An Endogenous Emission Cap Produces a Green Paradox

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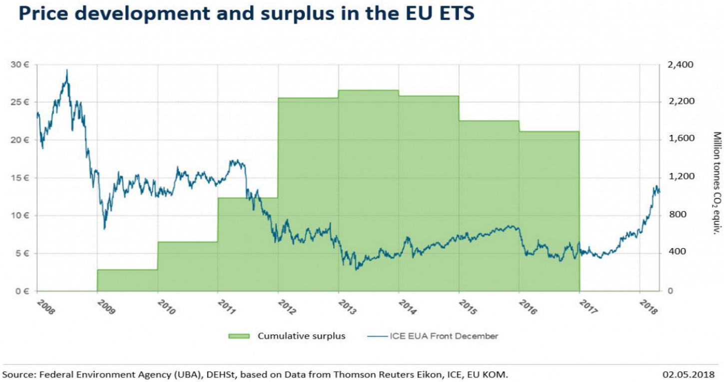
EU ETS: a cap-and-trade system with an endogenous cap

2005 Launch of EU ETS, world's second-largest market for CO_2
2008 Market crashed after credit crisis
2011 EU ETS bust deepened
2018 Crucial revision → **endogenous emission cap**

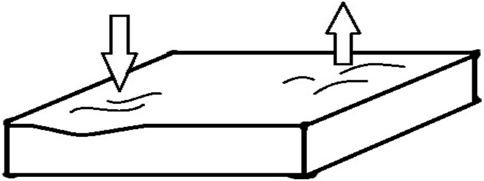


EU ETS

- Each year, new allowances are **supplied**.
- Supply reduces linearly over the years, to zero around 2050.
- Firms can do three things with an allowance: (1) surrender to emit CO2, (2) trade with other firms, or (3) store for future use (**banking**).
- Implements efficient use of allowances with **exogenous emission cap**

EU ETS and the Waterbed Effect

- With an **exogenous emission cap**, supplementary climate policies have no effect on total emissions
- Often referred to as the **waterbed effect**



- Moreover: Fixed supply + variable demand = variable allowance price

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- Cumulative supply of allowances depends on market outcomes = **endogenous emission cap**.
- MSR intended to restore effectiveness of abatement policy and stabilize allowance prices

Literature on EU ETS + MSR

- Perino (NCC, 2018): MSR temporarily punctures waterbed, restores effectiveness of abatement policy...
- Rosendahl (NCC, 2019): ... but only if policy is short-lived
- Gerlagh and Heijmans (NCC, 2019): Private agents can exploit loopholes for allowance canceling ("Buy, bank, burn")
- Gerlagh, Heijmans, & Rosendahl (ERE, 2020): MSR dampens allowance price volatility

This paper

- Proposition 1: EU ETS + MSR is susceptible to a green paradox:
  - Anticipated future emission reduction policies lead to increased aggregate emissions.
  - The **EU Green Deal** may be counterproductive!
- Proposition 2: Multiple equilibria in EU ETS + MSR.
- Simulations: Estimates for the green paradox (large), equilibrium multiplicity (real), and the importance of announcement.

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- Unused allowances are **banked**: b

$$e_1 = \bar{s}_1 - b$$
$$e_2 = \bar{s}_2 + b$$

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- EU ETS **with MSR**: If the bank is large $(b > \bar{b})$, **supply in period 2** is reduced by δb:

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- RQ: **What is the effect of complementary emissions policies on emissions?**

Proposition 1.1: Leakage

Proposition

An **early** *emissions-reducing policy,* $\lambda_1 < 0$*, is* **dampened** *by the MSR:*

$$0 < \frac{dE}{d\lambda_1} < 1$$

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- Emission-reduction in period 1 ($e_1 \downarrow$) $\rightarrow$ more banking ($b \uparrow$) $\rightarrow$ greater inflow in MSR $\rightarrow$ more canceling ($\bar{s}_2 - \delta b \downarrow$) $\rightarrow$ lower aggregate emissions ($E \downarrow$).

Proposition 1.2: Green Paradox

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A **late but anticipated** *emissions-reducing policy,* $\lambda_2 < 0$*, is* **reversed** *by the MSR:*

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- Low future demand ($e_2 \downarrow$) $\rightarrow$ lower prices ($p_2, p_1 \downarrow$) $\rightarrow$ higher current demand ($e_1 \uparrow$) $\rightarrow$ lower banking ($b \downarrow$) $\rightarrow$ less inflow in MSR $\rightarrow$ less canceling ($\bar{s}_2 - \delta b \uparrow$) $\rightarrow$ aggregate emissions increase ($E \uparrow$).
    - Requires that future policies affect banking
    - Timing and anticipation are crucial!
- Result not specific to simple model. For a much more general result, click here

Multiple equilibria

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If an equilibrium exists with banking sufficiently close to the threshold, $|b - \overline{b}| < \varepsilon$ and ε small, then at least two distinct equilibria exist. These equilibria are supported by distinct price-paths $(p_1^*, p_2^*) < (p_1^{**}, p_2^{**})$, and different levels of cumulative emissions $E^* > E^{**} + \delta\overline{b}$.

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- Intuition: small change in banking $\rightarrow$ cross MSR thresholds $\rightarrow$ discrete adjustment of supply
- Multiple equilibria = unpredictability
- "Coordination failure"

Model calibration

- Linear demand function:

$$d_t(p_t; \lambda_t) = (a - bp_t)(1 - ct) + \lambda_t$$

- Real discount rate of 5%
  - Demand zero in period T, when price equals choke price
  - T is endogenous
  - Supply drops to zero after 2057
- The parameters a, b and c are disciplined using historic evidence:
  1. Consistent with price-demand combination in 2018
  2. Base case scenario with MSR should have initial price of 21 Euro/t
  3. Base case scenario without MSR should have initial price of 7.5 Euro/t
- Calibration: $a/b = 221.5$ €/tCO2, $c = 0.021$, and $T = 2066$
- Figure for supply and demand here

Baseline scenario: stocks

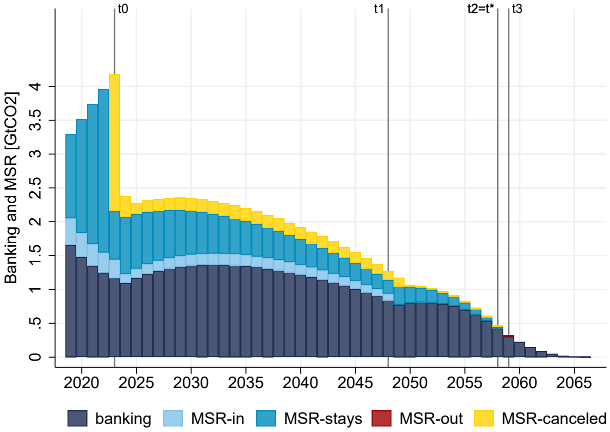

Figure: Stocks of allowances

Multiplicity of equilibria

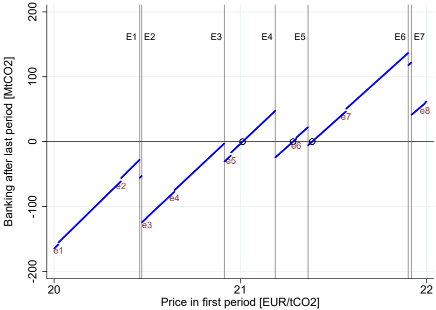

Figure: Banking in year $T = 2066$, as dependent on initial price

- Equilibrium requires that banking is zero in $T = 2066$
- Initial prices of 21.0, 21.3, and 21.4 are equilibria
- Figure for canceling here

Abatement policies: (in)effective

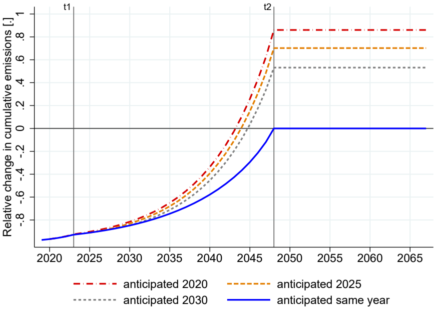

Figure: Effect of abatement policy on cumulative emissions

- Early abatement = reduction in emissions
- Unannounced abatement reduces emissions (until MSR inflow stops)
- Late but announced abatement increases emissions

Effective complementary policies

How to avoid the green paradox?

1. Match policies with a reduction of the ETS cap.
   - Repeated negotiations on cap, which MSR was meant to avoid...
2. Price-triggered canceling of allowances
   - Low allowances prices trigger cancellation, similar to RGGI.
   - Discrete canceling: still multiplicity...
   - Gerlagh & Heijmans (2020): canceling should decrease **continuously** with prices = optimal instrument for stock externalities
   - Continuous canceling also fixes equilibrium multiplicity

Price stability: separation of targets

Stable ETS prices require

1. **Endogenous** adjustment of emission cap to changes in demand
2. **Sufficient liquidity**

Liquidity

Liquidity balances two risks:

1. Large bank turns price volatility into **asset risk**.
2. Small bank causes a collapse of intertemporal trade and *causes* **price volatility** (South Korean ETS)

Lessons:

1. Cancel allowances in MSR to let supply respond optimally to demand.
2. Flows between MSR and ETS should target liquidity, **not** long-run supply adjustment.

Conclusions

- Abatement today can reduce emissions through the MSR
- But future abatement announced today (the **Green Deal**) may increase emissions
  - Warrants further revisions of EU ETS + MSR
- Possible caveat: our model is deterministic
  - Mechanism also relevant with imperfect foresight

Thank you for your attention!

General Model Theorem

- Note: The MSR implies that cumulative supply of allowances depends on the path of emissions (= demand for allowances) – via banking
$$S = s(\boldsymbol{d}) \text{ where } \boldsymbol{d} = \boldsymbol{d}(p, \boldsymbol{\lambda})$$
- We refer to this as a quantity-based (endogenous) emissions cap
- We set up a generic ETS model with quantity-based (endogenous) cap
- Aggregate demand equals aggregate supply
- Assume no free lunch ($\Delta \boldsymbol{d} > 0$ not feasible)

Theorem

For every quantity-based endogenuous cap system without a free lunch, there exists a policy $d\boldsymbol{\lambda} < 0$ that induces a green paradox, $d(\boldsymbol{u}^T \boldsymbol{d}^*) > 0$.

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Baseline scenario: supply and demand

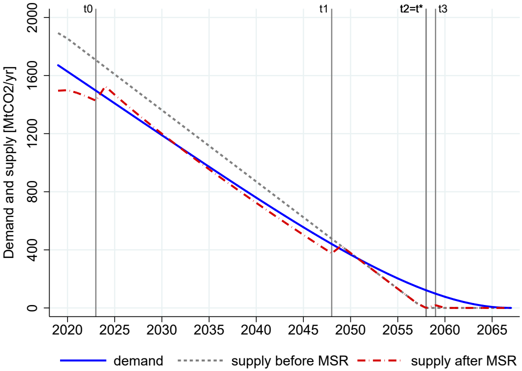

Figure: Market balance (p_t goes from 21 to 208 Euro/t in 2066)

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MSR cancelling

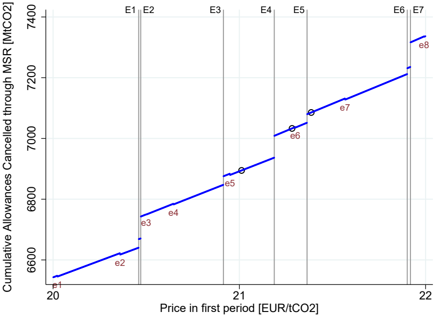

Figure: Cumulative cancellation of allowances, as dependent on initial price

- Cumulative cancellation jumps upwards when a threshold is passed
- Cumulative emissions are around 200 Mt higher with $p_0 = 21.0$ than with $p_0 = 21.4$
- Which equilibrium will the market choose??

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