this mechanism needed
- **Who?** Manufacturing firms that entered EU ETS in 2013
- **When?** 2006-2017

In a nutshell

- **What?** Effect EU ETS $\rightarrow$ climate investments
- **Why?** Evidence on this mechanism needed
- **Who?** Manufacturing firms that entered EU ETS in 2013
- **When?** 2006-2017
- **Where?** Germany

In a nutshell

- **What?** Effect EU ETS $\rightarrow$ climate investments
- **Why?** Evidence on this mechanism needed
- **Who?** Manufacturing firms that entered EU ETS in 2013
- **When?** 2006-2017
- **Where?** Germany
- **Wie?** (How?) Event study/Diff-in-Diff

In a nutshell

- **What?** Effect EU ETS $\rightarrow$ climate investments
- **Why?** Evidence on this mechanism needed
- **Who?** Manufacturing firms that entered EU ETS in 2013
- **When?** 2006-2017
- **Where?** Germany
- **Wie?** (How?) Event study/Diff-in-Diff
- **With what result?** More firms invest (but firms do not invest more)

This Paper...

- Advances literature on firm responses to the EU ETS by **isolating climate investments**

This Paper...

- Advances literature on firm responses to the EU ETS by **isolating climate investments**
- Adds to **limited ex-post evidence** for the **third trading phase**

This Paper...

- Advances literature on firm responses to the EU ETS by **isolating climate investments**
- Adds to **limited ex-post evidence** for the **third trading phase**
- **Improves identification** by separately analysing newly regulated firms in the third trading phase (**SUTVA** more likely to hold)

Main Outcome Variable

- **Climate Investments**
  - **Energy efficiency**: e.g. heat pumps, insulation
  - **Emission reduction**: investments aimed at lowering GHG emissions
  - **Renewable energy**: investments in wind, solar power etc. ▸ Detail

→ Numeric accounting variable from firm survey

Main Outcome Variable

- **Climate Investments**
  - **Energy efficiency**: e.g. heat pumps, insulation
  - **Emission reduction**: investments aimed at lowering GHG emissions
  - **Renewable energy**: investments in wind, solar power etc. ▸ Detail

$\rightarrow$ Numeric accounting variable from firm survey

$\neq$ Environmental Investments (air pollution, waste, ...)

Literature

- Emission reduction (Colmer et al., 2024; Dechezleprêtre et al., 2023)
- Mechanisms
  - Competitiveness (Colmer et al., 2024; Dechezleprêtre et al., 2023)
  - Carbon Leakage (Dechezleprêtre et al., 2022)
  - Fuel Switching (Delarue et al., 2008, 2010)
  - Innovation (Borghesi et al., 2015; Calel, 2020; Calel and Dechezleprêtre, 2016)
  - Product Switching
- Climate Investments (Colmer et al., 2024; Goerger, 2021; Jaraite et al., 2014; Löfgren et al., 2014)

Data

- **Administrative firm level** panel dataset from **Germany**
  - AFiD: *Amtliche Firmendaten für Deutschland*
  - Universe of German manufacturing firms ($\geq$ 20 emp.)
  - Highly protected
- EU Transaction Log (**EUTL**)
  - Information on regulation

Data

- **Administrative firm level** panel dataset from **Germany**
  - AFiD: *Amtliche Firmendaten für Deutschland*
  - Universe of German manufacturing firms ($\geq$ 20 emp.)
  - Highly protected
- EU Transaction Log (**EUTL**)
  - Information on regulation
- Time period: **2006-2017**

  $\rightarrow$ variables on climate investments not available before/after

Treatment Group & Sample Restrictions

- **Treatment Group**: All **newly regulated** firms in **2013**
  - Exploit **sector expansion** ▸ Detail
  - Standard definition: At least **one regulated installation**
- **Control**: Firms that **never** got regulated by EU ETS

Treatment Group & Sample Restrictions

- **Treatment Group**: All **newly regulated** firms in **2013**
  - Exploit **sector expansion** ▸ Detail
  - Standard definition: At least **one regulated installation**
- **Control**: Firms that **never** got regulated by EU ETS
- **Parametric sample restrictions** for comparability
  - Exclude firms with no treated firm in **sector** (NACE4)

▸ Detail

Descriptive Statistics (Pre-Treatment)

	Control	Treated	Difference	s.e.	p-value
Climate Investments	0.09	0.17	0.08	0.02	0.00
Climate Investments (Log)*	10.95	12.13	1.18	0.28	0.00
Climate Investments Share of Investments	0.01	0.01	0.00	0.00	0.26
Investments (Log)	12.77	14.99	2.21	0.18	0.00
Environmental Investments (Share)	0.24	0.50	0.26	0.03	0.00
Revenue (Log)	17.14	18.82	1.69	0.09	0.00
Employees (Log)	4.82	5.84	1.02	0.07	0.00
Av. Wages	42189	49512	7323	755	0.00
Direct Emissions (Log)	6.40	9.91	3.50	0.12	0.00
Wage Growth	0.00	0.01	0.01	0.00	0.07
Employment Growth	0.04	0.04	-0.00	0.02	0.96
Used Renewable Energy (Share)	0.02	0.03	0.01	0.01	0.34
East Germany (Share)	0.18	0.20	0.02	0.03	0.41
Single Plant	0.86	0.62	-0.24	0.03	0.00
Observations	5201	264			
Unique Firms	1803	90			

Notes: Table shows - if not otherwise stated - the averages of selected variables in the pre-treatment period (2006-2008) for treated and control firms. *Conditional on investment

Growth Rates

(in %)	Control	Treated	Difference	s.e.	p-value
Climate Investments	0.02	0.03	0.01	0.05	0.84
Investments	0.18	0.32	0.14	0.14	0.33
Revenue	0.09	0.15	0.07	0.05	0.17
Employees	0.07	0.06	-0.01	0.02	0.58
Av. Wages	0.01	0.03	0.02	0.01	0.07
Direct Emissions	0.08	0.32	0.23	0.14	0.09
Total Emissions	0.04	0.09	0.05	0.04	0.20
Invested Environment	-0.01	0.00	0.01	0.05	0.90
Firms	1798	89			

Notes: This table shows the average growth rate between 2006 and 2008

Method and Identifying Assumptions

- Difference-in-Differences (DiD) approach (Event Study)

- **Three assumptions for identification**
  - **Common trend**: same time trend in absence of treatment
  - **Stable Unit Treatment Value Assumption**: no general equilibrium or spillover effects
  - **No anticipation**: no effect in the pre-treatment period

No Anticipation Assumption

- **Gap** between **announcement** (2009) and **implementation** (2013) of Phase 3
- Some firms might **anticipate regulation**
- **Climate investments** might occur **prior to implementation** to **minimise costs** of regulation

No Anticipation Assumption

- **Gap** between **announcement** (2009) and **implementation** (2013) of Phase 3
- Some firms might **anticipate regulation**
- **Climate investments** might occur **prior to implementation** to **minimise costs** of regulation

Approach:

Take **2009 as reference period** to capture possible anticipation effects

Methodology

- Estimation equation:

$$Y_{it} = \lambda_t + \gamma_i + \sum_{\substack{j=-3 \\ j \neq 0}}^{8} \delta_j D_{it} + u_{it} \tag{1}$$

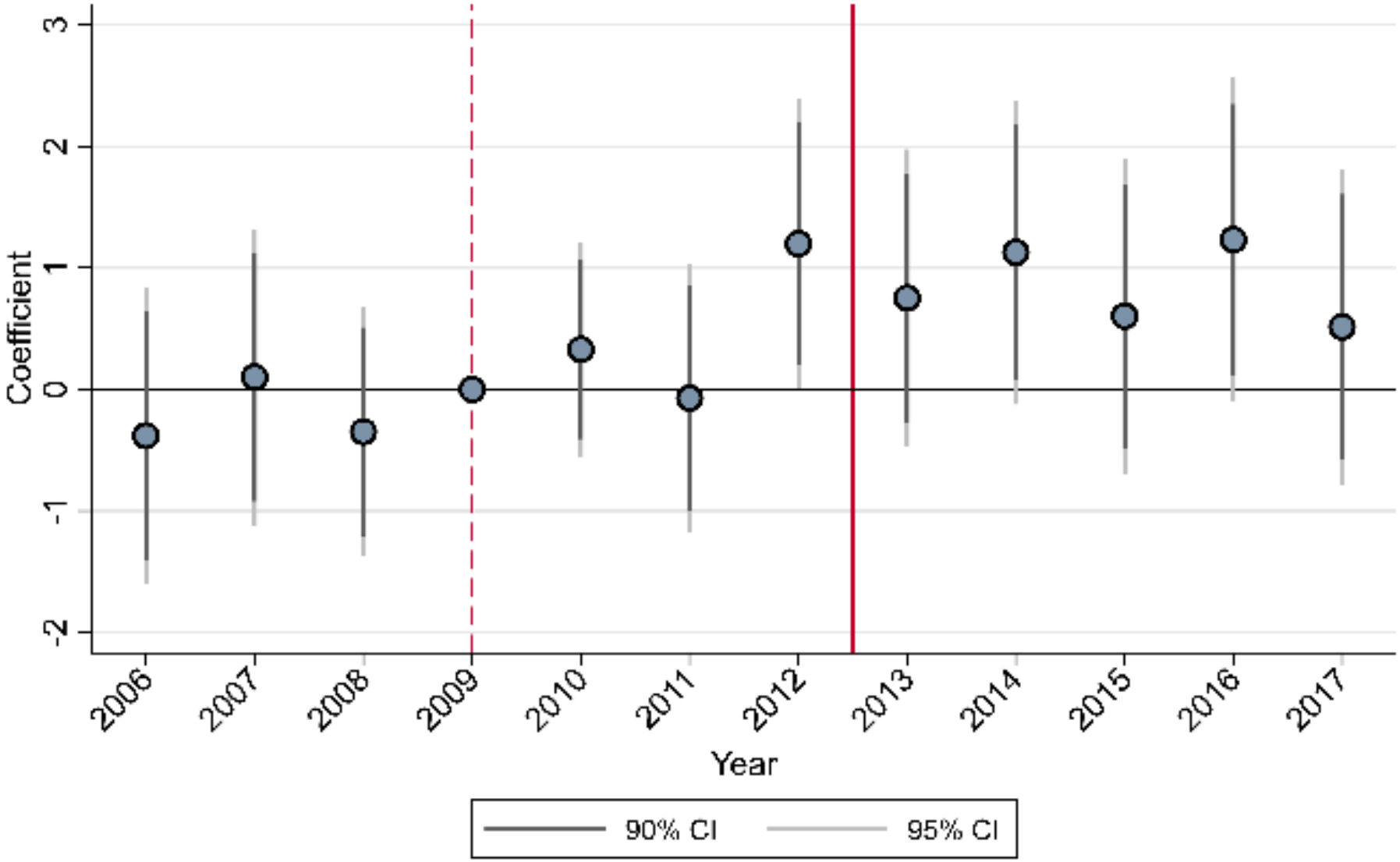
  - Y_{it}: outcome
  - D_{it}: treatment dummy
  - λ_t: year fixed effects
  - γ_i: firm fixed effects
  - u_{it}: error term
  - δ_j: effect of interest
    - $j > 0$: dynamic treatment effects (heterogeneity over time)
    - $j < 0$: test for common pre-treatment trends

Margins

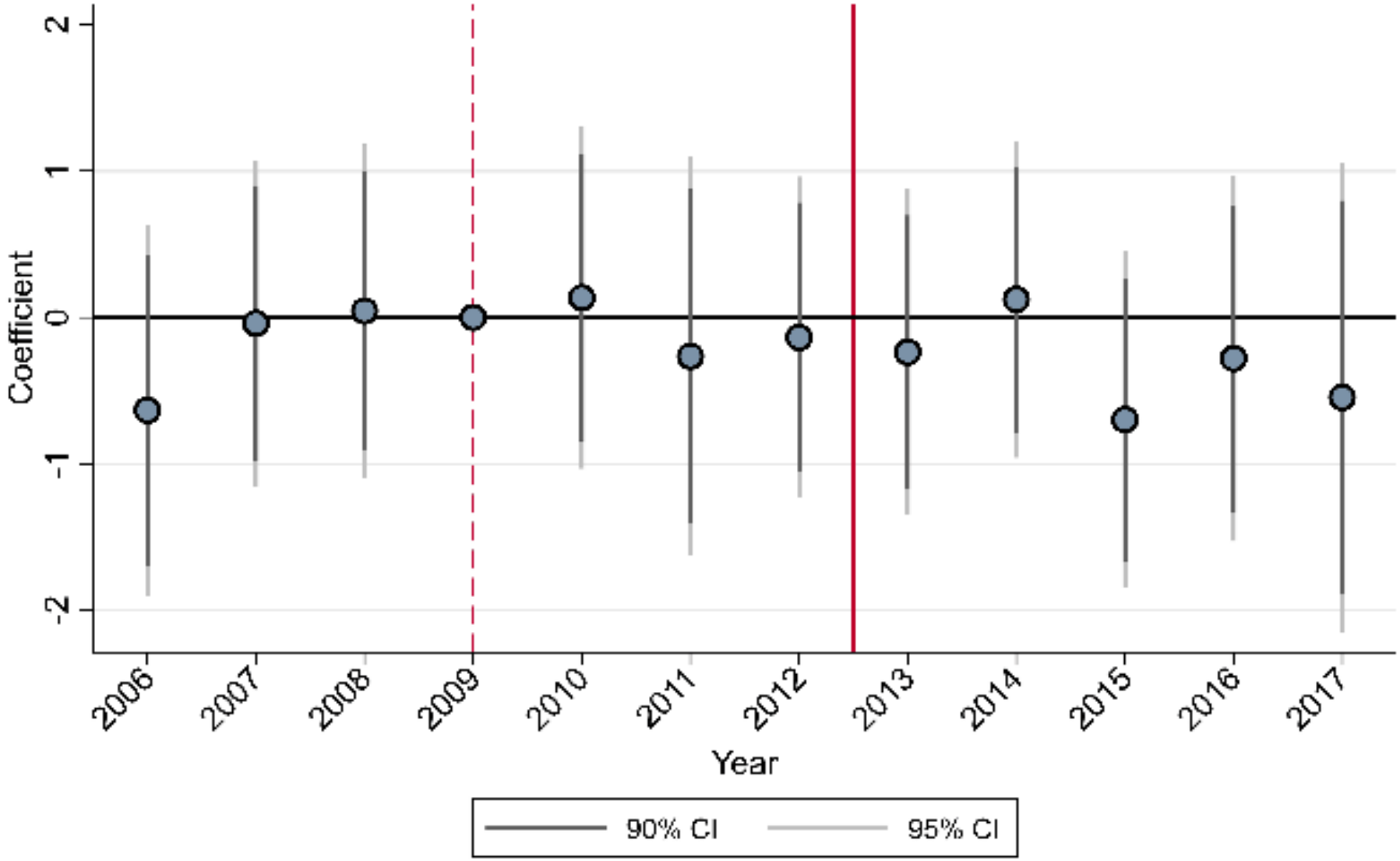
- **Overall**: Total change in climate investments across all firms?
- **Intensive**: Higher total climate investments per firm (that invested)?
- **Extensive**: Did (relatively) more firms invest?

(Log) Climate Investments by Year

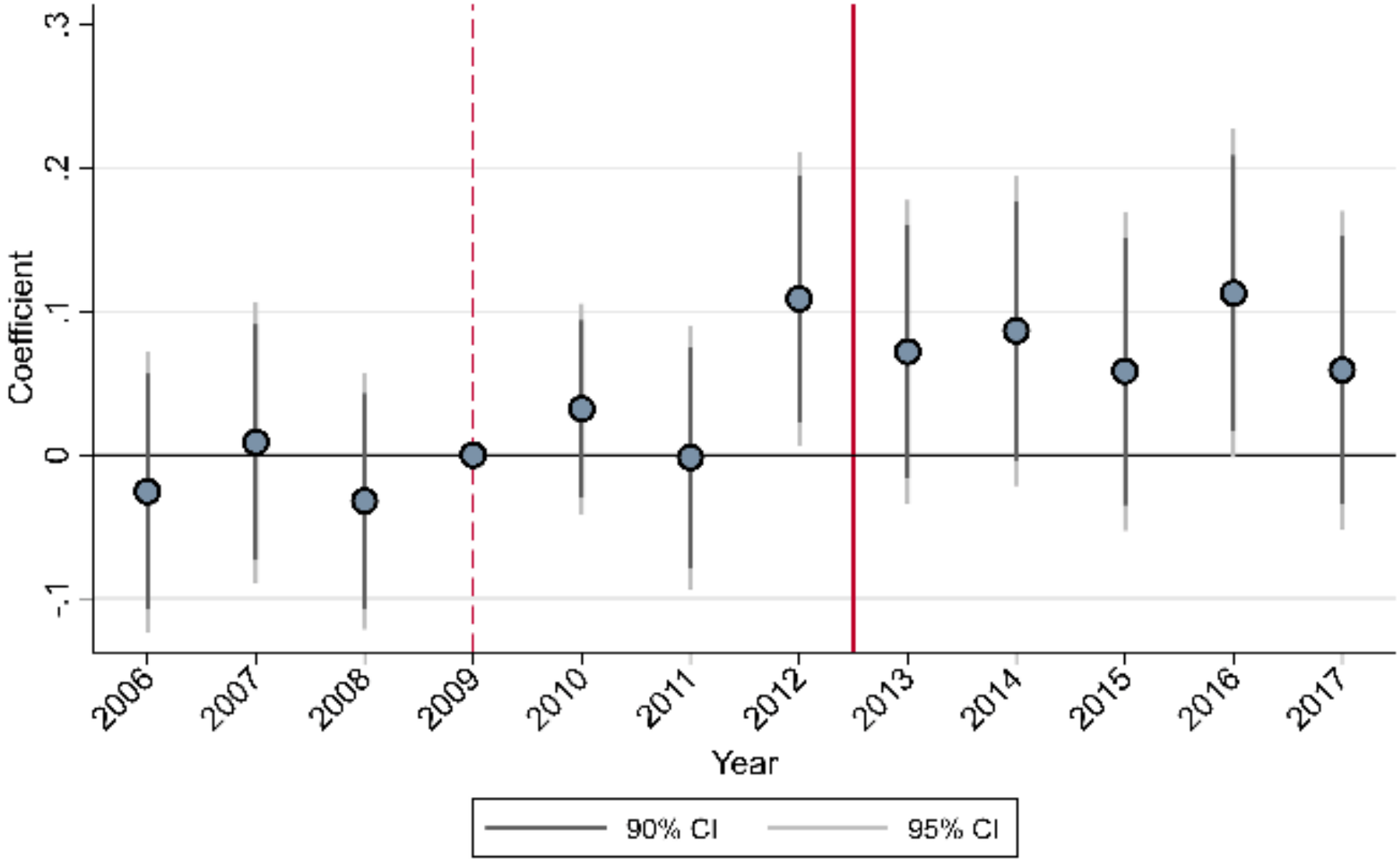
Event Study: Overall Margin



Event Study: Intensive Margin



Event Study: Extensive Margin



Average Treatment Effect on the Treated (ATET)

	(1) Overall	(2) Intensive	(3) Extensive
Pre-Period	-0.209	-0.146	-0.0163
	(0.482)	(0.444)	(0.0395)
Anticipation	0.488	-0.0712	0.0467
	(0.427)	(0.516)	(0.0354)
Post-Period	0.857	-0.312	0.0788*
	(0.533)	(0.569)	(0.0456)
Constant	1.229***	11.08***	0.109***
	(0.0641)	(0.117)	(0.00569)
N	22834	3587	22834
R^2	0.028	0.003	0.028

Firm-level cluster-robust standard errors in parentheses; (1)-(2) in Logs

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

▸ With 2012

Robustness

- Results relatively **robust** to:
  - **Matching** ▸ Graph
  - Broader **sector** definition ▸ Graph
  - Leave one sector out
  - **Reference year** (2008/2010) ▸ Graphs
  - Adding **Controls** ▸ Graph
  - (Higher **emissions cutoff**) ▸ Graph

Drivers

- Results are **driven** by:
  - Investments in **energy efficiency** ($\sim$ 85% of investments) ▸ Graphs
  - **Intensity of regulation**
    - Single Plants ▸ Graph
    - Ratio: Emissions/Free Allowances ▸ Graph
    - Nr. permit purchases ▸ Graph
  - **Small** investments ▸ Graphs

Conclusion

- EU ETS led to **more firms investing into climate related measures**
- **No change** at the **intensive** margin
- **Intensity** of regulation matters
- **External validity?**

Future research:

Research post 2017 (presumably EU ETS' most effective phase)

Thank you!

Felix Rochlitz
felix.rochlitz@unibas.ch

References I

Borghesi, S., G. Cainelli, and M. Mazzanti (2015, April). Linking emission trading to environmental innovation: Evidence from the Italian manufacturing industry. *Research Policy 44*(3), 669–683.

Calel, R. (2020, August). Adopt or Innovate: Understanding Technological Responses to Cap-and-Trade. *American Economic Journal: Economic Policy 12*(3), 170–201.

Calel, R. and A. Dechezleprêtre (2016). Environmental policy and directed technological change: evidence from the European carbon market. *Review of economics and statistics 98*(1), 173–191. Publisher: The MIT Press.

Colmer, J., R. Martin, M. Muûls, and U. J. Wagner (2024, May). Does Pricing Carbon Mitigate Climate Change? Firm-Level Evidence from the European Union Emissions Trading System. *Review of Economic Studies*, rdae055.

Dechezleprêtre, A., C. Gennaioli, R. Martin, M. Muûls, and T. Stoerk (2022, March). Searching for carbon leaks in multinational companies. *Journal of Environmental Economics and Management 112*, 102601.

Dechezleprêtre, A., D. Nachtigall, and F. Venmans (2023, March). The joint impact of the European Union emissions trading system on carbon emissions and economic performance. *Journal of Environmental Economics and Management 118*, 102758.

References II

Delarue, E., K. Voorspools, and W. D'haeseleer (2008, June). Fuel Switching in the Electricity Sector under the EU ETS: Review and Prospective. *Journal of Energy Engineering 134*(2), 40–46.

Delarue, E. D., A. D. Ellerman, and W. D. D'Haeseleer (2010, August). SHORT-TERM CO_2 ABATEMENT IN THE EUROPEAN POWER SECTOR: 2005–2006. *Climate Change Economics 01*(02), 113–133.

Goerger, A. (2021, March). The Effects of the EU ETS on Pollution Abatement Investments.

Jaraite, J., A. Kazukauskas, and T. Lundgren (2014, May). The effects of climate policy on environmental expenditure and investment: evidence from Sweden. *Journal of Environmental Economics and Policy 3*(2), 148–166. Publisher: Routledge _eprint: https://doi.org/10.1080/21606544.2013.875948.

LIFE ETX (2021). Eu ets 101 – a beginner's guide to the eu's emissions trading system. Accessed: [insert access date here].

Löfgren, , M. Wråke, T. Hagberg, and S. Roth (2014, September). Why the EU ETS needs reforming: an empirical analysis of the impact on company investments. *Climate Policy 14*(5), 537–558. Publisher: Taylor & Francis _eprint: https://doi.org/10.1080/14693062.2014.864800.

References III

Teixidó, J., S. F. Verde, and F. Nicolli (2019, October). The impact of the EU Emissions Trading System on low-carbon technological change: The empirical evidence. *Ecological Economics 164*, 106347.