Potsdam Institute for Climate Impact Research

Interaction of ETS with other policies, and how to measure it

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(with inputs from M. Leroutier, M. Kosch, J. Abrell, C. Gambardella, S. Osorio, and J. Bushnell)

LIFE-DICET Seminar, Florence, 15 Nov 2019

Overview

1. Theoretical considerations
2. Analyzing the interaction of policies
   a) Ex-post approaches
   b) Ex-ante approaches

Part 1)

Theoretical considerations

Coordination relevant for ambition

- Starting point: *The scope and the stringency of an ETS (as measured, respectively, by the share of total GHG emissions covered, and by the total volume of allowances relative to business-as-usual emissions) determine its level of environmental ambition.*

- Luca's comment: **Complex (often negative) interactions** between ETS and other policies **require coordination** (e.g. Goulder & Stavins 2011, Fankhauser et al. 2010)

- **Timing** and **agency** matters: when and by whom are policies implemented

- Does incoordination **influence ambition**, e.g. lower allowance price?

Coordination interaction: what is the benchmark?

- **European 2020 framework** a benchmark case? Single agency, simultaneous adoption
- Interaction effects (synergies) **considered** cost-wise in RIA
- Yet both targets were **input** to RIA, **not output**

An important finding is that the compliance cost of 78.9 billion € for meeting the GHG emission reduction target, ignoring the RES target, is lower than meeting both targets: 9.1 billion € or 0.06% of GDP. The compliance cost of meeting the RES target alone amounts to 29.1 billion € (0.19% of GDP). However, meeting both targets implies lower compliance cost than the sum of compliance costs of meeting the two targets separately. The gain from the synergy between the two targets amounts to 17.3 billion € (0.11% of GDP).

Source: Capros et al. (2011)

Waterbed effect and internal carbon leakage

"over time"

- Main interaction effect between ETS and complementary policy (CP): lower allowance price (**waterbed effect**)
  - If time-aggregated demand for allowances ($D_T(p_t)$) is price-inelastic ⇔ $p_t > 0$ => **no additionality** from CP

"over space"

- When **overlap is partial**, e.g. unilateral policy in EU-ETS, then additional **ETS-internal carbon leakage** (cp. Perino et al. 2019)
  - **Cost-increasing** unilateral policy, e.g. top-up carbon tax => **positive** leakage (if emission intensity of other countries is higher)
  - **Demand-reducing** or **supply-increasing** unilateral policy, e.g. energy efficiency / renewable support => **negative** leakage

Illustrations

Figure 2: Unilateral policies facing internal carbon leakage and a waterbed effect

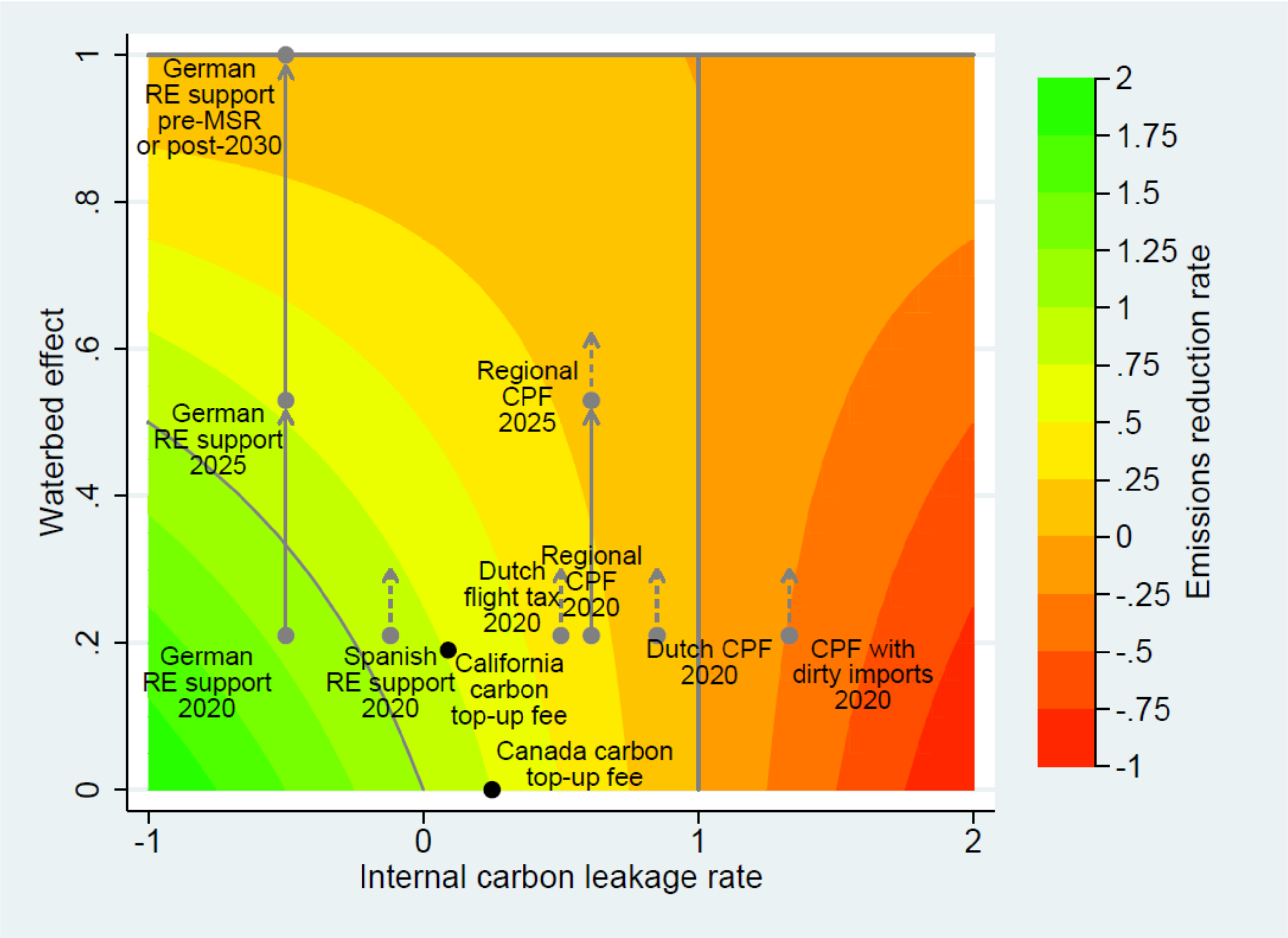


Figure shows the contour plot of the emissions reduction rate R_{it} = (1-L_{it})(1-W_t) of various policies. Solid black lines indicate the contour lines where R_{it} = 0 (when L = 1 or W = 1) and R_{it} = 1 (bottom left). Dashed grey rrows indicate that, in the EU ETS, a policy's R_{it} moves towards zero as t approaches tB=833 and Wt ->1. We assume tB=833 = 2030. Solid grey arrows show specific shifts in time for the German renewable energy support schemes and for a proposed regional carbon price floor.

Source: Perino et al. (2019)

Part 2)

Disentangling the effects of overlapping policies

(A tour through recent work)

Empirical methods (ex-post)

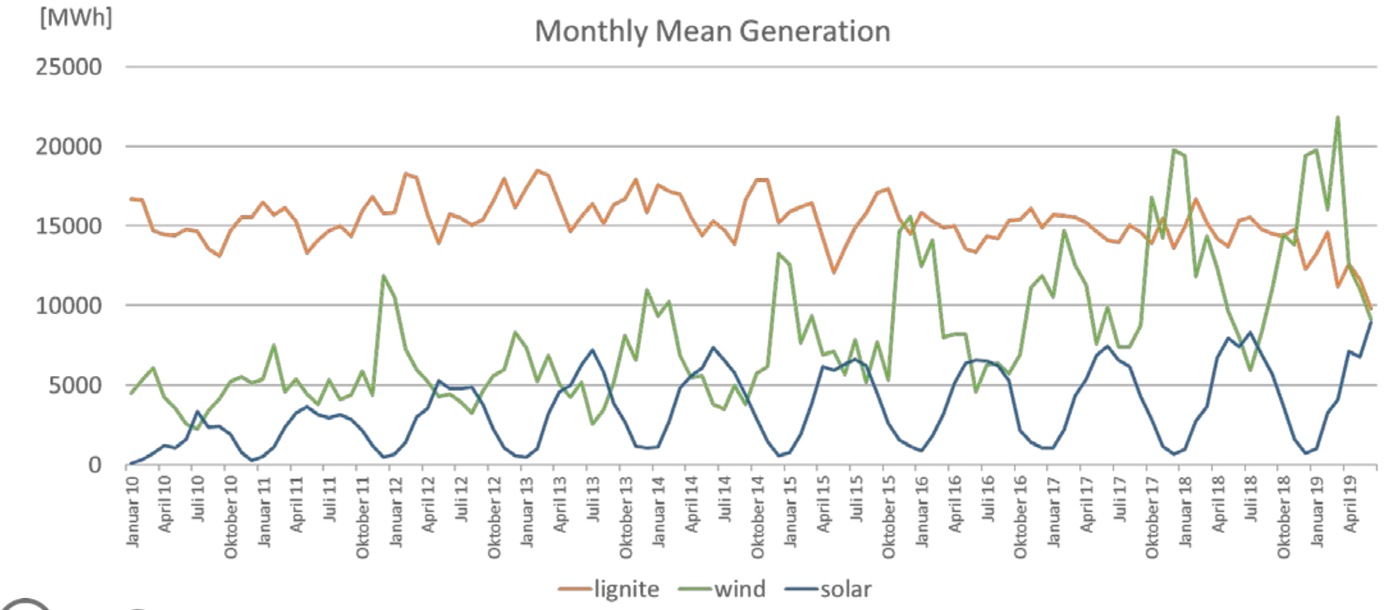
- Effects of e.g. renewable (RE) policy from theory: generation $(q_{RE})\uparrow$ $\Rightarrow$ allowances prices $(p_A)\downarrow$?, emissions $(e)\downarrow\uparrow$?
- Two strands of literature:
  1. Influence of q_{RE} on p_A
  2. Influence of q_{RE} on e (for varying p_A)
- In the following focus on strand #2
- For an overview of strand #1 see review by Friedrich et al. (under review)

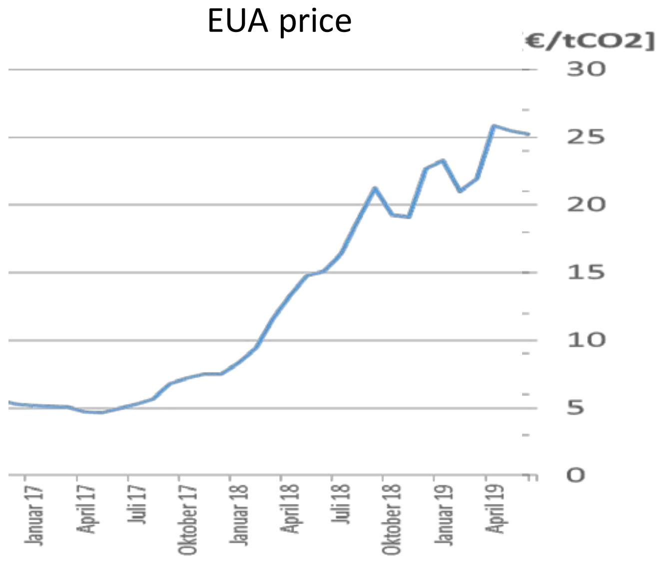
Identification strategies

- Standard regression focuses on **correlations**
- Establishing **causality** requires some sort of **counterfactual**
  - Gold standard is RCT but mostly natural experiments in climate policy
- Various alternative approaches (see Athey & Imbens 2017):
  - Regression discontinuity analysis / "event study" (e.g. Bushnell et al. in preparation)
  - Differences-in-differences (*not covered here*)
  - Synthetic control group (e.g. Leroutier submitted)
  - Machine learning (e.g. Abrell et al. submitted)

Bushnell, Gambardella, Novan & Pahle (in preparation)

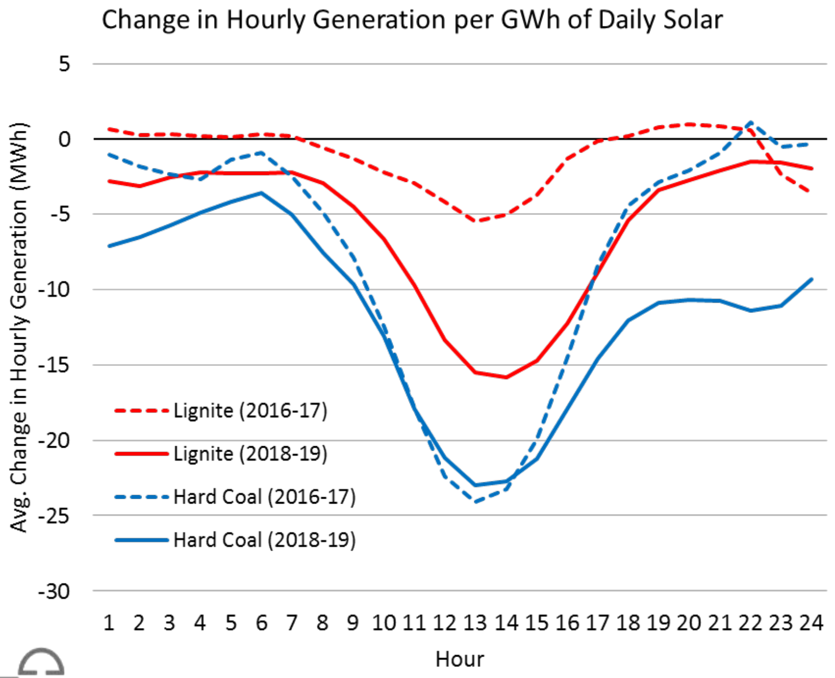
- Analysis of effects of renewables on **German coal generation** considering interaction with EUA prices
- Background: EUA prices ↑, lignite generation ↓, RE generation ↑
  - “Markets drive Germany’s exit from coal much harder than Merkel” (Bloomberg)

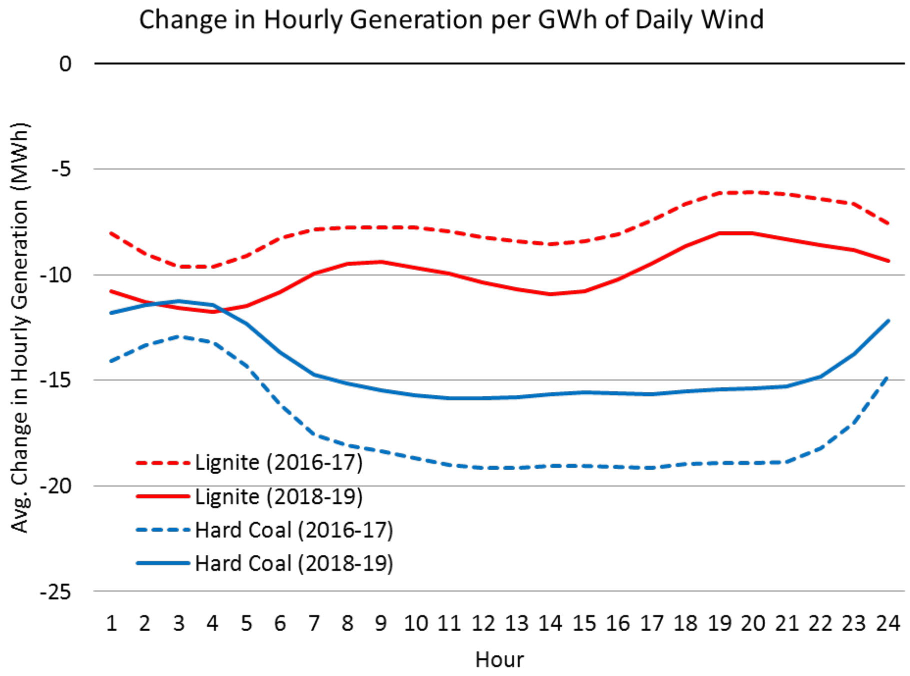




Bushnell, Gambardella, Novan & Pahle (in preparation)

- EUA price & renewable interaction: **mutually reinforcing** reduction of lignite production (positive interaction)
- Hypothesis: higher EUA moves lignite to the margin ⇒ stronger displacement (“merit order effect”) through RE





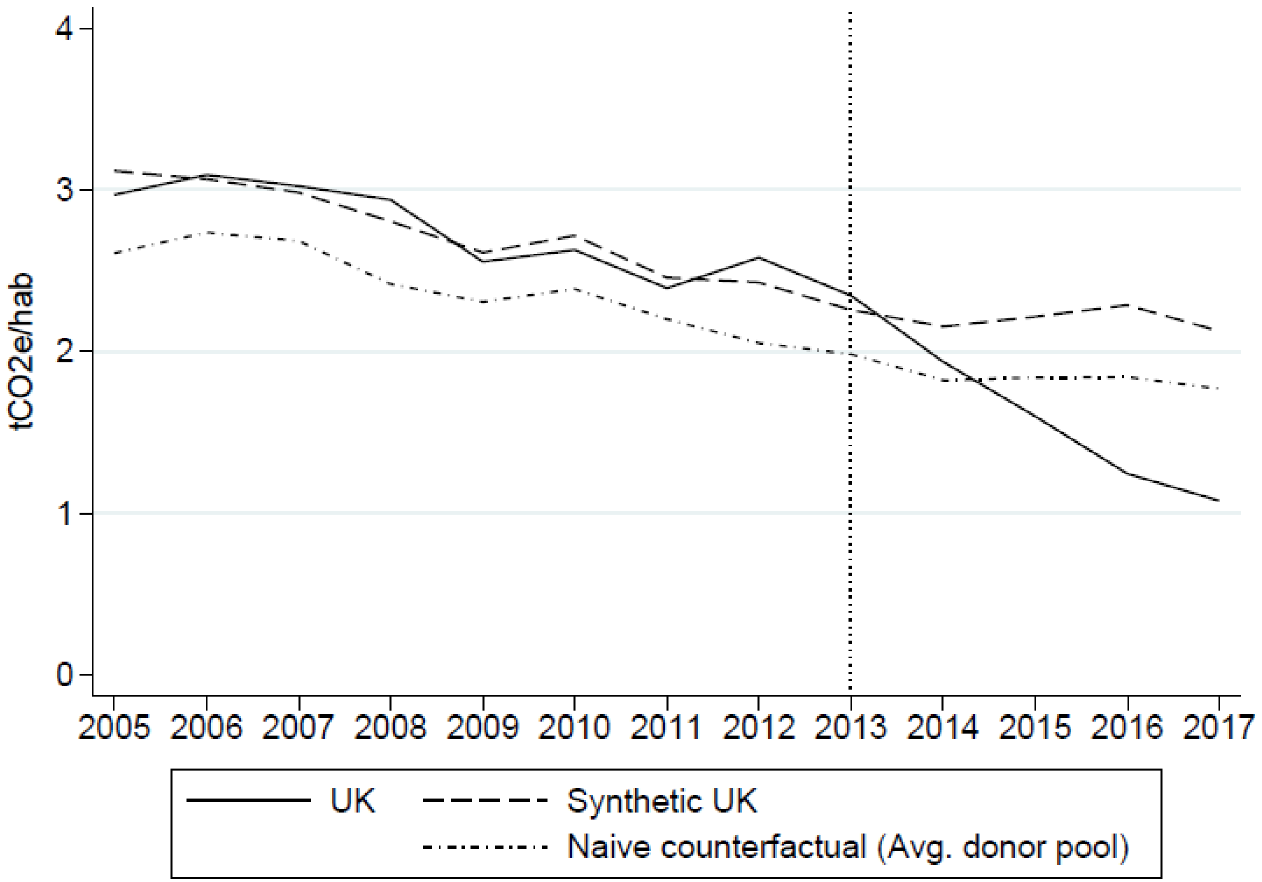
2016-2017: **low** EUA price

2018-2019: **high** EUA price

Leroutier (submitted)*

- Analysis of **impact of UK Carbon Price Support** on abatement
- Constructing counterfactual UK power sector using a weighted combination of other European countries (**synthetic control group**)

Results



*Slide based on talk by M. Leroutier at PIK

Leroutier (submitted)*

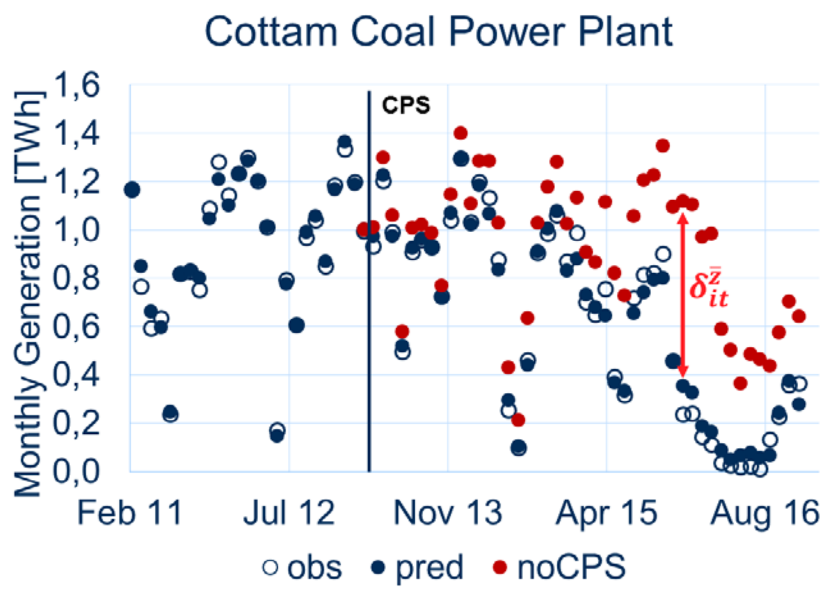
- Potential **confounding** from EU's Large Combustion Plant Directive (**LCPD**)
- **Alternative Synthetic UK** so that a similar amount of emissions falls under LCP opt out regime in 2009

→CPF may have **accelerated plant closure**

*Slide based on talk by M. Leroutier at PIK

Abrell, Kosch & Rausch (submitted)*

- Alternative to using (synthetic) control group is **using machine learning to predict** unobserved counterfactual
- Assumption: prediction errors independent of treatment



Proposed procedure

(1) Theoretical model

$y_{it} = f_i(x_{it}, z_t) + \epsilon_{it},$

$\epsilon_{it} \sim (0, \sigma_\epsilon^2); \epsilon_{it} \perp (x_{it}, z_t)$

x_{it} controls

z_t treatment variable

(2) Learn prediction model *f*

➔ Machine Learning approach

(3) Counterfactual prediction

$y_{it}^{\bar{z}} = f_i(x_{it}, z_t = \bar{z}_t)$

$\bar{z}_t$ counterfactual treatment

(4) Derive treatment effect

$\delta_{it}^{\bar{z}} = y_{it} - y_{it}^{\bar{z}}$

*Slide based on talk by M. Kosch at PIK

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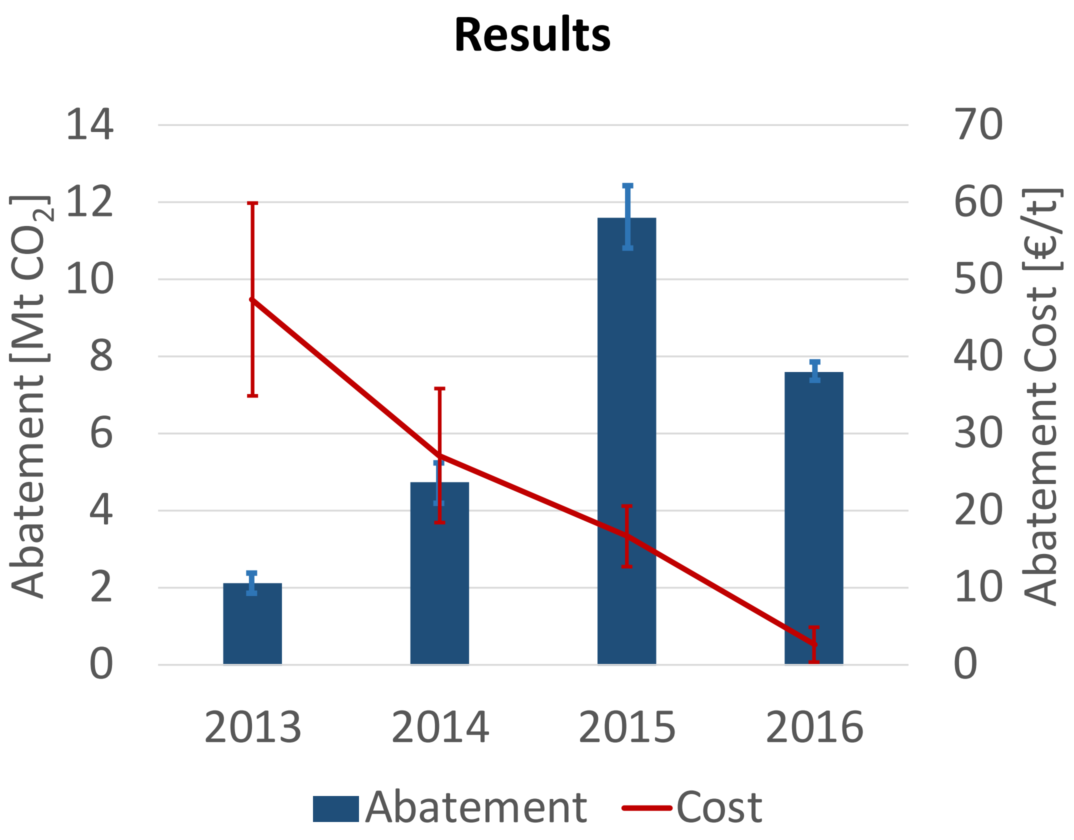
Abrell, Kosch & Rausch (submitted)*

- Conducted prediction considers EUA price in treatment variable:

$$r_t := \frac{(p_t^{coal} + \theta^{coal}(p_t^{EUA} + p_t^{CPS}))}{(p_t^{gas} + \theta^{gas}(p_t^{EUA} + p_t^{CPS}))}$$

- In general approach could **investigate other policies too**
- But usual requirements of regression analysis apply, e.g. sufficient variation in observables (LCPD?)



*Slide based on talk by M. Kosch at PIK

Ex-ante approaches

- Analysis of past interactions is insightful, but for policy design **anticipation of future interactions** is more relevant
- Different approaches with more or less empirical grounding
  - Ex-post based projections (e.g. Borenstein et al. 2019)
  - Numerical modelling (e.g. Pahle et al. 2019)

Borenstein et al. (2019)

- Study of California C&T program, quantify business-as-usual emissions and abatement resulting from non-market policies (renewables, transportation)
- Main question: Probability of “interior equilibrium”, i.e. price between ARP and ACPR?

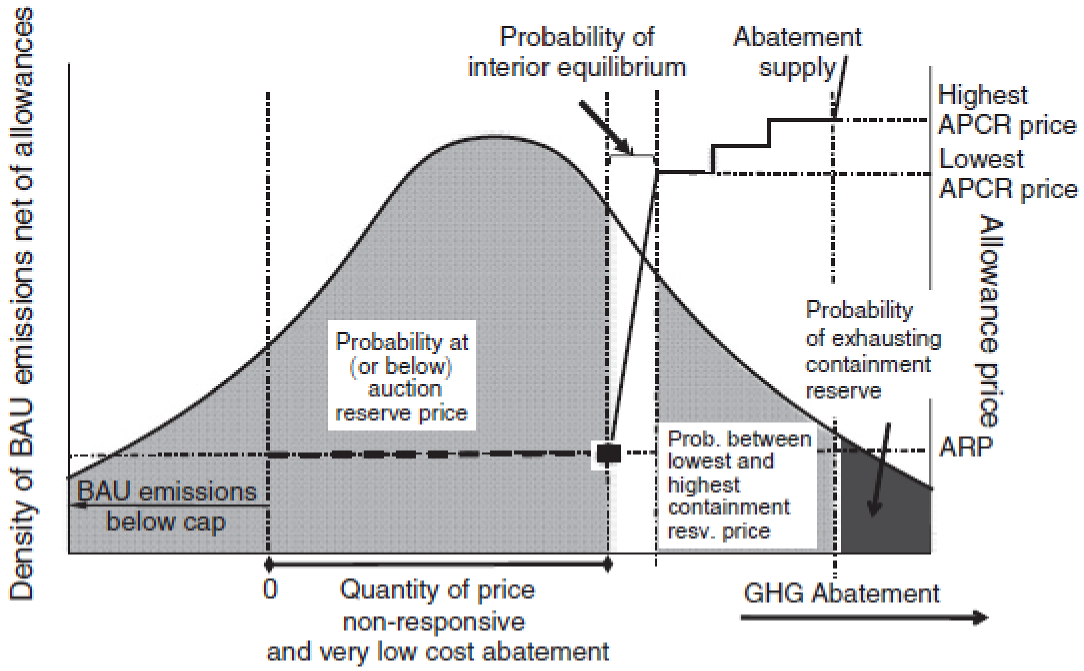


Figure 1. Hypothetical Distribution of Abatement Demand and Supply

APCR = allowance containment reserve price
ARP = auction reserve price

Borenstein et al. (2019)

- Analysis of how much difference complementary policies (CP) make

(i) Renewable electricity output is frozen at its 2012 level;[32]

(ii) No effect of complementary or other policies on the realization of vehicle emissions intensity from the VAR;

(iii) No LCFS, so no impact of the LCFS on the price of fuels;

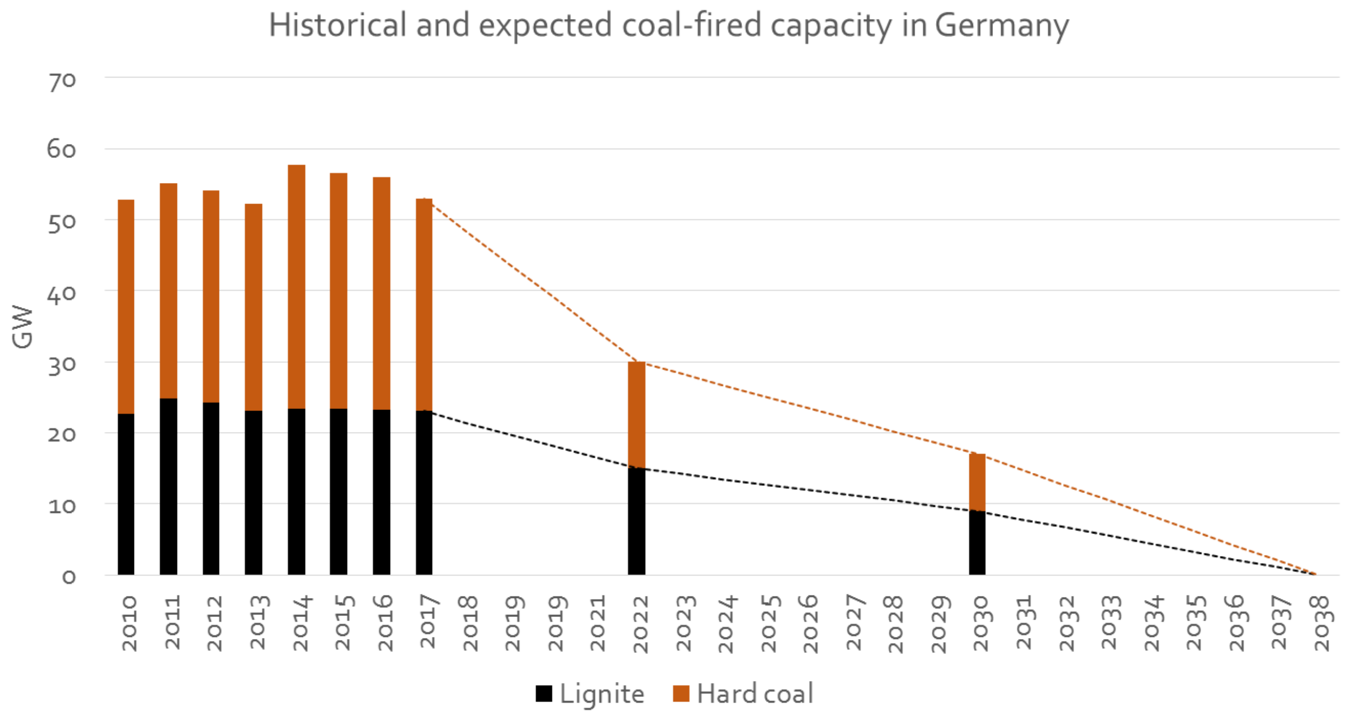
(iv) Higher price elasticity of response of energy demand to energy price changes.[33]

- No impact on fundamental finding that great majority (~90%) of probability distribution **outside area of interior equilibrium**

➔Impact on allowance price unlikely, **ambition preserved?**

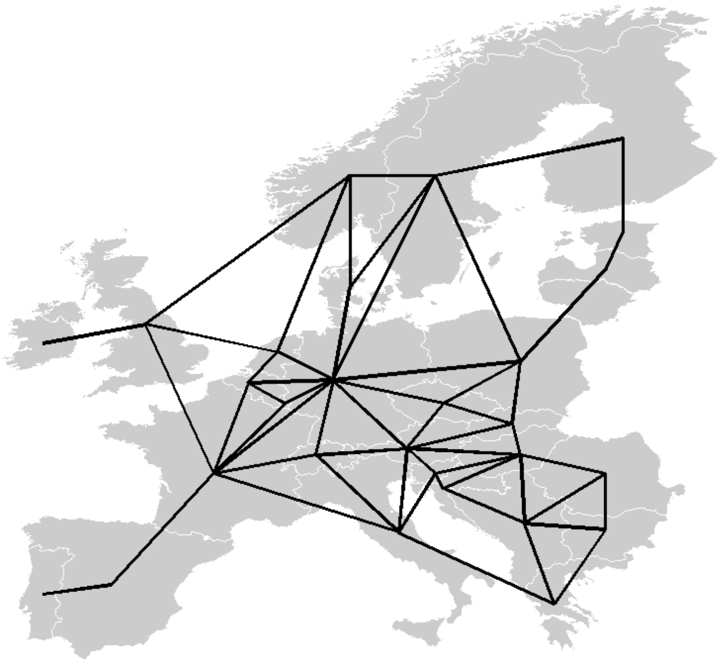
Pahle et al. (2019)

- Analysis of the impact of **German coal phase out** on EU-wide emissions and EUA prices



Pahle et al. (2019)

- Based on LIMES-EU model
- Detailed power sector:
  - Geographical scope: Europe (29 model regions)
  - 33 generation and storage technologies
- EU ETS energy-intensive industry: MACC

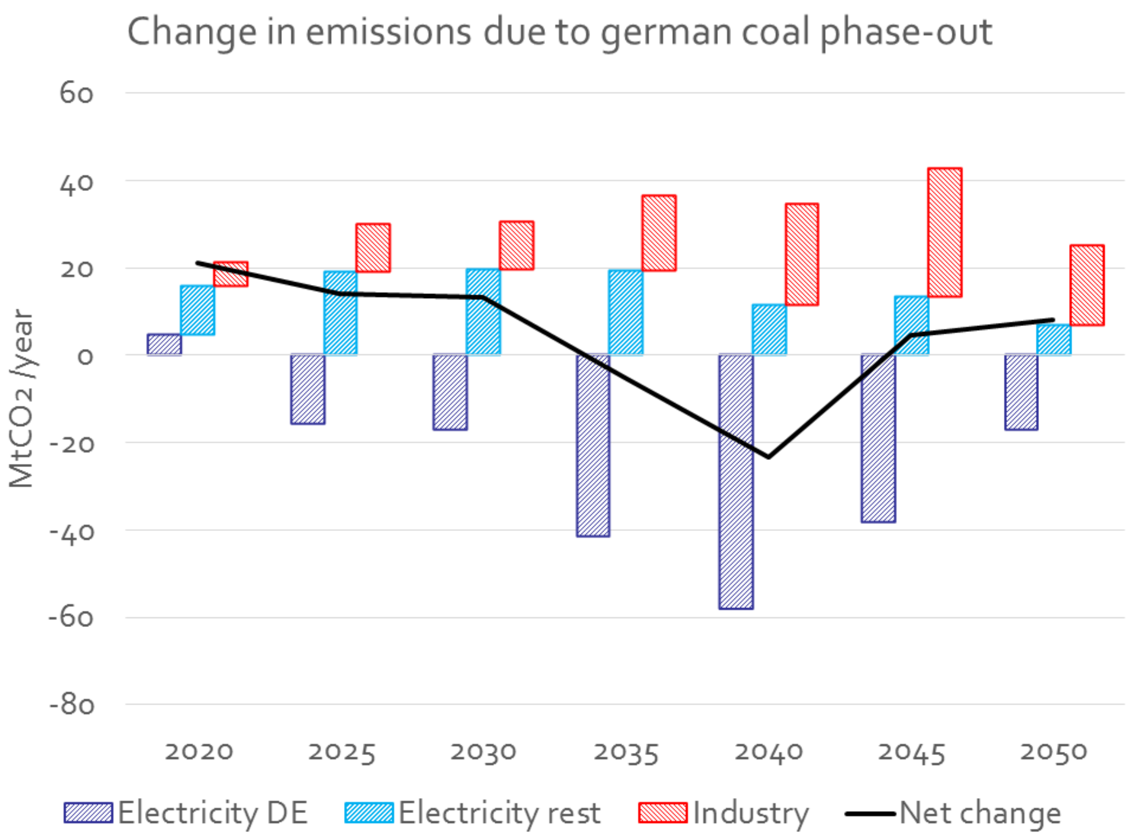


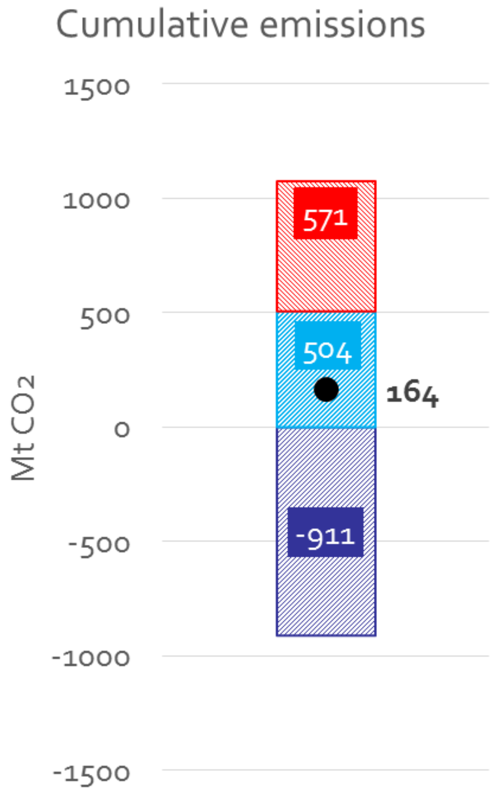
More detailed information available from: https://www.pik-potsdam.de/research/transformation-pathways/models/limes/limes

- EU ETS according to recent reform (MSR cancellation), EUA prices endogenous

Pahle et al. (2019)

- Coal phase out (w/o Article 12 cancellation) **reduces MSR cancellation** by 164 Mt r.t. to baseline ➝ waterbed effect > 100%





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Questions for discussion

- How to asses **environmental ambition** in light of policy interaction and (in)coordination? Ambition might be unaffected, but not **integrity** (also BAU uncertainty).
  - → Need to refine/revise the definition and indicators?
  - → Tie ambition to design features, e.g price collar & MSR?

- What is the view of ETS regulators on policy interaction? Is there need for / interest in (more) research on trade-offs and complementarities as suggested by Luca?