The Impact of Green Policies on Local Economic Performance: Evidence from the EU ETS (Hernandez, Mallarino & Percoco)

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Nov 28, 2023
FRS Climate Annual Conference

Impact of ETS on local economic performance

Key question

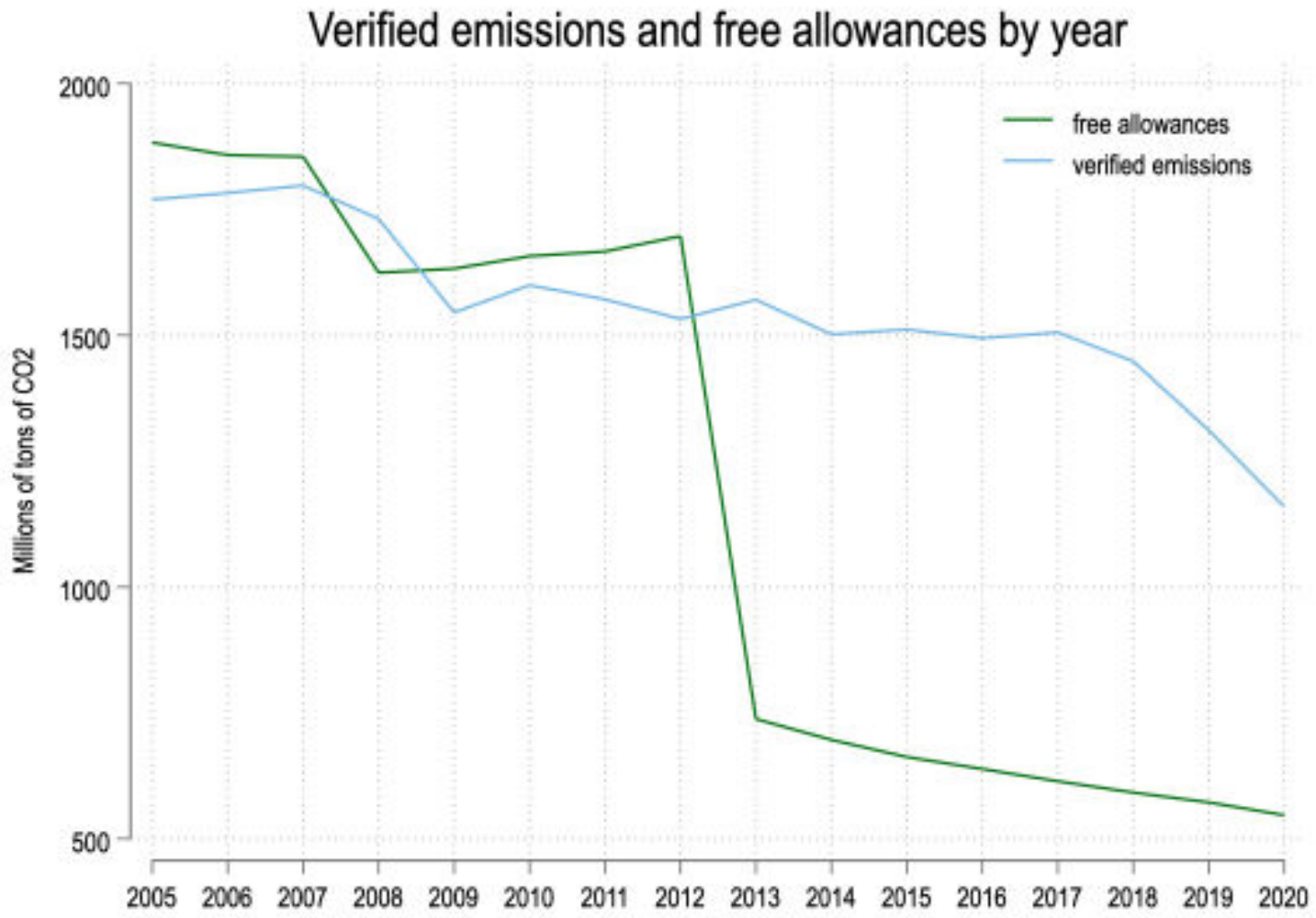
What has been the impact of the EU ETS on local economic performance?

- Why? 1) Growing interest for social and economic impacts of green policies and 2) existing research on EU ETS mainly focused on firms rather than local economies
- How? Exploiting a policy change in free allocations from phase 2 to phase 3 of the policy and
  - using both continuous and binary DiD with fixed effects
  - using data on emissions from EU ETS registry and
  - combining with local economic performances from the Regions Database from Eurostat (2021) on three outcomes: GVA, Employment and PPE

The EU ETS

- One of the world's largest carbon markets
- Inaugurated in 2005: covers 45% of the EU's greenhouse gases (GHG) emissions in 31 countries
- Phases 1 (2005-2007) and 2 (2008-2012): decentralized, free allowances (90% of the total) based on mostly historical emissions (grand-parenting)
- **Phase 3 (2013-2020):**
  - Single EU-wide cap instead of national caps
  - auctioning as default allocation method;
  - harmonised allocation rules for free allowances;
  - more sectors and gases included

Free Allocations Across Time



EU ETS Price


EU Carbon Permits
Phase 1 (2005- 2007)
Phase 2 (2008- 2012)
Phase 3 (2013- 2020)
120
100
80
60
40
20
2008
2011
2014
2017
2020
2023
source: tradingeconomics.com

Contributions to the literature

Our paper contributes to the growing literature on carbon policies on two different levels:

- **Broader literature on the effects of carbon policies** on: GDP change Bernard et al. (2018), employment Yamazaki (2017), household consumption Goulder et al. (2019), industry performance Bernstein et al. (2017) and manufacturing Martin et al. (2014)
- **Specific literature on the effects of cap-and-trade systems and EU ETS** see, for example: Commins et al. (2011); Costantini and Mazzanti (2012); Reinaud (2008); Yu (2011); Healy et al. (2018) Dechezleprêtre et al. (2023) and Känzig and Konradt (2023)
- In particular, we contribute to the topic on the heterogeneous spatial effects of the EU ETS (Roseta-Palma et al. (2011); Robaina and Goncalves (2019)) and by focusing on local labor markets providing for the **first time evidence for a) Phase III of the policy and b) at the NUTS3 level across the EU.**

Will pricing emissions decrease labor and output?

- Cobb-Douglas Production function

$$Y = AL^{\beta}K^{\alpha}E^{\gamma} \tag{1}$$

- Emissions as input in the production process
- a cap-and-and trade program increases production costs (by pricing the negative externality)
- theory suggests that output should decrease while the effect on the other inputs remains ambiguous
- But also depends on how costly it is to emit
- The relative emission-intensive input decision of the firm will depend on the relative marginal productivities, input prices, and the substitution elasticity.

Data
and
Emprical Exploration

Data on Local Economic Performance

Eurostat Regions and Cities Database

- Gross Value Added (GVA), employment
- Productivity: we build a measure of productivity per employee (GVA/EMP)
- Population, education (share of population per education level: primary, secondary, tertiary)
- Outcomes at total NUTS 3 level total AND separate analysis on main sectors covered by ETS [1]

[1] This includes B: mining and quarrying; C: manufacturing; D: electricity, gas, steam and air conditioning supply; E: water supply

Data on CO2 Emissions

ETS emission

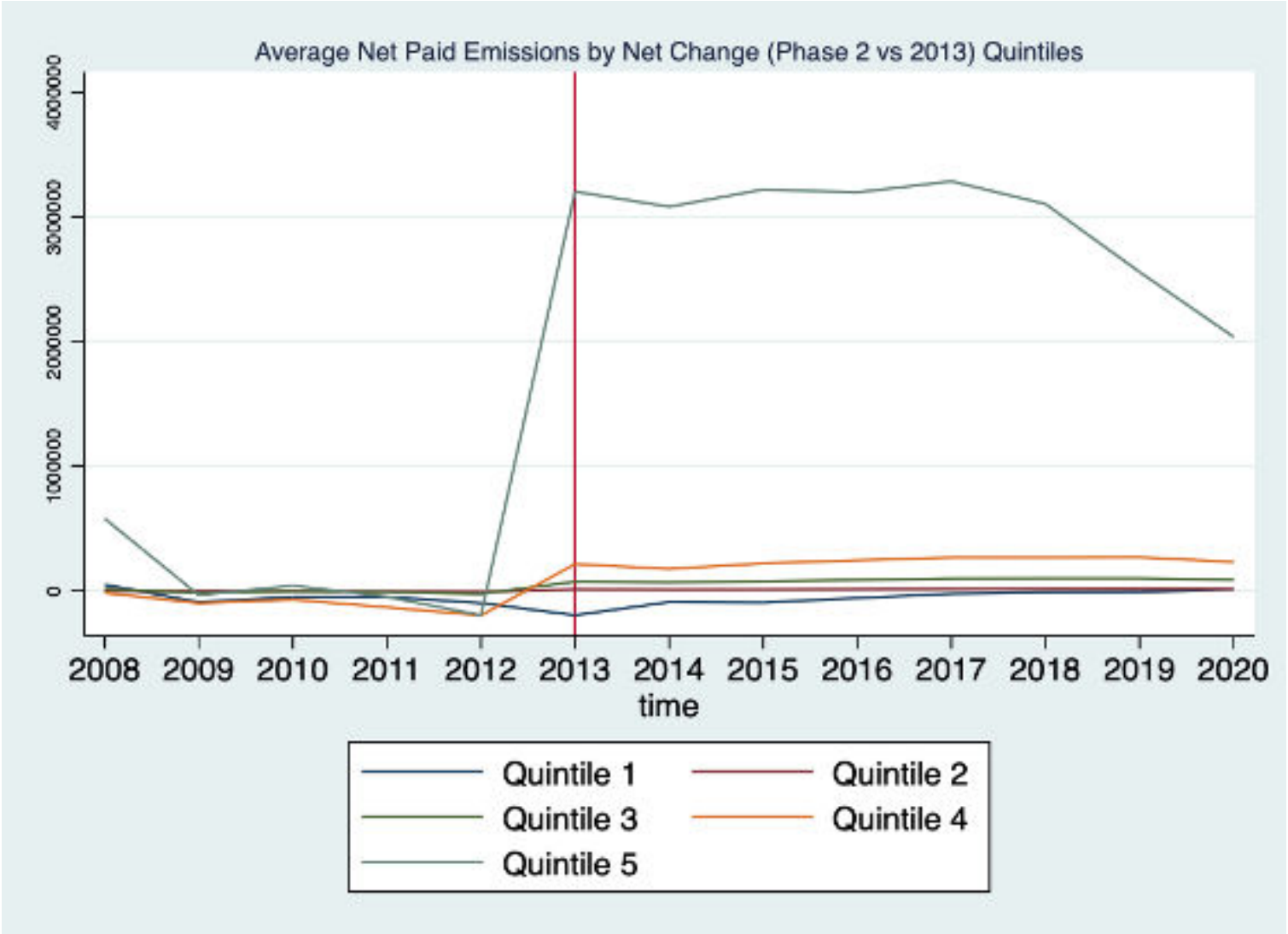
- CO2 emissions at the plant level from the EU Emission Trading System (EU-ETS) register are aggregated at the NUTS3 level to calculate absolute local exposure

Treatment

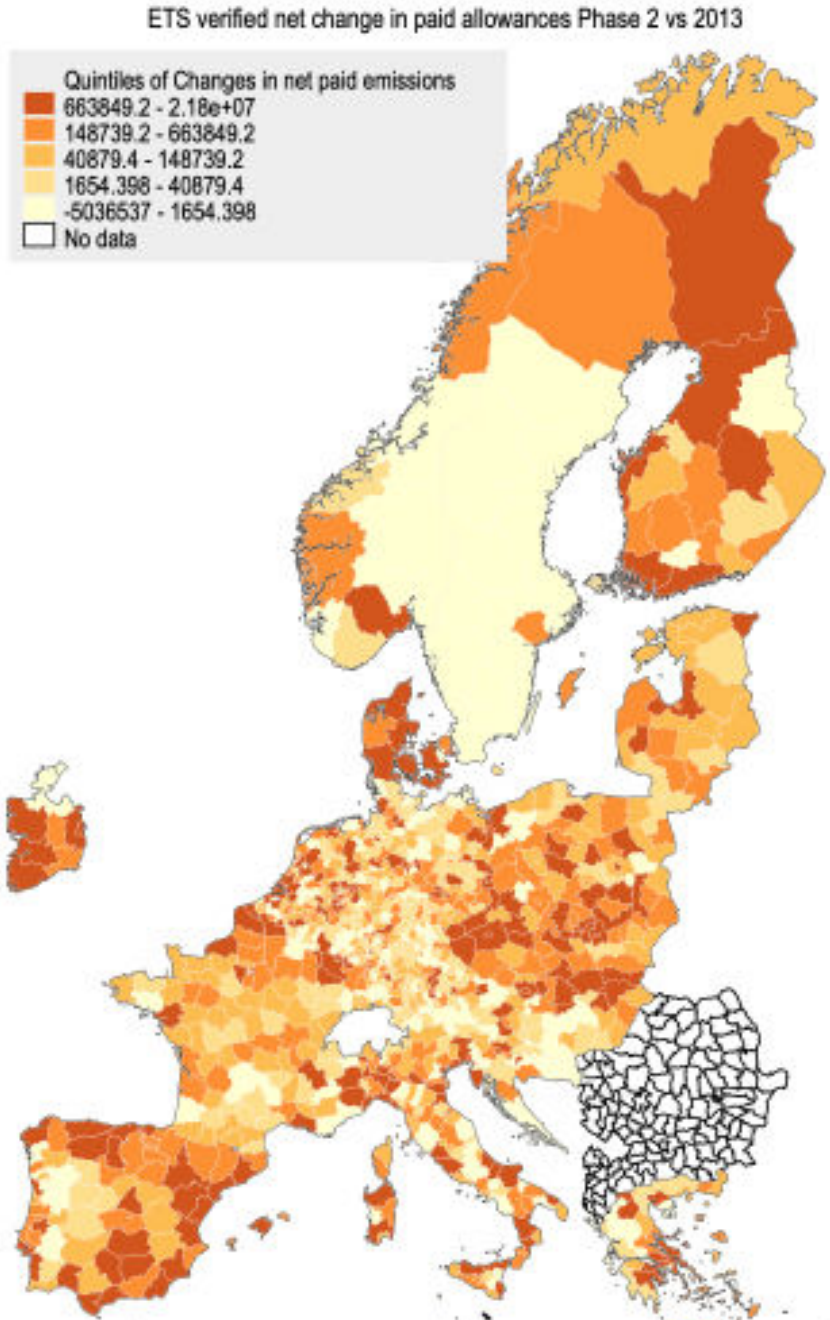
For each province, we compute the difference between the net paid emissions (emissions-free allowances) in 2013 and the average in phase 2

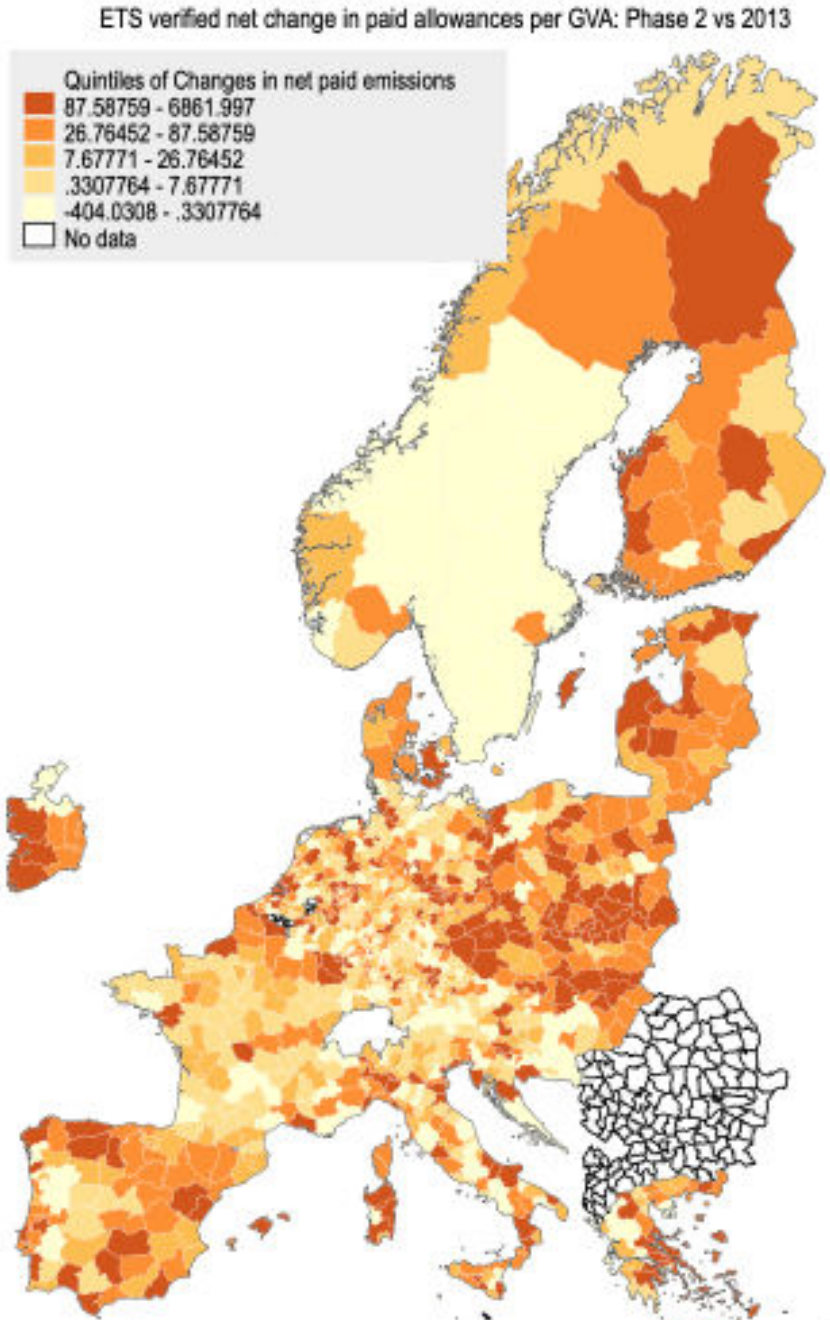
- For the first specification, we assign treatment status $= 1$ to quintile 5; and treatment status $= 0$ to quintiles 1-4
- For the second specification, we use the computed difference as the continuous measure of exposure

Change in Net Emissions Across Time by Quintile



Exposure to the Policy





Empirical Strategy

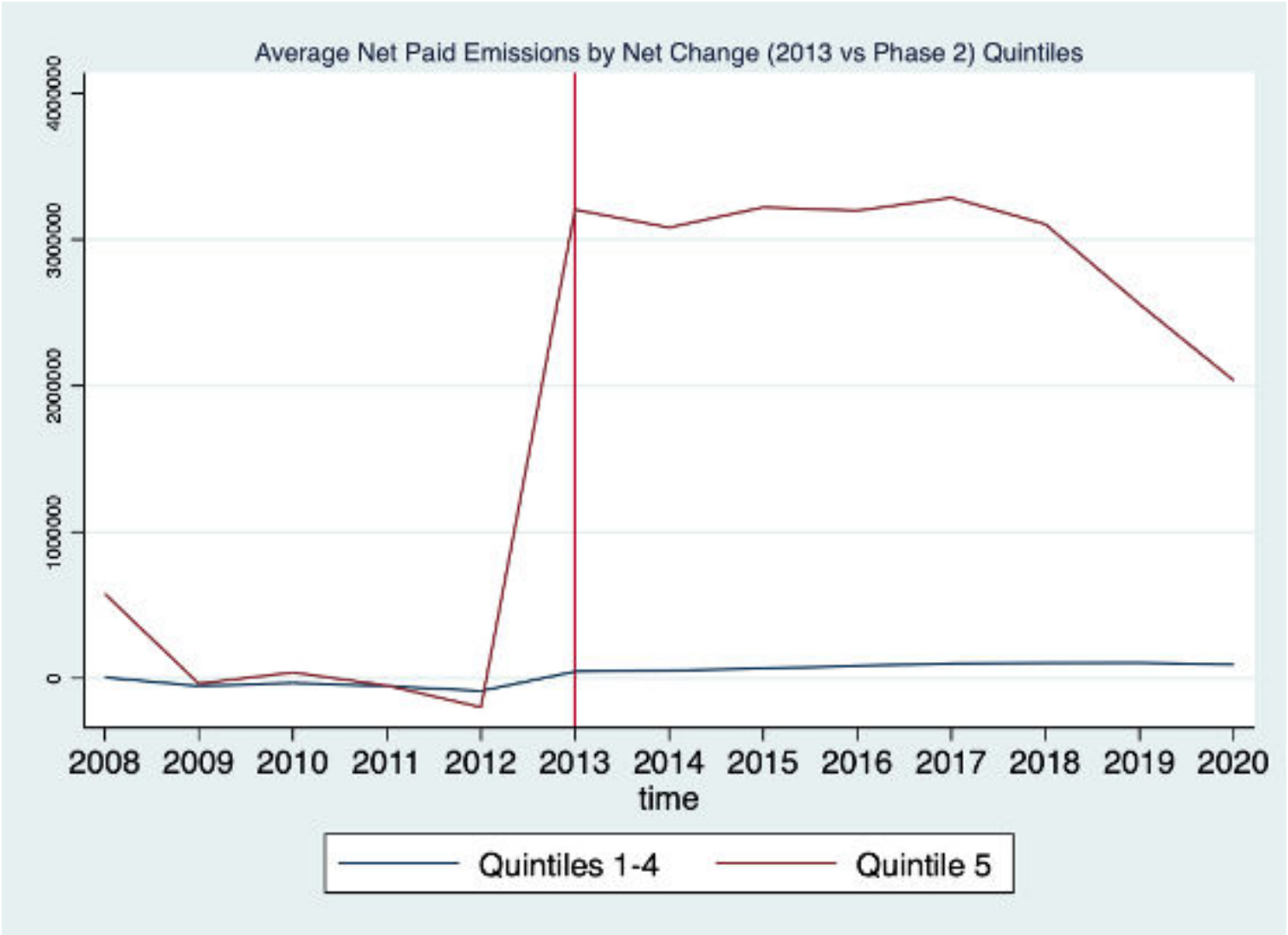
Binary difference-in-differences:

$$logY_{it} = \alpha + \beta_{it} log(ETSD_i) * Post_t + \gamma_t + \lambda_i + \boldsymbol{\sigma} X_{it} + \epsilon_{it} \quad (2)$$

Where

- i indexes NUTS3 and t the years.
- Log(Y_{it}): log of GVA, employment or PPE (GVA/EMP).
- $ETSD_i$ is the exposure: binary variable with quintile 5 of ETS dose = 1 (treated) and quintiles 1-4 = 0 (control),
- $Post_t$ is an indicator variable for post-phase 3 start (2013 onwards)
- γ_t is a set of year fixed effects and λ_i are NUTS3 fixed effects.
- X_{it}, a vector of controls that vary over NUTS3 and time, including population and education levels.
- SEs clustered at the NUTS3 level

Change in Net Emissions Across Time Treat (Q5) vs Contr (Q1-4)



Empirical Strategy

Continuous difference-in-differences:

$$logY_{it} = \alpha + \beta_{it} log(ETSD_i) * Post_t + \gamma_t + \lambda_i + \boldsymbol{\sigma} X_{it} + \epsilon_{it} \quad (3)$$

Where

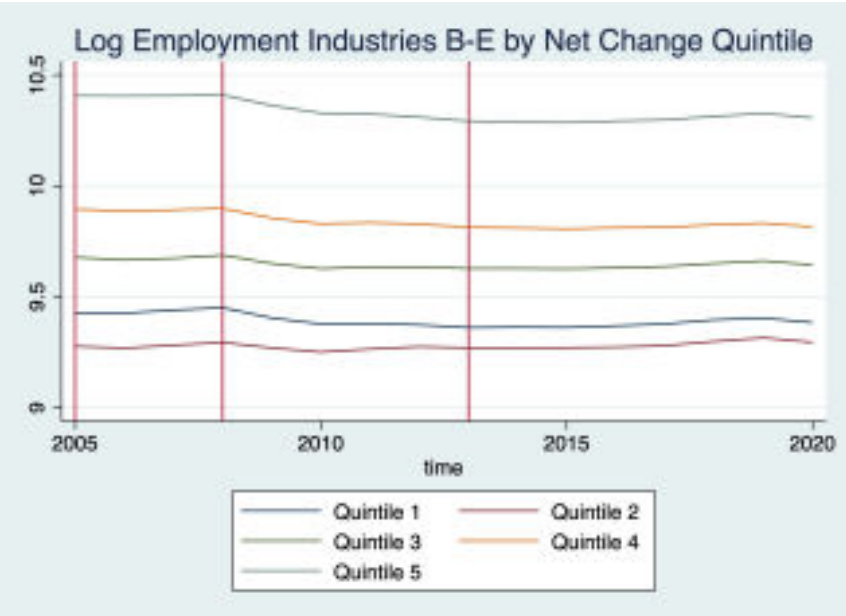
- i indexes NUTS3 and t the years.
- Log(Y_{it}): log of GVA, employment or PPE (GVA/EMP).
- $ETSD_i$ is the exposure: differences of net position (emissions - allowances) between 2013 and avg phase 2 in each province ("ETS dose"),
- $Post_t$ is an indicator variable for post-phase 3 start (2013 onwards)
- γ_t is a set of year fixed effects and λ_i are NUTS3 fixed effects.
- X_{it}, a vector of controls that vary over NUTS3 and time, including population and education levels.
- SEs clustered at the NUTS3 level

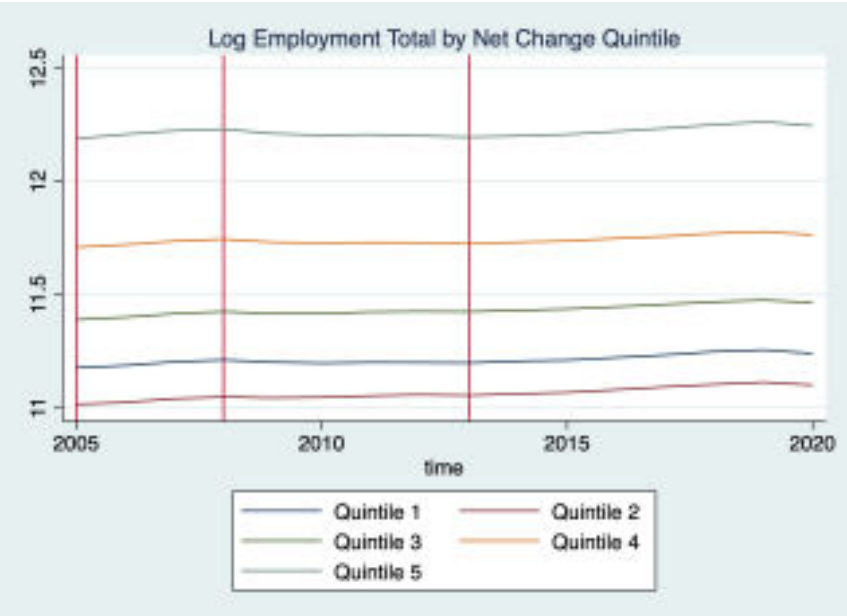
Identification Assumptions

Continuous DID assumptions from Callaway et al. (2021):

- iid data, support (no units treated in t-1 and continuous treatment), no simultaneous shocks, no anticipation
- **Strong parallel trends for a given level of a dose**: for all doses, the average change in outcomes over time across all units if they had been assigned that amount of dose is the same as the average change in outcomes over time for all units that experienced that dose

Trends in outcomes





Q5 vs Q4-1.Net Change as Measure of Exposure Results: Employment

Table: Difference-in-differences Estimates of Phase 3 on Employment using Net Allowance Change starting in Phase 3

	(1) Emp Tot	(2) Emp B-E	(3) Emp NOT B-E
Ph3*Q5	-0.0160***	-0.0365***	-0.0130***
	(0.0040)	(0.0066)	(0.0041)
Population	Yes	Yes	Yes
Education	Yes	Yes	Yes
Year f.e.	Yes	Yes	Yes
N	12901	12901	12901

Standard errors in parentheses
Quintile 5 vs 1-4
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Q5 vs Q4-1 Matched Sample. Net Change as Measure of Exposure Results: Employment

Table: Difference-in-differences Estimates of Phase 3 on using Net Allowance Change starting in Phase 3

	(1) Log Emp Total	(2) Log Emp B-E	(3) Log Emp NOT B-E
ATET			
Ph3*Q5	-0.0114**	-0.0185**	-0.0119**
	(0.0047)	(0.0088)	(0.0049)
Population	Yes	Yes	Yes
Education	Yes	Yes	Yes
Year f.e.	Yes	Yes	Yes
N	5120	5120	5120

Standard errors in parentheses
Quintile 5 vs 1-4. NN 3 matches
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Continuous Net Change as Measure of Exposure Results: Employment.

Table: Continuous difference-in-differences Estimates of Phase 3 on Employment using Net Allowance Change starting in Phase 3

	(1) Emp Tot	(2) Emp B-E	(3) Emp NOT B-E
Ph3*log netchange	-0.0010***	-0.0020***	-0.0010***
	(0.0003)	(0.0006)	(0.0003)
Population	Yes	Yes	Yes
Education	Yes	Yes	Yes
Year f.e.	Yes	Yes	Yes
N	12901	12901	12901

Standard errors in parentheses

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

Q5 vs Q4-1.Net Change as Measure of Exposure Results: GVA

Table: Difference-in-differences Estimates of Phase 3 on GVA using Net Allowance Change starting in Phase 3

	(1) GVA Tot	(2) GVA B-E	(3) GVA NOT B-E
Ph3*Q5	-0.0342***	-0.0587***	-0.0280***
	(0.0072)	(0.0123)	(0.0075)
Population	Yes	Yes	Yes
Education	Yes	Yes	Yes
Year f.e.	Yes	Yes	Yes
N	12901	12900	12901

Standard errors in parentheses
Quintile 5 vs 1-4
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Continuous Net Change as Measure of Exposure Results: GVA.

Table: Continuous difference-in-differences Estimates of Phase 3 on GVA using Net Allowance Change starting in Phase 3

	(1) GVA Tot	(2) GVA B-E	(3) GVA NOT B-E
Ph3*log netchange	-0.0020***	-0.0033***	-0.0018***
	(0.0006)	(0.0010)	(0.0006)
Population	Yes	Yes	Yes
Education	Yes	Yes	Yes
Year f.e.	Yes	Yes	Yes
N	12901	12900	12901

Standard errors in parentheses

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

Q5 vs Q4-1.Net Change as Measure of Exposure Results: PPE

Table: Difference-in-differences Estimates of Phase 3 on PPE using Net Allowance Change starting in Phase 3

	(1) PPE Tot	(2) PPE B-E	(3) PPE NOT B-E
Ph3*Q5	-0.0182***	-0.0222**	-0.0150**
	(0.0066)	(0.0097)	(0.0073)
Population	Yes	Yes	Yes
Education	Yes	Yes	Yes
Year f.e.	Yes	Yes	Yes
N	12901	12900	12901

Standard errors in parentheses
Quintile 5 vs 1-4
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Continuous Net Change as Measure of Exposure Results: PPE

Table: Continuous difference-in-differences Estimates of Phase 3 on PPE using Net Allowance Change starting in Phase 3

	(1) PPE Tot	(2) PPE B-E	(3) PPE NOT B-E
Ph3*log netchange	-0.0010**	-0.0013*	-0.0009
	(0.0005)	(0.0007)	(0.0005)
Population	Yes	Yes	Yes
Education	Yes	Yes	Yes
Year f.e.	Yes	Yes	Yes
N	12901	12900	12901

Standard errors in parentheses

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

Next Steps

- Event Study and Robustness checks to DID
- Industry-specific impacts and addition of new sectors in new phases
- Study industry heterogeneity closer: depending on urban/rural, workforce characteristics, effect of local business demography
- exploit cross- market variation in ETS exposure coming from initial differences in industry specialization
- add new data based on latest years and Phase 4
- What are the mechanisms?

Recap

- Treated provinces (Q5) recorded a [(exp(-0.03)-1)*100] = -3.0 % change in GVA in Phase 3, relative to those in the bottom 4 quintiles.
- Employment also decreased but by a lower percent, 1.6% for total employment and 3.6% for employment in sectors B-E
- If this trend is confirmed, one might expect stronger effects for the current period, given the sharp increase in price
- Results are robust when extending the observation period (2005) and to sample selection for possible false positive/negative observations

Thank you!
Questions?
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