Understanding overlapping climate policies: Internal carbon leakage and the punctured waterbed

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BIEE Research Conference 2021

Motivation: Overlapping climate policies

Carbon pricing often involves multiple jurisdictions

- EU ETS, Regional Greenhouse Gas Initiative (RGGI), California-Québec cap-and-trade, Canada minimum carbon tax

Additional unilateral policies often overlap with carbon price

- Unilateral carbon price
- Coal phase-out
- Renewable subsidies
- Energy-efficiency program
- Aviation tax

$\Longrightarrow$ **What is the climate benefit of such overlapping policies?**

Contribution of this paper

Integrated approach

1. Wide range of overlapping climate policies
2. Almost all types of carbon-pricing systems

Carbon market

- Textbook ETS: Fixed emissions cap $\Longrightarrow$ "waterbed effect" is 100%
- Real world: Flexibility mechanisms with "punctured" waterbed
  - Post-2018 EU ETS Market Stability Reserve
  - Price corridors in RGGI, California, new UK ETS

$\Longrightarrow$ Now overlapping policy *may* have a climate benefit

Product market

- Coal phase-out cuts domestic emissions by 1 tCO_2 but (say) raises imported emissions by 1 tCO_2—"internal carbon leakage" of 100%
  - Pre-2018 EU ETS: Internal leakage did not matter so underresearched
  - More important than "external" leakage for e.g. aviation, electricity

$\Longrightarrow$ *Climate benefit driven by waterbed effect & internal carbon leakage*

Policy relevance

2018 EU ETS reform was motivated partly by "complementary" policies:

> "the Market Stability Reserve will also enhance synergy with other climate and energy policies" — European Parliament and Council

This paper:

- Punctured waterbed raises the stakes:
  - Some unilateral policies are truly complementary in that they induce further emissions reductions elsewhere in the system...
  - But other policies now backfire due to internal carbon leakage...
- Practical guidance for 25 combinations of overlapping policy instruments and types of carbon-pricing designs

Plan for today's talk

1. Conceptual framework
2. Product market: Internal carbon leakage
3. Carbon market: Waterbed effect
4. Empirical illustrations

Conceptual framework

- **System-wide carbon price**: $\boldsymbol{\tau} = (\tau_1, \tau_2)$
- **Overlapping policy**: Reduces jurisdiction i's *domestic* emissions demand, $\Delta e_{it} < 0$ and $\Delta e_i \equiv \Delta e_{i1} + \Delta e_{i2} < 0$ (fixed $\boldsymbol{\tau}$)

  $\Longrightarrow$ What is its equilibrium impact on emissions, $\Delta e^* \equiv \Delta e_1^* + \Delta e_2^*$?
- **Internal carbon leakage**: $L_{it} \equiv -\Delta e_{-it}/\Delta e_{it}$ (fixed $\boldsymbol{\tau}$)
- **Waterbed effect**: $W \equiv 1 - \Delta e^*/\Delta e$ (equilibrium $\boldsymbol{\tau}$)
  - $W = 1$ with fixed emissions cap, $\Delta e^* \equiv 0$
  - $W = 0$ with simple carbon tax

Lemma 1

Equilibrium change in long-run emissions due to i's unilateral policy is:

$$\Delta e^* = [1 - L_i][1 - W]\Delta e_i,$$

where L_i is the average internal carbon leakage across both periods

Product market: Internal carbon leakage

- Perfect competition in product market, with two jurisdictions
  - Heterogeneity: Production cost, emissions intensity, abatement

Proposition 1

Supply-side policy has **positive** internal leakage, $L_i > 0$ (even $L_i > 1$)

- Unilateral carbon price (e.g. UK price floor for power generation)
- Reduction in emissions-intensive production (e.g. coal phase-out)

Proposition 2

Demand-side policy has **negative** internal leakage, $L_i < 0$

- Renewables support procures extra zero-carbon generation
- Energy-efficiency program cuts emissions demand
- Carbon consumption tax

Intuition: Former leads to substitution; latter displaces imports

- Simple formulae for L_i in paper, straightforward to calibrate

Carbon market: Waterbed effect

Flexibility mechanisms based on past allowance prices

- Carbon taxes, pre-2018 EU ETS, new UK ETS, California, RGGI
  - Allowance supply in period 2 depends on carbon price in period 1
  - Allowance demand shifted downwards by i's overlapping policy

Proposition 3

$$W = \frac{\varepsilon \text{ of allowance demand}}{\varepsilon \text{ of allowance demand} + \varepsilon \text{ of allowance supply}} \in [0, 1]$$

is independent of specifics of overlapping policy and internal leakage

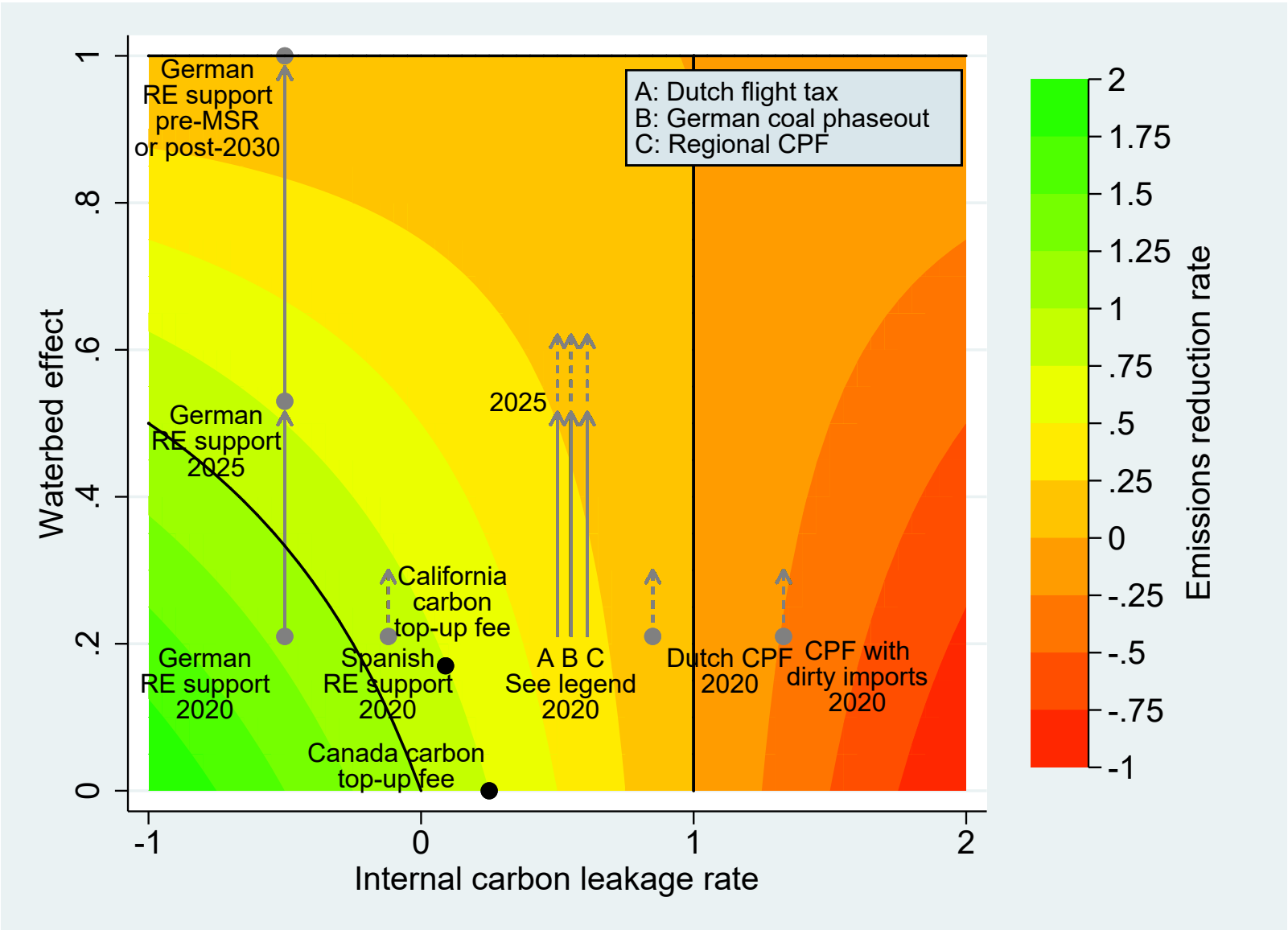
$\Longrightarrow$ Classic principle of tax incidence (Jenkin 1872; Weyl-Fabinger 2013)

Flexibility mechanisms based on past allowance banking

- Post-2018 EU ETS Market Stability Reserve
- Very complex: Waterbed depends on timing of overlapping policy, whether it is anticipated, etc. (see Proposition 4)

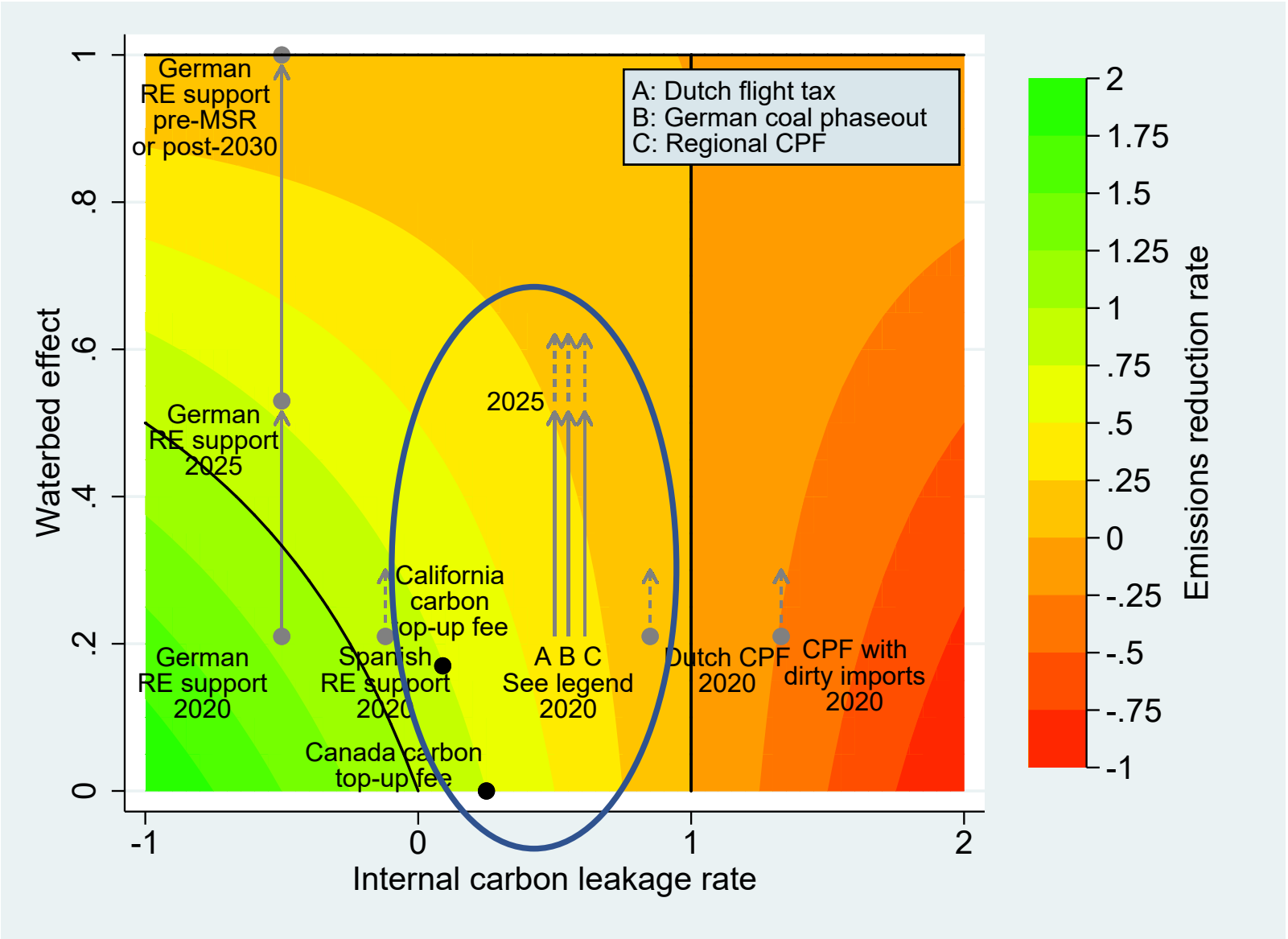
Empirical illustrations

Framework: Emissions reduction rate $R_i \equiv \frac{\Delta e^*}{\Delta e_i} = [1 - L_i][1 - W]$



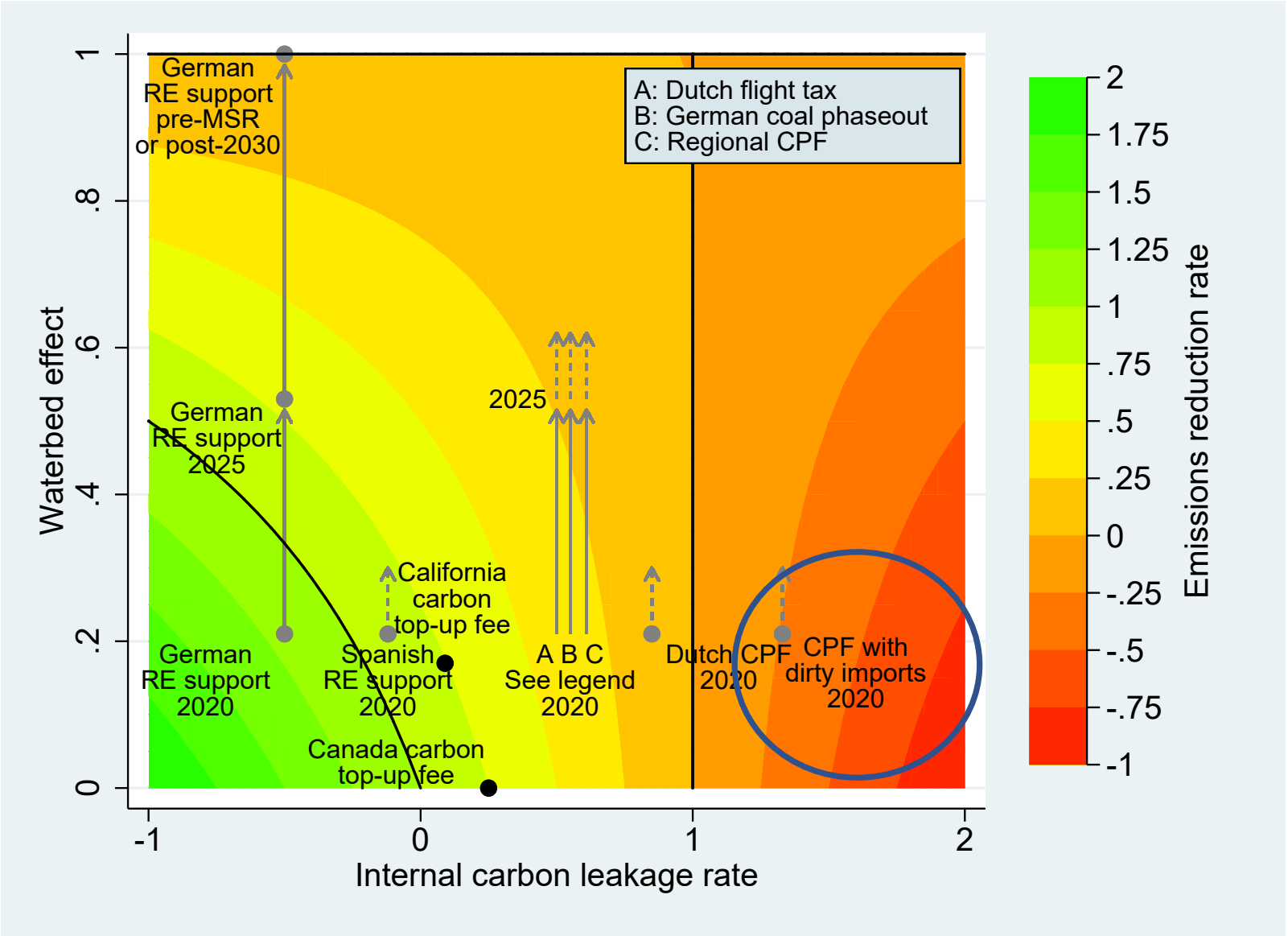
Empirical illustrations

Supply-side overlapping policies can yield a climate benefit ($R_i > 0$)...



Empirical illustrations

.. but they can backfire if imports are sufficiently "dirty" ($R_i < 0$)...



Empirical illustrations

... while demand-side policies *may* be truly complementary ($R_i > 1$)