Regulating Global Externalities

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Trading Emission Allowances

Conventional wisdom: Trading emissions allowances is 'good'

Rationale: equal marginal costs = minimal total costs

Applications: ETS covering many sectors, linking countries, ...

This paper: we can do better

Fundamental mechanism: There is information in trade flows, that can be used for efficient regulation

Intuition: To minimize losses from uncertainty, we must anchor an ETS to the country/sector/GHG that has most predictable abatement costs.

One Evening in a Cosy Bar...

... folks gather...

... two of them like a smoke...

(... and the bartender studied economics)

- First night: 10 total
- observing outcome
- Second night: 6 total

Asymmetric Uncertainty: Some Agents Are Less Predictable Than Others...

Signal Extraction

- Advanced Bayes' Rule
- Most famous: Kalman filter
- Basic intuition: give more weight to less noisy signals/information

Our case

- Less predictable agents: more scope for learning
- Regulation (total smoking) responds most to differences between expectation and realization for *unpredictable* agents.
- Efficient regulation takes into account asymmetric uncertainty

Related literature

- Weitzman (1974): Prices vs Quantities at aggregate level
  EAERE2020 Friday 15:00-17:00: in memory of MW
- Pizer and Prest (2018)/Gerlagh and Heijmans (2018)/Heutel (2020): Extracting information from dynamic markets.
- Mideksa and Weitzman (2019): Competition between emission jurisdictions (instead of cooperation)
- Doda, Quemin, Taschini (2019): neat decomposition of gains from ETS trade through improving allocative efficiency and reducing volatility.

- This paper: Tradable allowances with horizontal linkages and endogenous adjustment of aggregate cap (Theory)

Model and Welfare

The regulator maximizes expected welfare:

$$W = B_1(x_1; \theta_1) + B_2(x_2; \theta_2) - C(x_1 + x_2). \tag{1}$$

where

- x_i is the number of allowances used by country/sector i
- θ_i his private information/unobserved preference (shock), sd σ_i and correlation ρ
- $B(.)$ is private benefit (firms' profits)
- $C(.)$ is global costs (climate damage)

More structure (linear marginal model)

Benefits:

$$MB_i(x_i;\theta_i) = p^* + \theta_i - \beta_i x_i \tag{2}$$

Costs:

$$MC(x_1 + x_2) = p^* + \gamma(x_1 + x_2) \tag{3}$$

Normalization

- p^*, x_i^* prices and quantities: ex-ante optimum (if $\theta_1 = \theta_2 = 0$)
- p, x_i (without star): deviations from ex-ante optimum ($p = x_1 = x_2 = 0$ if $\theta_1 = \theta_2 = 0$)

Typical Policy: Quantities

Definition (Quotas)

The regulator allocates the ex ante optimal number of allowances x^* to each country/sector. Thus (after normalization):

$$x_1^Q = x_2^Q = 0. \tag{4}$$

Mathematical interpretation:

$$\max_{x_1, x_2} \mathbb{E}\left[W(x_1, x_2, \theta_1, \theta_2)\right] \tag{5}$$

Property:

$$\mathbb{E}[MB_1|x_1] = \mathbb{E}[MB_2|x_2] = MC \tag{6}$$

Better: Trade

Definition (Trade)

The regulator allocates the ex ante optimal number of allowances x^* to each country/sector. Firms can freely trade allowances, subject to:

$$x_1^T + x_2^T = X^T. \tag{7}$$

Interpretation:

$$\max_{X} \quad \mathbb{E}\Big[\max_{x_1,x_2} W(x_1, x_2, \theta_1, \theta_2)\Big] \tag{8}$$

$$\text{s.t.} \quad x_1 + x_2 = X \tag{9}$$

Property:

$$MB = MB_1 = MB_2 \tag{10}$$

$$\mathbb{E}[MB | x_1 + x_2] = MC \tag{11}$$

Substitution

- What, really, is the marginal rate of substitution for allowances?
- Thought experiment: suppose there are two.
  - MRS_i: rate at which allowances change hands between individual firms.
  - $MRS_A = -x_2/x_1$: rate at which the aggregate levels of allowances are substituted.
- We propose to set $MRS_i = 1$ to keep incentives consistent with efficiency properties (10). No ex-ante reasoning for MRS_A; thus, a regulator choose.

Stabilized Trading

Definition (Stabilized Trading)

The regulator adapts the total allocation of allowances based on a fixed $MRS_A = \delta$:

$$\delta x_1^{ST} + x_2^{ST} = X^*. \tag{12}$$

Profit maximization and free trading with $MRS_i = 1$ ensures that firms exchange allowances such that marginal benefits are equal in both countries/sectors:

$$p_1^{ST} = p_2^{ST}. \tag{13}$$

Is there a rationale for ST?

Filtering information

We want to use all information including trade (smoking in a bar)
Replace the trade-information property

$$MB = MB_1 = MB_2 \tag{10}$$
$$\mathbb{E}[MB|x_1 + x_2] = MC \tag{11}$$

By the best quantity information available (think of bar):

$$MB = MB_1 = MB_2 \tag{10}$$
$$\mathbb{E}[MB|x_1, x_2] = MC \tag{14}$$

Stabilized Trade

Equation (10) gives

$$p_1 = p_2 \tag{15}$$

We can show that (14) gives

$$\delta x_1 + x_2 = X^*. \tag{16}$$

with

$$\delta^* = \frac{\beta_1[\sigma_2^2 - \rho\sigma_1\sigma_2] + \gamma[\sigma_1^2 + \sigma_2^2 - 2\rho\sigma_1\sigma_2]}{\beta_2[\sigma_1^2 - \rho\sigma_1\sigma_2] + \gamma[\sigma_1^2 + \sigma_2^2 - 2\rho\sigma_1\sigma_2]}, \tag{17}$$

If the second country/sector has much more volatile demand, $\sigma_2 \gg \sigma_1$, then the first country/sector allowances allocation will not adjust much compared to the second, $\delta \gg 1$.

Properties

- Stabilized Trade outperforms traditional Trade in terms of welfare and price stability.
- MRS_A may well be negative, meaning that more-than-expected smoking by one individual translates into more-than-expected smoking by the other too.
  - More likely for strongly positively correlated preference shocks.
- Aggregate trade flows are corrected for the fact that larger preference shifts should be expected for more unpredictable individuals.
- Share of aggregate shocks absorbed by a country/sector decreases in the country's/sector's responsiveness of benefits to allowances, that is, in slope parameter β_i.

Theorem

Stabilized Trade is strictly welfare-superior among the class of quantity-based instruments. (It uses all information x_1, x_2)

Note: but it does not use price information, thus is not First-Best.

Summary

- We built a model of regulating global externalities under (demand) uncertainty
- We showed instead of allocating a fixed 'budget' to the market, welfare can be increased through offering the market a regulatory *function*
  - Function should be a *rule*, known to the market
- mechanism: non-unity rates of substitutions can anchor ETS to most stable (weighted average) market.
- result: Reduces volatility of ETS prices
- scope: Applicable to multi-gas, multi-sector, multi-country linkages

Thank you. Comments appreciated.