

Competitiveness and investments under emissions trading

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Introduction

EU ETS

- ▶ EU's main climate policy tool, operating since 2005
- ▶ World's largest emissions trading system
- ▶ Covers 40-45% of EU GHG emissions (EU27 + NO, IS, LI)

Policy (side) effects

↓ 45% GHG emissions since 2005, but ...

- ▶ ... Competitiveness loss?
- ▶ ... Leakage? (Pollution haven hypothesis)
- ▶ ... Investment impulse? (Weak Porter Hypothesis, EE paradox?)

Research questions

What is the effect of the EU ETS on Dutch *manufacturing* firms' ...

- 1 ... competitiveness? (Employment, profits)
- 2 ... technology adoption? (Investments)

What are the ETS's ...

- 3 ... *heterogeneous* effects between cohorts and over phases?

Novelty

- 1 Fit the staggered heterogeneous treatment
- 2 Utilize typical TWFE & newer flexible DiD method
- 3 Include the more stringent Phase 3

Competitiveness

- ▶ No negative effects on productivity and employment (Dechezleprêtre et al., 2023; Jaraite-Kažukauske & Di Maria, 2016; Löschel et al., 2019; Verde, 2020; Wagner & Petrick, 2014)

Leakage

- ▶ Little evidence of leakage (Dechezleprêtre et al., 2019; Martin et al., 2014)
- ▶ Negative intra-firm leakage in Japan (Sadayuki & Arimura, 2021)

Innovation

- ▶ Some directed technological change (Calel & Dechezleprêtre, 2016; Teixidó et al., 2019)

Methods

- ▶ Difference-in-differences with multiple treatment periods (Callaway & Sant'Anna, 2021; Klemetsen et al., 2020)

EU ETS

- ▶ Introduced in 2005, revised in 2008, 2013, 2021 (Phases 1-4)
- ▶ Caps 40-45% of EU emissions (in 2021: 1.57 bln tCO₂eq)
- ▶ 2021: 56% auctioned, LRF 2.2%
- ▶ Auctions and (futures) trade establish a carbon price

ETS inclusion of an *installation* if ...

- ▶ ... incorporating certain processes (NACE sectors C17,19,23,24), or
- ▶ ... exceeding fuel combustion capacity threshold, or
- ▶ ... exceeding sector-specific output or input thresholds

Exemptions from auctions based on *industry-level* leakage risk.

ETS allowance price

Persistent low prices until 2018

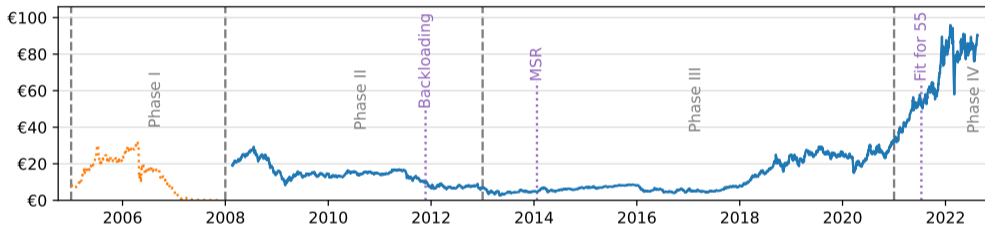


Figure 1: EU ETS allowance price (futures contracts, €/tCO₂eq). Data: FactSet & EEA.

Data

ETS

 Union Registry

- ▶ Regulated installations per phase

 EU Transaction Log (EUETS.info)

- ▶ Transactions, emissions, free allowances, int'l credits
- ▶ Installations and their holder accounts

Firm data

 CBS Microdata

- ▶ Employees, value added, turnover, investments, energy expenses, ...
- ▶ Unit: CBS's own "business unit"
- ▶ Select manufacturing firms

Our sample

- ▶ Unbalanced panel over 2000-2020 incl. 119 ETS firms

ETS regulation in the Netherlands

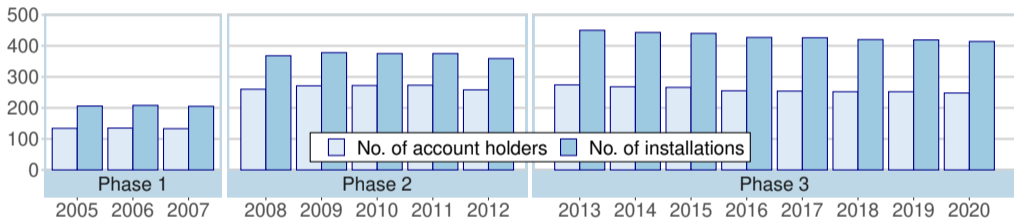


Figure 2: Regulated owners and installations in the Netherlands. Data: EUETS.info.

ETS stringency in the Netherlands

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Introduction

Data

Methodology

Findings

Conclusions

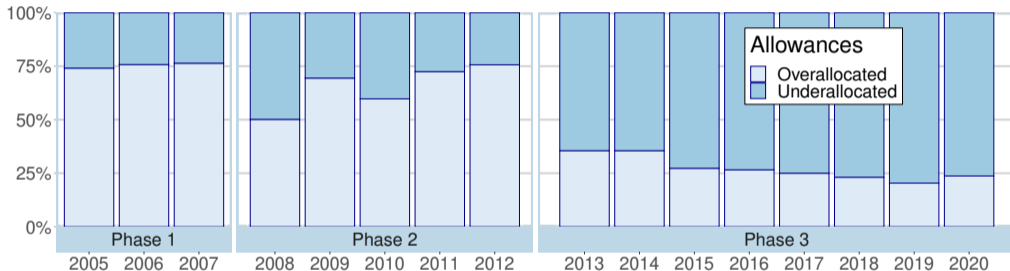


Figure 3: Over- and underallocations of free allowances. Data: EUETS.info.

Methodology

Identification strategy

Strategy

Difference-in-differences (DiD) comparing ETS firms with *comparable* control firms.

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Introduction

Data

Methodology

Findings

Conclusions

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Difference-in-differences (DiD) comparing ETS firms with *comparable* control firms.

Matched two-way fixed effects (TWFE)

- ▶ Match *each cohort* on pre-treatment ($T - 2$) covariates (emp, turn, wage, enexp, va) within 2-digit sector code. Match to nearest 5 neighbors with replacement. Enforce common support.
- ▶ TWFE commonly used, but has limitations.

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DiD as in Callaway and Sant'Anna (2021)

- ▶ More flexible towards group and (event) time heterogeneity
- ▶ Can aggregate to group, time or event-time estimates

Matched TWFE & doubly-robust DiD

TWFE (86 treated, 131 matched control firms)

$$y_{jt} = \sum_{c \in C} \sum_{p \in P} ETS_j^c \times P_t^p \times \mathbb{1}_{\{p \geq c\}} \alpha^{cp} + \gamma_j + \gamma_t + \varepsilon_{jt} \quad (1)$$

DiD (Callaway & Sant'Anna, 2021)

$$\hat{\alpha}_{ct} = \frac{1}{N} \sum_{j \in \mathcal{J}} \left[\underbrace{(\hat{W}_{jc}^{treated} - \hat{W}_{jc}^{control})}_{\text{Inv. prob. weight.}} \left(\overbrace{y_{jt} - y_{jb}}^{\text{diff. treat}} - \underbrace{\hat{m}_{jct}(X_j, \hat{\lambda}_{ct})}_{\text{Outcome reg.}} \right) \right] \quad (2)$$

- ▶ \hat{w} s from propensity scores; $\hat{\lambda}$ from reg $y_{it} - y_{ib} = X_i \lambda + \varepsilon_i | D_i = 0$
- ▶ Doubly-robust (Sant'Anna & Zhao, 2020)

Findings

Distributions for No. of employees

Year = 2003

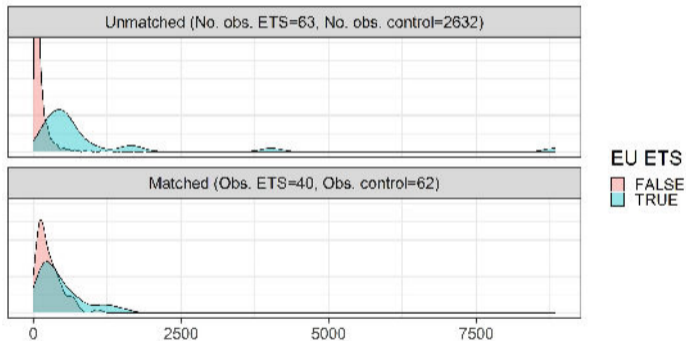


Figure 4: Freq. distributions for the no. of employees and the Phase 1 cohort.

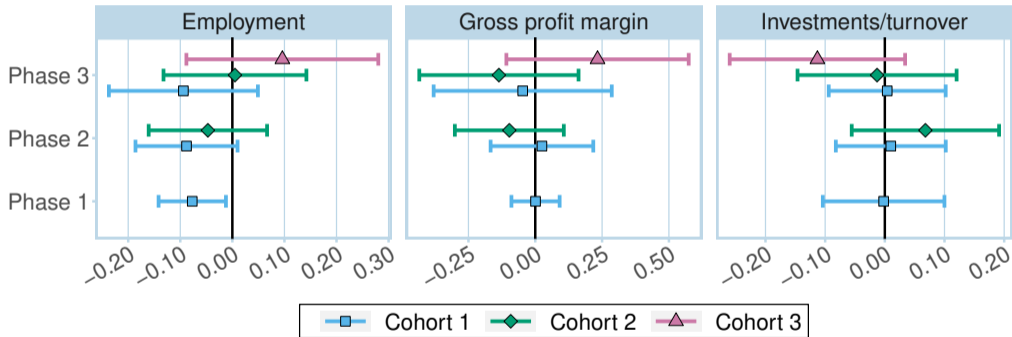


Figure 5: TWFE cohort-phase results (95% conf. intervals) with firm and year FEs.

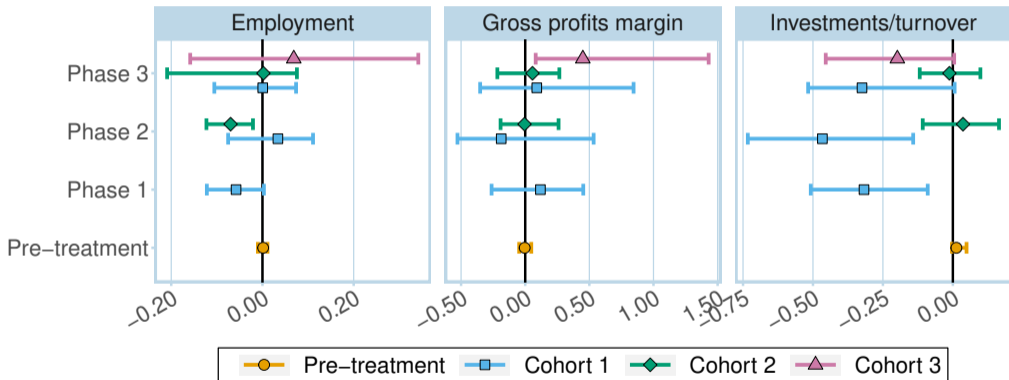


Figure 6: CS cohort-phase results (95% bootstrapped conf. intervals).

CS-DiD – Anticipation

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Introduction

Data

Methodology

Findings

Conclusions

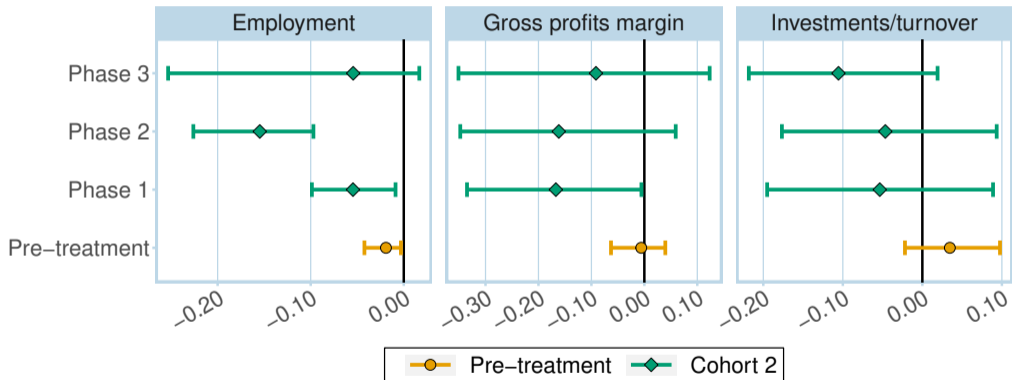


Figure 7: CS Cohort 2 results with anticipation (95% bootstrapped conf. intervals).

Conclusions

Conclusions and way forward

Conclusions

- ▶ Immediate, but temporary negative employment effects
- ▶ Cohort 1 decreases investments
 - ▶ Cohort 1 firms most energy intensive
- ▶ No effects on profits
- ▶ Anticipation seems plausible
- ▶ Methodology matters

☰ Way forward

- ① Continuous firm-specific stringency treatment variable: Endogeneity issues
- ② Clearer one-to-one comparison of TWFE vs CS-DiD

Thanks 😊

🗨️ Questions? Comments?

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Introduction

Data

Methodology

Findings

Conclusions

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Figures

Means – Energy expenses

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References

Figures

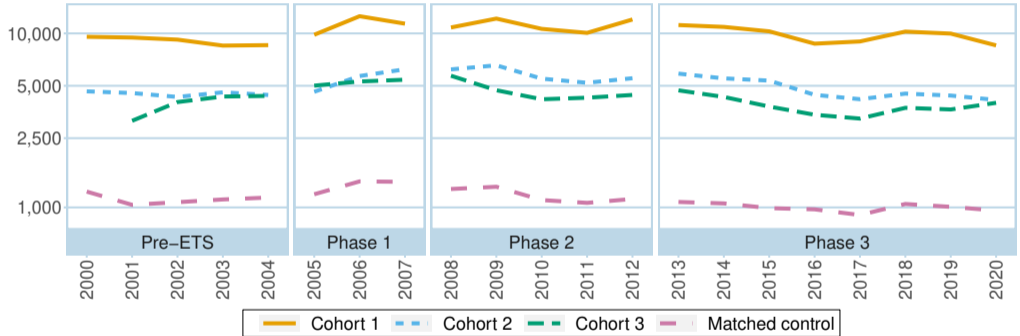


Figure 8: Energy expenses (in thousands 2015 Euros)

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References

Figures

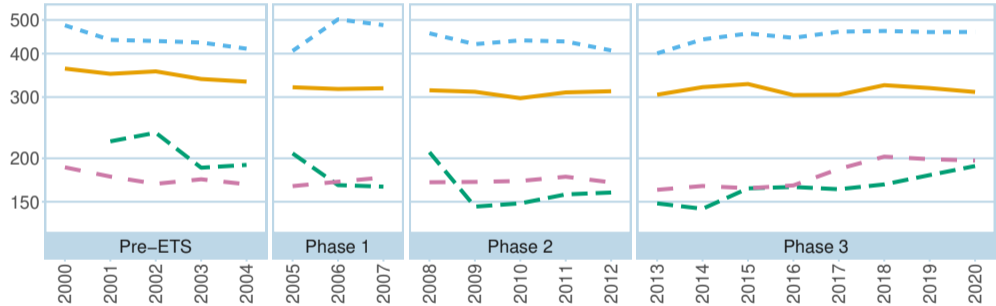


Figure 9: Employment (in full-time equivalents)