Climate Policy and the Economy:

Evidence from Europe's Carbon Pricing Initiatives

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The looming climate crisis

- Climate change is now at the top of the **global policy agenda**
- **Carbon pricing** is increasingly used as a tool to mitigate climate change
  - **Carbon taxes**
  - **Cap-and-trade**
- We know little about the **effects** of these policies in practice
  - Effective at reducing emissions?
  - Short-term economic costs?
  - How do different policies compare?

This paper

- Comprehensive analysis of **carbon pricing** policies in **Europe**
- Why Europe? **Global leader** in climate policy with 20+ years of experience
  - EU-wide **emissions trading scheme** (EU ETS)
  - Many countries also enacted **carbon taxes** at national level
- Sufficient variation to identify the effects of interest
  - Key challenge: Carbon prices not set in a vacuum
- We compare two empirical strategies:
  - **high-frequency** identification and "**control-based**" approach
- Provide unified framework to study impact of cap-and-trade prices & carbon taxes

Main results

- Carbon pricing leads to **emission reduction** but comes at economic cost
- Economic effects **larger** for carbon market than for national carbon taxes
  - Robust to the identification strategy used
  - In line with previous evidence in Känzig (2022) and Metcalf and Stock (forthcoming)
- We look into potential explanations for this finding
  - Revenue recycling
  - Coverage and pass-through
  - Spillovers and leakage
  - Monetary policy
  - ...

Main results

- Use of **carbon revenues** turns out to be crucial
  - Carbon taxes often introduced as part of broader tax reform lowering income taxes
  - European carbon market has no direct measures to cushion effects on households

  $\Rightarrow$ Carbon taxes that do **not recycle** revenues display stronger economic effects
- **Pass-through** and **coverage** are also very important
  - **Energy sector** covered under carbon market, excluded from carbon taxes
  - Energy, consumer and producer prices increase strongly after increase in EU ETS price, muted price response after equivalent increase in national carbon taxes
  - National carbon taxes have limited effect on **EU emissions**; potential carbon leakage

Both policies can be successful at reducing emissions but may have to be complemented with other policies to cushion economic impacts and prevent leakage

Additional results

- We explore the regional impacts of the European carbon market
- Economic impacts vary substantially by
  1. Share of **free allowances**
  2. **Concentration** of electricity markets
- Southern European countries most affected as they receive relatively few free allowances and tend to have concentrated electricity markets
- **Today's presentation**: focus on carbon tax versus cap-and-trade

Identification

- Carbon prices are **endogenous**
  - **Simultaneity**: weak economy could induce government to reduce carbon price
  - **Confounders**: other shocks could affect both carbon price and the economy
- **Two approaches** to identification
  1. **High-frequency approach**: isolate impact of policy news on carbon prices, use as IV
  2. **Control-based approach**: control for relevant economic variables to isolate plausibly exogenous variation in carbon prices

High-frequency identification

- **Idea**: Collect relevant policy events and look at response of carbon prices in tight window around policy events (Känzig, 2022) Details
  - Only possible for cap-and-trade where we have high-frequency price information
  - Challenge: high-frequency carbon policy surprises may be weak instruments at lower frequencies (quarterly/annual)
- By imposing VAR structure, we can obtain an estimate of a carbon policy shock
  - Shock measure can be aggregated to the frequency of interest, $\mathrm{cps}_t = \sum_{m=1}^{12} \mathrm{cps}_{m,t}$
- Estimate dynamic causal effects using local projections:

$$y_{i,t+h} - y_{i,t-1} = \alpha_i^h + \beta^h \mathrm{cps}_t + \sum_{j=1}^{p} \theta_j^h \Delta y_{i,t-p} + \Delta \mathbf{x}_{i,t}' \boldsymbol{\theta}_x^h + \varepsilon_{i,t+h},$$

Carbon policy shocks

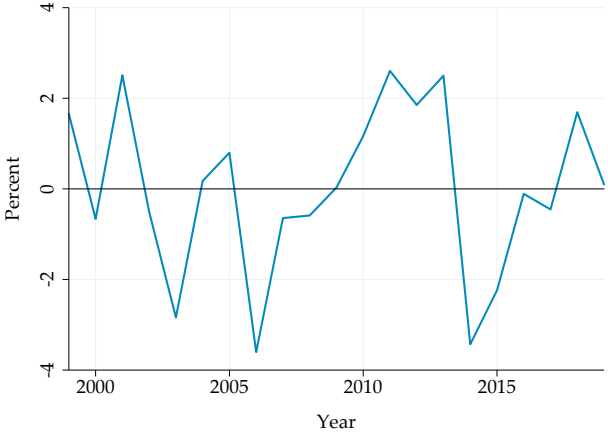


Figure 1: Carbon Policy Shocks in the European Carbon Market

Control-based identification

- **Idea**: Control for economic and financial variables to isolate some plausibly exogenous variation in carbon prices (Metcalf and Stock, forthcoming)
  - e.g. driven by changes in political preferences for ambitious environmental policies, international climate policy pressure, or historically legislated schedules
- Estimate dynamic causal effects of **ETS price and carbon tax** using local projections:

$$y_{i,t+h} - y_{i,t-1} = \alpha_i^h + \beta_{ets}^h \mathrm{cp}_{i,t} + \beta_{tax}^h \mathrm{ctax}_{i,t} + \sum_{j=1}^{p} \theta_j^h \Delta y_{i,t-p} + \Delta \mathbf{x}_{i,t}' \boldsymbol{\theta}_x^h + \Delta \mathbf{z}_t' \boldsymbol{\theta}_z^h + \varepsilon_{i,t+h}$$

Challenges:

- For carbon market most variation at EU level: cannot control for time FE
  $\Rightarrow$ for carbon taxes we include time FE, results with controls very similar
- ETS prices are market prices and thus endogeneity bigger concern
  $\Rightarrow$ instrument by carbon policy shock as robustness check

ETS price and carbon tax rates

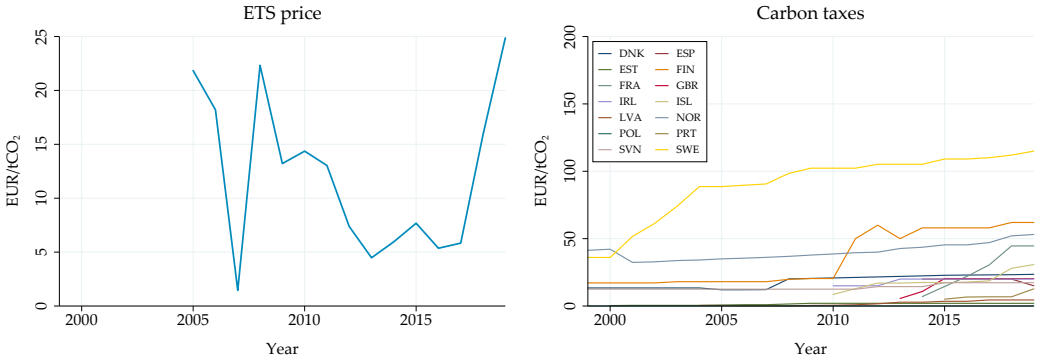


Figure 2: Carbon Prices in Europe

Notes: The left panel shows the EU ETS price since its introduction in 2005. The right panel shows European carbon taxes. Both are expressed in euro per metric ton of CO_2 equivalent.

The effects of an EU ETS policy shock

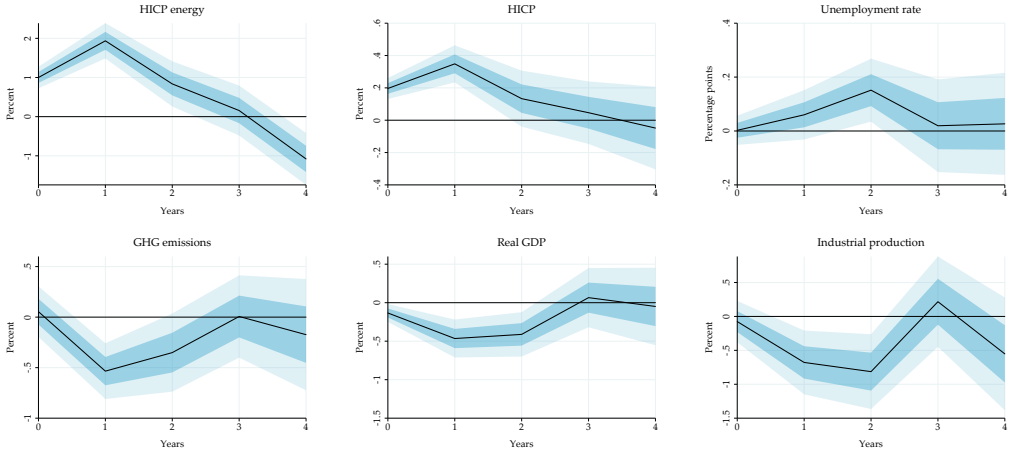


Figure 3: The Effects of an EU ETS Policy Shock

Notes: Dark and light shaded areas are 68 and 95 percent confidence bands.

The effects of an innovation in EU ETS prices

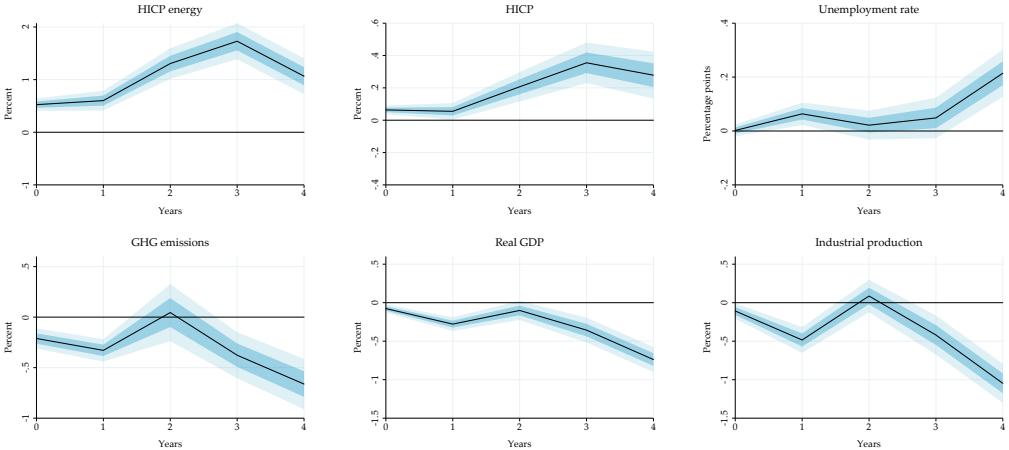


Figure 4: The Effects of a Euro Increase in EU ETS Prices

Notes: Dark and light shaded areas are 68 and 95 percent confidence bands.

Environmental and economic impact of the carbon market

- High-frequency and control-based approach produce **consistent** results
  - Signs and magnitudes consistent, in line with results in Känzig (2022)
  - But energy price increase much more persistent under control-based approach
    $\Rightarrow$ Different variation for identification
- Instrumenting carbon price by carbon policy shocks also produces similar results

More

The overall effects of European carbon taxes

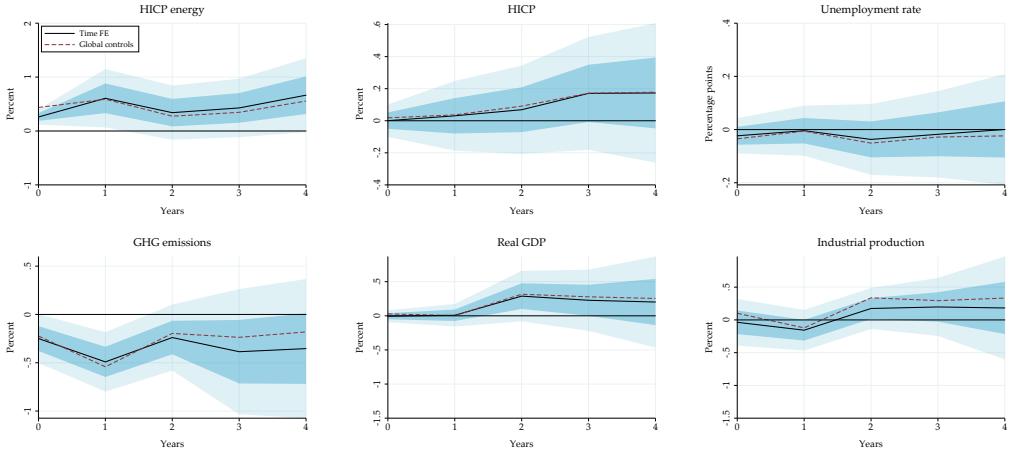


Figure 5: The Effects of a Euro Increase in European Carbon Taxes

Notes: Dark and light shaded areas are 68 and 95 percent confidence bands.

. . . and in Northern and Western Europe

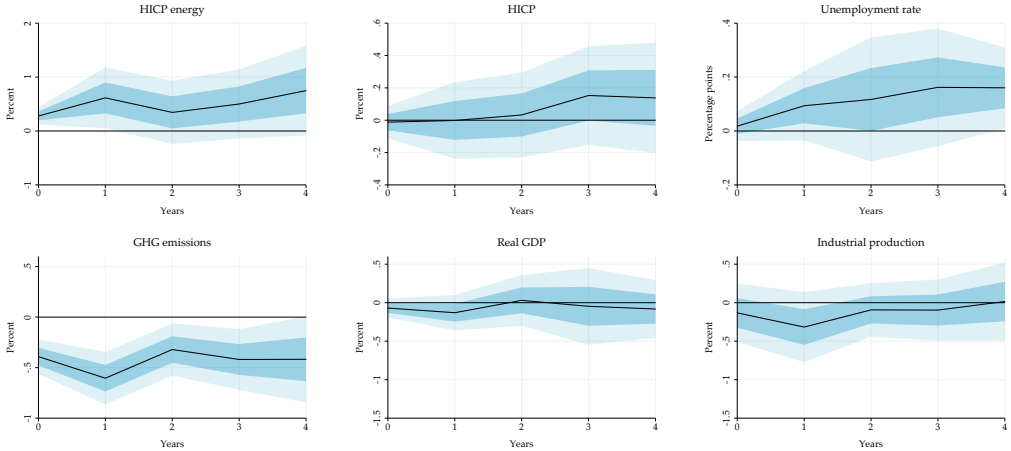


Figure 6: The Effects of a Euro Increase in Carbon Taxes in Northern and Western Europe

Notes: Dark and light shaded areas are 68 and 95 percent confidence bands.

▸ Southern and Eastern Europe

Taking stock

- ETS prices and carbon taxes lead to **comparable emission reductions**, but have vastly **different** economic consequences
- What drives these differences? Are carbon taxes the more desirable policy?
- Explore **different explanations** to account for differential impacts
  1. Revenue recycling
  2. Coverage and pass-through
  3. Spillovers and leakage
  4. Monetary policy

Fiscal policy and revenue recycling

- Theory suggest that use of **carbon revenues** can be crucial for transmission of carbon pricing
- Also relevant in practice
  - Carbon taxes often introduced as part of broader tax reform lowering income taxes
  - European carbon market has no direct measures to cushion effects on households
- Study how effects differ in countries that **do recycle** carbon revenues to countries that **don't**
  - Revenue recycling: Denmark, Finland, Norway and Sweden

Fiscal policy and revenue recycling

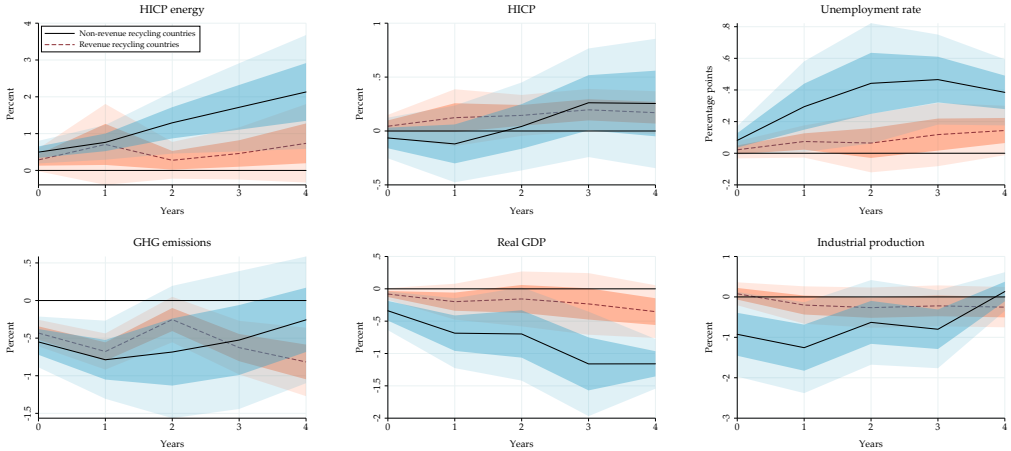


Figure 7: The Role of Revenue Recycling

Notes: Dark and light shaded areas are 68 and 95 percent confidence bands.

Fiscal policy and revenue recycling

- Countries that do **not recycle** tax revenues experience stronger economic effects
- But emission reductions are comparable

$\Rightarrow$ Recycling revenues doesn't offset emission reductions but cushions economic costs

Coverage and pass-through

- Stark difference in **sectoral coverage** of EU ETS and carbon taxes
- Carbon market covers power sector and energy-intensive industry
  - Pass-through particularly strong in power sector (Fabra and Reguant, 2014)
- Carbon taxes mainly apply to transportation and remaining industrial sectors

Coverage and pass-through

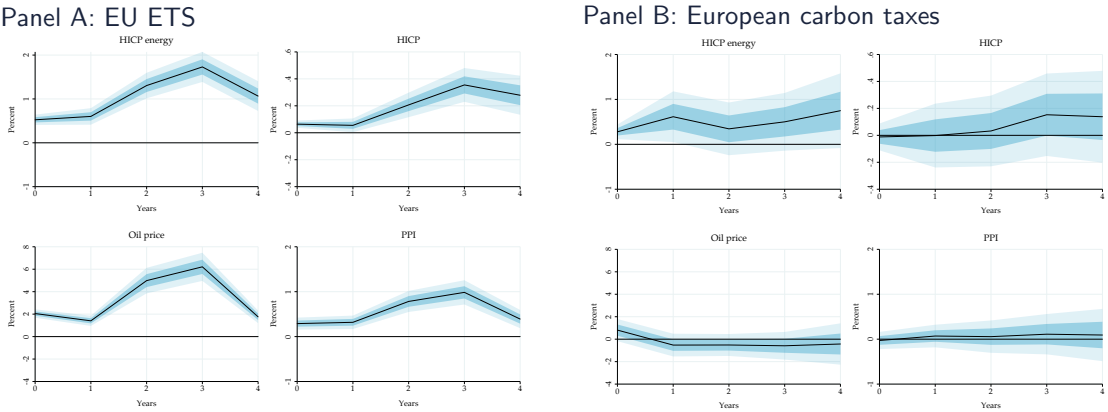


Figure 8: The Impact on Prices

More

Coverage and pass-through

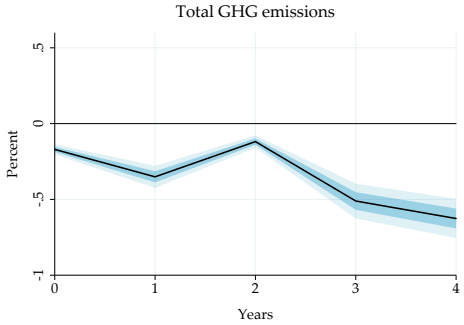
- **Energy prices** increase strongly after increase in EU ETS price and are passed on to producer and consumer prices
- Price responses muted after equivalent increase in national carbon taxes

Spillovers and leakage

- Carbon market is an **EU-wide** policy, carbon taxes levied at **national** level
  - Strong integration of EU countries may cushion economic effects of national policies
  - National carbon tax policies may be subject to leakage, particularly in manufacturing
- What is the impact on EU-wide emissions?

Spillovers and leakage

Panel A: EU ETS



Panel B: European carbon taxes

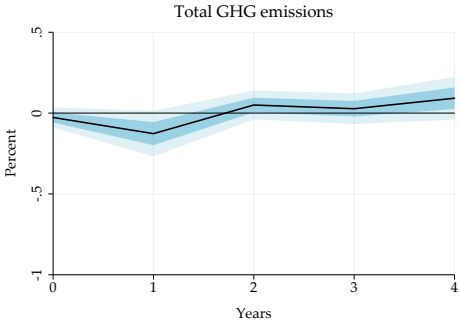


Figure 9: The Effect on EU-wide GHG emissions

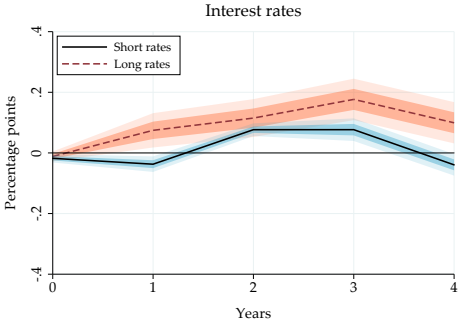
- National carbon taxes do **not** lead to a significant fall in EU-wide emissions
- Some suggestive evidence for carbon leakage

Monetary policy

- **Monetary policy** could also play a role in accounting for the different effects of EU-wide and national carbon pricing policies
  - Higher ETS prices lead to higher EU inflation
    $\Rightarrow$ monetary policy **leans against** these pressures
  - National carbon taxes not inflationary (let alone at EU level)
    $\Rightarrow$ **no** monetary response

Monetary policy

Panel A: EU ETS



Panel B: European carbon taxes

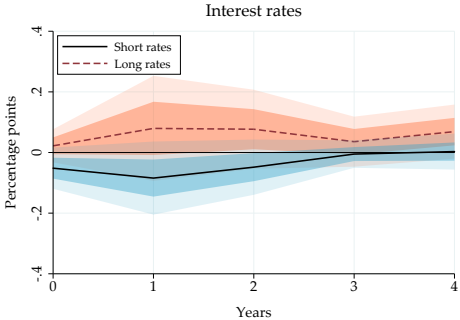


Figure 10: The Effect on Interest Rates

- ECB **leans against** inflationary pressure in carbon market, no monetary response to carbon taxes

Conclusion

- New evidence on the effects of **carbon pricing** in Europe
- Policies successful in **reducing emissions**, but comes at economic cost
- Economic costs crucially depend on **coverage** and **revenue use**
  $\Rightarrow$ Complement carbon pricing with **other policies** to cushion costs and prevent leakage

▸ Supplement

Thank you!

Example events

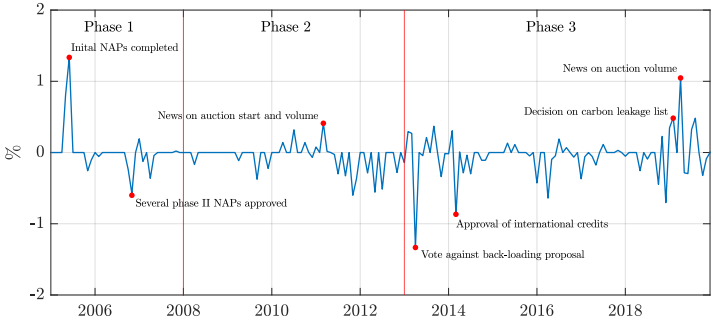
Table 1: Regulatory update events (extract)

	Date	Event description	Type
54	30/11/2012	Commission rules on temporary free allowances for power plants in Hungary	Free alloc.
55	25/01/2013	Update on free allocation of allowances in 2013	Free alloc.
56	28/02/2013	Free allocation of 2013 aviation allowances postponed	Free alloc.
57	25/03/2013	Auctions of aviation allowances not to resume before June	Auction
58	16/04/2013	The European Parliament voted against the Commission's back-loading proposal	Auction
59	05/06/2013	Commission submits proposal for international credit entitlements for 2013 to 2020	Intl. credits
60	03/07/2013	The European Parliament voted for the carbon market back-loading proposal	Auction
61	10/07/2013	Member states approve addition of sectors to the carbon leakage list for 2014	Free alloc.
62	30/07/2013	Update on industrial free allocation for phase III	Free alloc.
63	05/09/2013	Commission finalized decision on industrial free allocation for phase three	Free alloc.
64	26/09/2013	Update on number of aviation allowances to be auctioned in 2012	Auction

Carbon policy surprises

$$CPSurprise_{t,d} = \frac{F^{carbon}_{t,d} - F^{carbon}_{t,d-1}}{P^{elec}_{t,d-1}},$$

where $F_{t,d}$ is settlement price of the EUA front contract on event day d in month t and $P^{elec}_{t,d-1}$ is the wholesale electricity price on the day before



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Instrumenting ETS prices

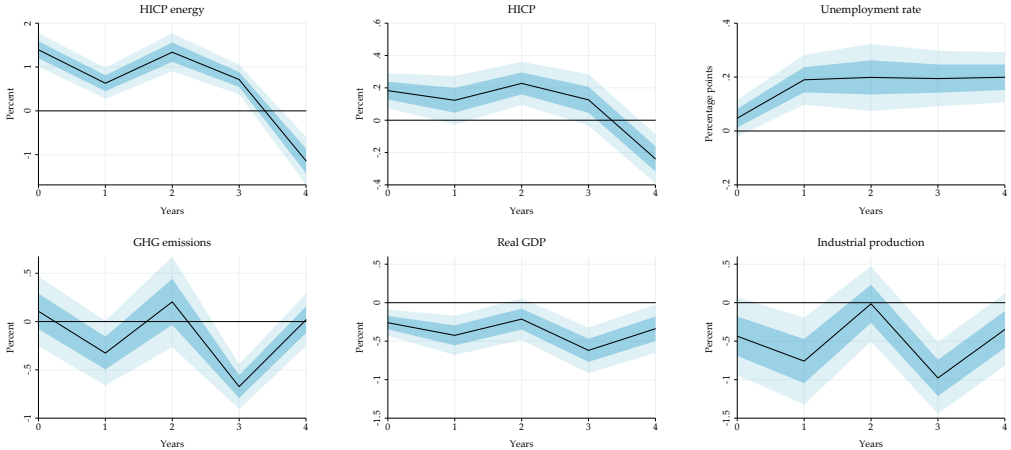

Figure 11: The Effects of a Euro Increase in EU ETS Prices, IV Approach

Notes: Dark and light shaded areas are 68 and 95 percent confidence bands.

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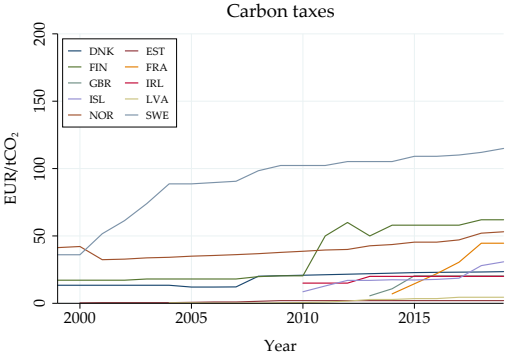
Carbon taxes in European regions

Panel A: Western and Northern Europe



Panel B: Southern and Eastern Europe

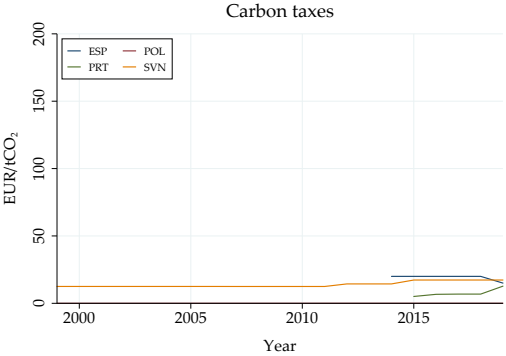


Figure 12: Carbon Taxes in European Regions

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Effect in Southern and Eastern Europe

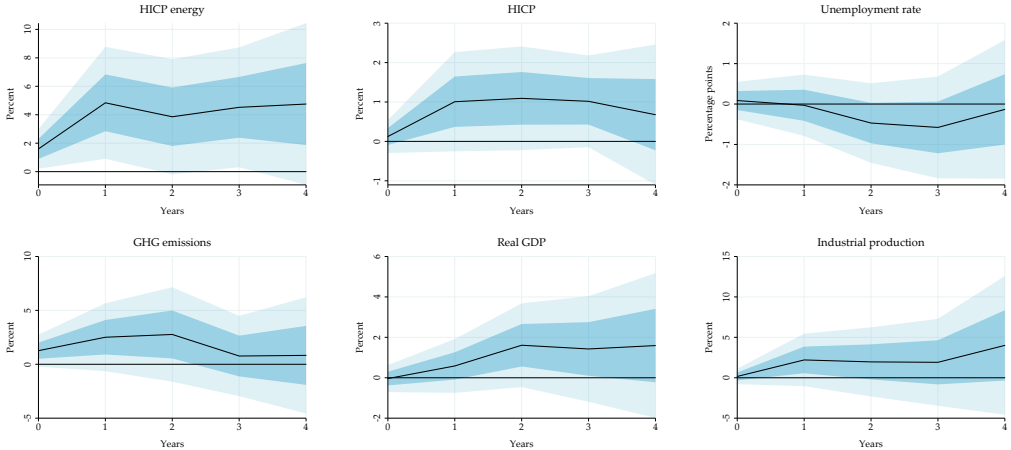

Figure 13: The Effects of a Euro Increase in Carbon Taxes in Southern and Eastern Europe

Notes: Dark and light shaded areas are 68 and 95 percent confidence bands.

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ETS shocks and oil prices

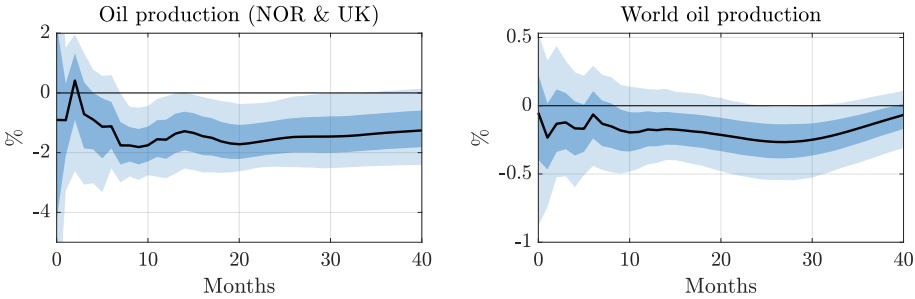

Figure 14: The Effect on Oil Production

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Regional impact of the carbon market

- Until now we focused on the average impact of carbon pricing
- How do the effects of the EU ETS vary across regions?
- To study this, we consider different exposure variabes and include an interaction term in our local projections:

$$y_{i,t+h} - y_{i,t-1} = \alpha_i^h + \beta^h \mathrm{cps}_t + \gamma^h \mathrm{cps}_t * \mathrm{exposure}_{t_0-1} + \ldots + \varepsilon_{i,t+h}$$

- Consider two main exposure variables:
  - Share of free allowances
  - Concentration of electricity market

The role of free allowances

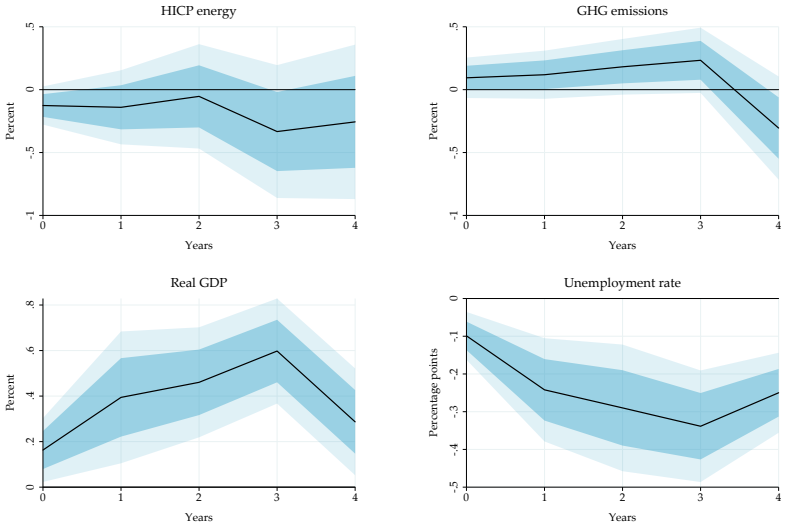

Figure 15: The Role of Free Allowances in the EU ETS

The role of market concentration

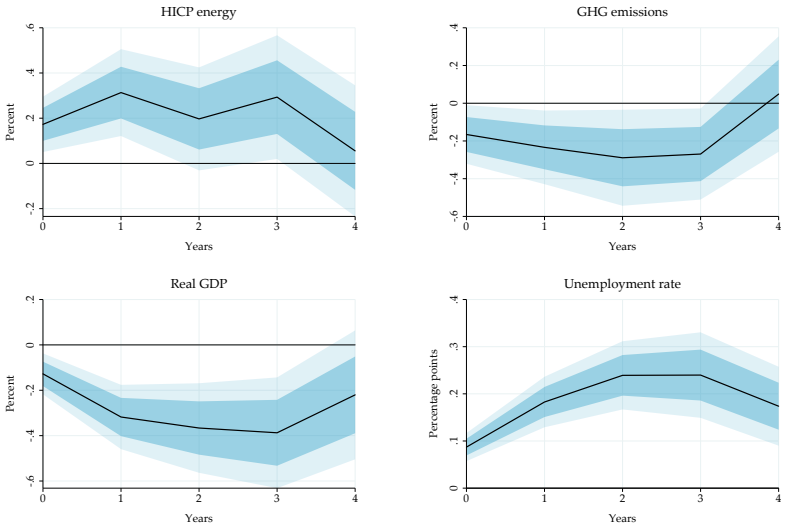

Figure 16: The role of Market Concentration in the EU ETS

Distributional impact

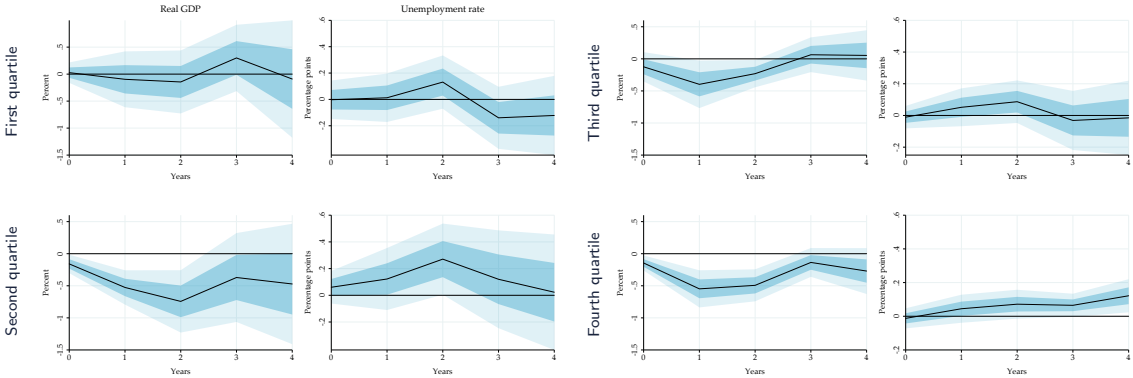

Figure 17: The effect of the EU ETS by income

Distributional impact

Table 2: Summary Statistics of Interaction Variables by Income

	GDP per capita quartiles			
Variable	First	Second	Third	Fourth
Share of free allowances to total emissions	102.43	77.83	84.57	88.43
	(39.56)	(36.27)	(30.69)	(28.58)
Primary energy per electricity retailer	4.25	9.01	9.52	6.30
	(1.91)	(9.36)	(6.78)	(6.34)
Share of non-renewables in primary energy	93.10	89.80	90.56	75.62
	(6.47)	(7.20)	(5.27)	(21.92)
Share of services in value added	66.35	70.05	71.88	73.76
	(3.98)	(6.32)	(5.13)	(7.81)

Notes: All variables are expressed as sample averages per income quartile, with standard deviations in parentheses. Quartiles are constructed based on 1998 real GDP per capita. First quartile: Bulgaria, Hungary, Lithuania, Latvia, Poland, Romania, Slovakia; second quartile: Cyprus, Czechia, Spain, Estonia, Greece, Portugal, Slovenia; third quartile: Belgium, Germany, Finland, France, United Kingdom, Ireland, Italy; fourth quartile: Austria, Denmark, Iceland, Luxembourg, Netherland, Norway, Sweden.

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