From Free to Fee

How Allowance Allocation Affects ETS Performance

Marie Alder Eva Franzmeyer Benjamin Hattemer

International Conference on Ex-Post Evaluation of Emissions Trading 2025

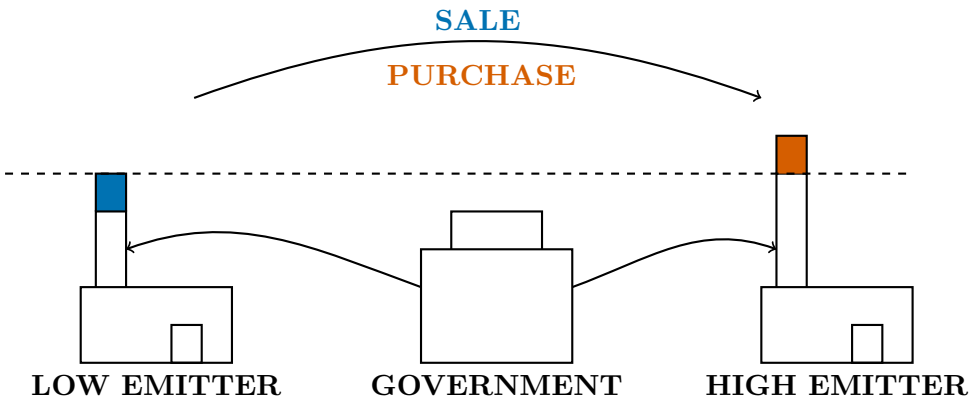
June 2025

Motivation

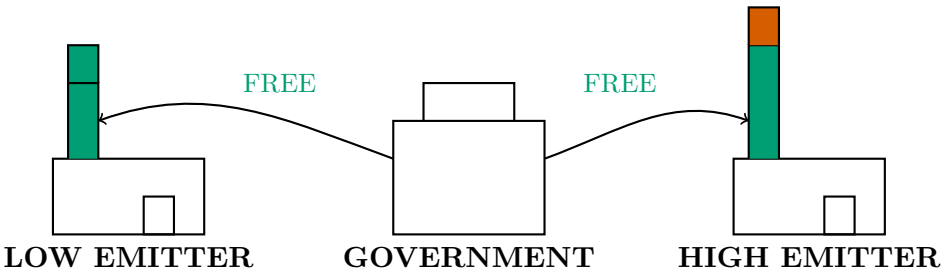
- Emission Trading Systems are key mitigation policy tools for Climate Change
- Share of worldwide emissions covered increased to almost 20%
  (World Bank, 2025)
- The design of ETS may be crucial for their performance
  (Grubb et al., 2022)
- Key feature: Allocation of allowances for free or sold to firms?

↪ **How does the allocation mechanism affect ETS performance?**

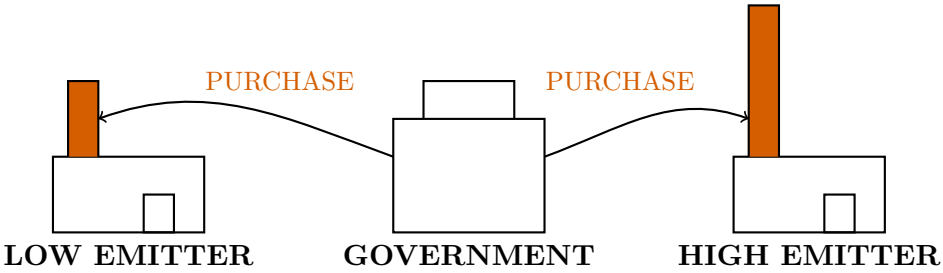
Emission Trading System



Allocation Mechanism - Free Allocation

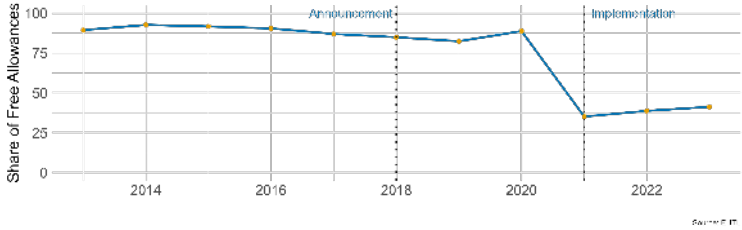


Allocation Mechanism - Selling to Firm



The EU ETS Reform

- This paper: focus on the **EU ETS**
- **Reform**: Some firms lost $\approx 50\%$ of their free allowances
  - **2018:** Official publication of the list of sectors losing free allowances
  - **2021:** Implementation of the reform
- **Goal:** Increase the incentives of firms for decarbonization



The Paper

Question

What is the effect of free allowance allocation on the environmental and economic performance of emission trading systems?

Setting

- Policy: change in allocation rule of free allowances in EU ETS
- Manufacturing firm-level panel data (2014-2022)
- Event-study DiD estimation

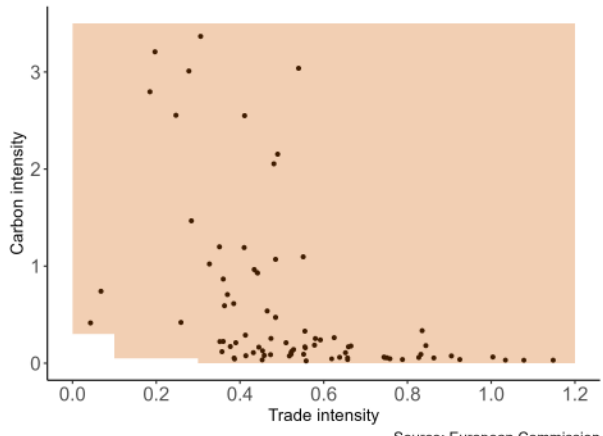
Results

- Paying for allowances decreases emissions by more than 10%
- Similar decrease in turnover, employment and total assets

Free Allocation

Before Reform:

1. Emission intensity $\geq 5\%$ & Trade intensity $> 10\%$
2. Emission intensity $\geq 30\%$
3. Trade intensity $> 30\%$



▸ Calculation CI and TI ▸ Distribution BA ▸ Allocation Rule

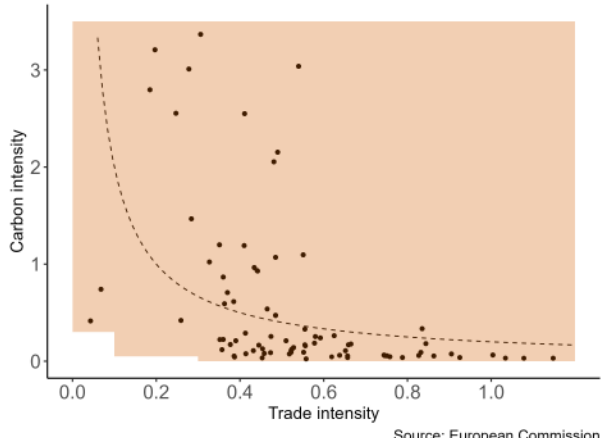
Free Allocation

Before Reform:

1. Emission intensity $\geq 5\%$ & Trade intensity $> 10\%$
2. Emission intensity $\geq 30\%$
3. Trade intensity $> 30\%$

After Reform:

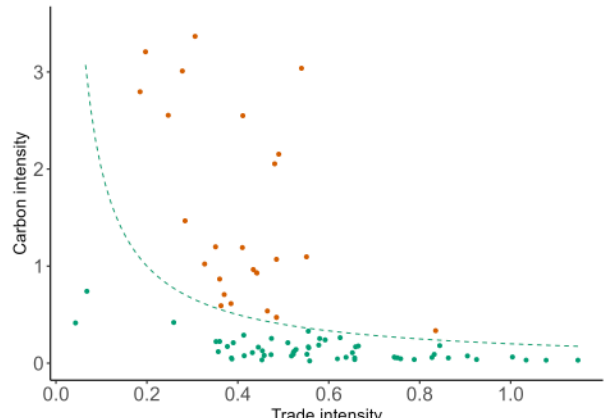
- Emission intensity $\times$ Trade intensity $> 20\%$



▸ Calculation CI and TI ▸ Distribution BA ▸ Allocation Rule

Free Allocation

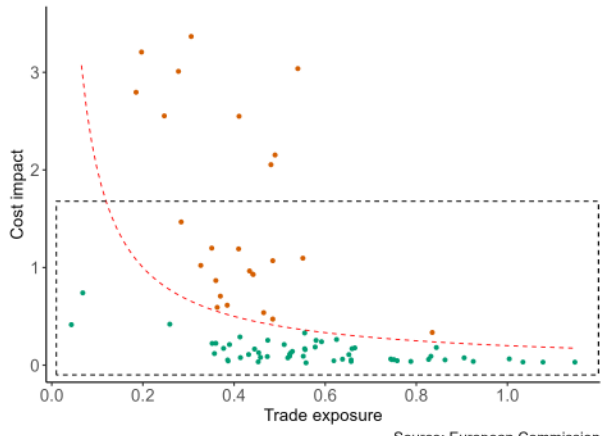
- Control group:
  - Before: **Free**
  - After: **Free**
- Treatment group:
  - Before: **Free**
  - After: **Pay**



▸ Calculation CI and TI ▸ Distribution BA ▸ Allocation Rule

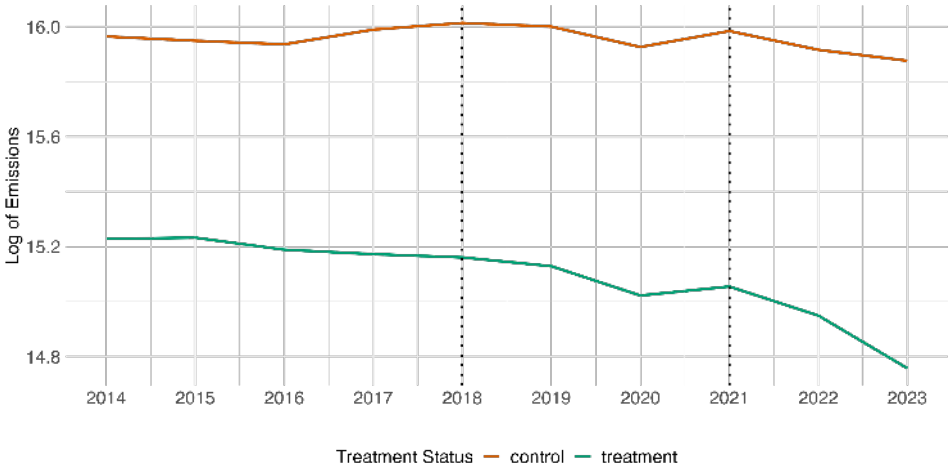
Free Allocation

- Control group:
  - Before: **Free**
  - After: **Free**
- Treatment group:
  - Before: **Free**
  - After: **Pay**



Calculation CI and TI | Distribution BA | Allocation Rule

Descriptive Trends



Data

Sample: Firm-by-year balanced panel from 2014 to 2022

1. **Emissions**
2. **Economic Performance**
3. **Treatment Status**

Summary Statistics

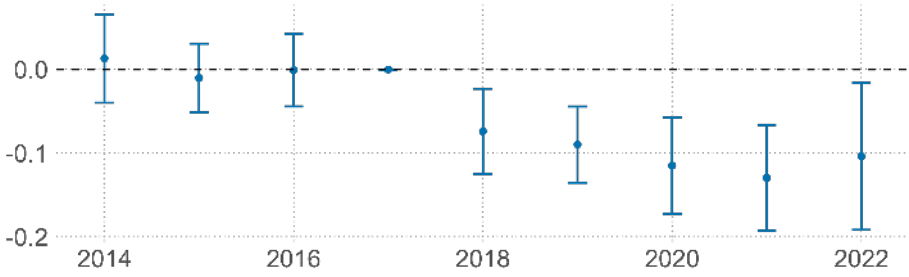
	Control					Treatment				
	N	Mean	Min	Max	SD	N	Mean	Min	Max	SD
Financial Variables										
Turnover	1484	635100	424	18946398	1589469	953	2982297	7297	106893328	10676704
Sales	1484	617975	424	18873591	1570023	953	2798936	912	101213625	10180572
Employees	1280	1261	1	34328	4001	885	8894	0	429367	41254
Emissions										
Emissions	1630	52203	434	1178053	98719	1060	34052	107	495454	45964
Free / Emissions (%, 2020)	163	117	0	664	85	105	111	0	760	92
Free / Emissions (%, 2021)	163	89	13	484	65	105	54	5	403	63

Event Study

$$\ln(\mathrm{y}_{i,s,t}) = \alpha_i + \gamma_t + \sum_{k=-3}^{6} \beta_k(\mathbb{1}[t - c_i = k]) + \varepsilon_{i,s,t}$$

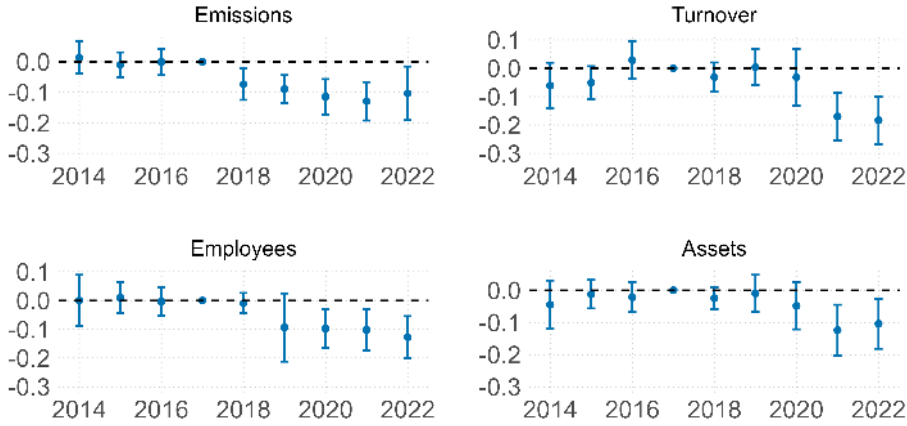
- $y_{i,s,t}$ is the outcome of interest for firm i in sector s in time t
- α_i and γ_t are firm and time fixed effects
- Standard errors are clustered at the sector and time level
- $c_i \in \{-\infty, 2018\}$ is equal to 2018 if the firm is treated, $-\infty$ otherwise

Emissions



▸ COVID and Ukraine ▸ Firm Exits ▸ Restriction Sensitivity ▸ Detailed Timing

Economic Outcomes



▸ COVID and Ukraine ▸ Firm Exits ▸ Restriction Sensitivity ▸ Detailed Timing

Conclusion

1. **Selling allowances decreases emissions**
   - Could not be shown empirically before (Zaklan, 2023)
   - This paper studies multiple sectors with larger share of the economy with heterogeneous and tradable goods

2. **Also economic outcomes of firms are affected**
   - Trade-off between emission reduction and economic performance new (Colmer et al., 2024; Dechezleprêtre et al., 2023)
   - Different variation: In- or outside the ETS
   - Different time: Most allowances for free in early phases and very low prices
   - Magnitude comparable with firms participating

References I

Colmer, J., Martin, R., Muûls, M., and Wagner, U. J. (2024). Does pricing carbon mitigate climate change? firm-level evidence from the european union emissions trading system. Review of Economic Studies, page rdae055.

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

Grubb, M., Jordan, N. D., Hertwich, E., Neuhoff, K., Das, K., Bandyopadhyay, K. R., Van Asselt, H., Sato, M., Wang, R., Pizer, W. A., et al. (2022). Carbon leakage, consumption, and trade. Annual Review of Environment and Resources, 47:753–795.

World Bank (2025). Carbon pricing dashboard. Accessed: 2025-06-06.

Zaklan, A. (2023). Coase and cap-and-trade: Evidence on the independence property from the european carbon market. American Economic Journal: Economic Policy, 15(2):526–558.

Appendix

Allocation Rule

Rule:

$$A_{ist} = B_s \cdot HAL_{i\bar{t}} \cdot R_t \cdot \mathbf{CLEF}_{st}$$

1. B_s: average allowances required by 10% most efficient installations in sector s
2. $HAL_{i\bar{t}}$: median annual activity level of installation i in reference period $\bar{t}$
3. R_t: ensures to not go beyond the overall cap at time t
4. $\mathbf{CLEF}_{st}$: if sector s is at "risk of carbon leakage", it is equal to 100%

Back

Example Allocation Rule

For installation i in the steel sector:

- B_s: 1.8 allowances per ton of steel
- $\text{HAL}_{i\bar{t}}$: 200,000 tons of steel produced annually
- R_{it}: 0.9 (to align with the total EU ETS cap)
- CLEF_{st}: on the list (1.0) or not (0.3)

$$\begin{aligned} A_{ist} &= B_s \cdot HAL_{i\bar{t}} \cdot R_{it} \cdot CLEF_{st} \\ &= 1.8 \cdot 200,000 \cdot 0.9 \cdot 1.0 \ (0.3) \\ &= \ 324{,}000 \ (97{,}200) \text{ allowances.} \end{aligned}$$

Back

Exposure calculation

$$\text{Emission intensity} = \frac{(\text{direct emissions} \cdot \text{auctioning factor} + \text{indirect emissions}) \cdot 30€/\text{ton}CO_2}{\text{gross value added at factor costs}}$$

$$\text{Trade intensity} = \frac{\text{imports} + \text{exports}}{\text{imports} + \text{production}}$$

Back

Restriction on Emission intensity

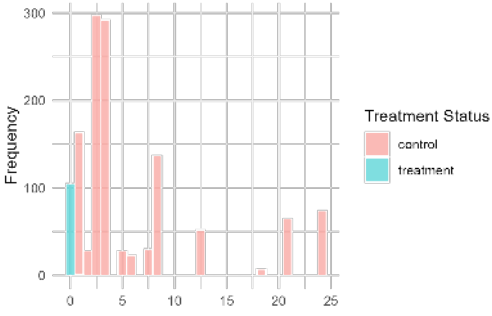


Figure: Distribution Before Restriction

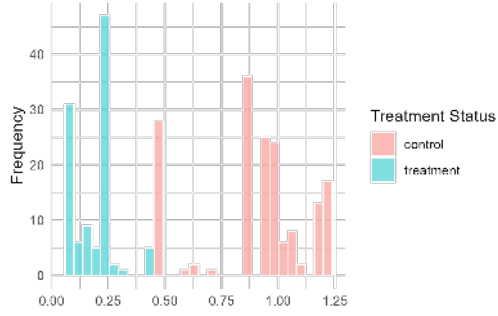


Figure: Distribution After Restriction

Back

Restriction on Emissions

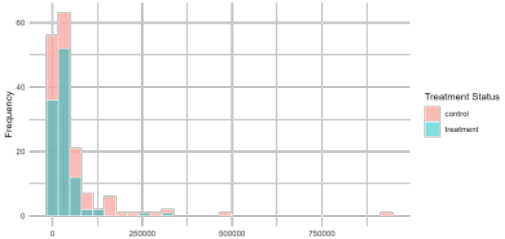


Figure: Distribution Before Restriction

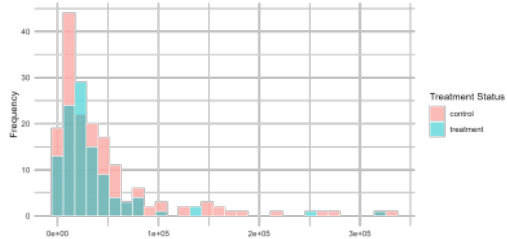
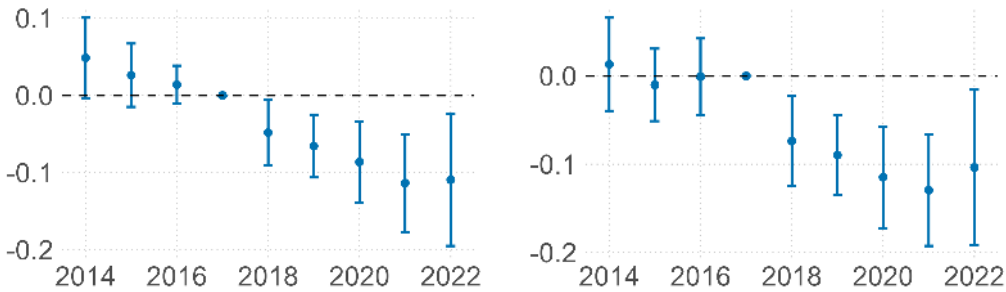


Figure: Distribution After Restriction

▸ Back

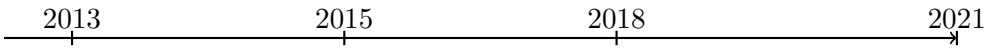
Restriction

Figure: Estimation without restriction (left panel) vs. with restriction (right panel)



Back

Timing



Start of Phase III (List I)

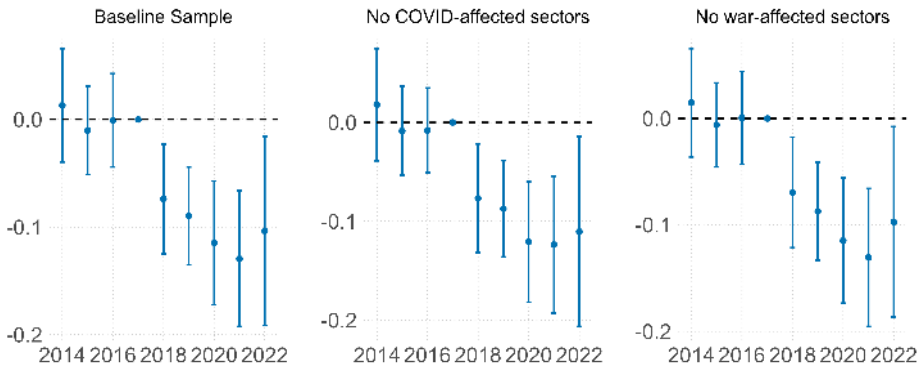
Implementation List II

Official publication List III

Start of Phase IV (List III)

Back

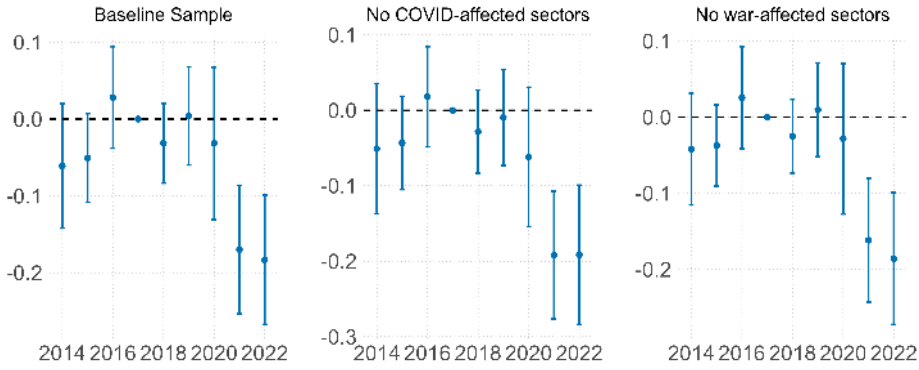
COVID and the Ukraine War: Emissions



- **COVID-affected sector:** Pharmaceutical manufacturing (*C2120*)
- **War-affected sectors:** Weapons and shipbuilding (*C2540*, *C3011*)

Back

COVID and the Ukraine War: Turnover



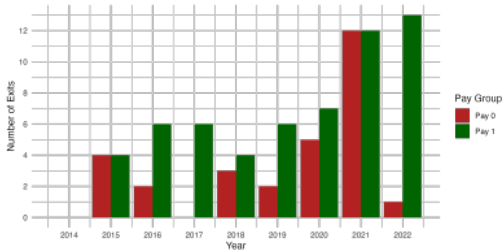
- **COVID-affected sector:** Pharmaceutical manufacturing (*C2120*)
- **War-affected sectors:** Weapons and shipbuilding (*C2540*, *C3011*)

Back

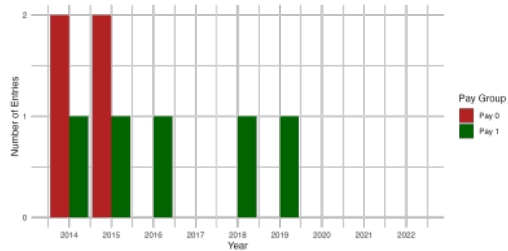
Firm Entry and Exit

Exit year: no verified emissions or free allowances, expired permit and closed account

Entry year: 1st year with free allowances or verified emissions (active permit & account)



Firm Exits Over Time



Firm Entries Over Time

Back