Endogenous Emission Caps Always Induce a Green Paradox

Reyer Gerlagh*, Roweno J.R.K. Heijmans*, **Knut Einar Rosendahl**+

*Tilburg University +Norwegian University of Life Sciences and Statistics Norway
All are affiliated with CREE - Oslo Centre for Research on Environmentally friendly Energy

Workshop on EU Climate Policies, Berlin
November 20th 2019

Motivation

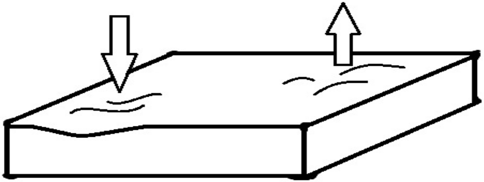
- EU Emission Trading System (EU ETS): New mechanism recently introduced: Market Stability Reserve (MSR)
- February 2018: Crucial revision of the MSR rules
- Consequence #1: Large amounts of emission allowances will be cancelled (probably more than one year of emissions in total)
  $\rightarrow$ Long-run cap on emissions substantially reduced
- Consequence #2: Long-run cap on emissions endogenuous
  $-$ depends on the market outcome
- What are the implications of the new MSR rules?

This paper

- Theorem 1: In any ETS with a quantity-based endogenous emission cap, there exists a Green Paradox (GP)
- Proposition 2: The EU ETS MSR is a special case of Theorem 1: A 'late' negative shock in demand (e.g. abatement policy) gives rise to a Green Paradox (if announced 'early'): Cumulative emissions increase
- Proposition 1: The new MSR rules introduce multiple equilibria in the ETS market
- Numerical results: Quantitative estimates for the effects of abatement policies, and the importance of announcement

The waterbed effect

- With a fixed cap on emissions, supplementary climate policies have no effect on total (cumulative) emissions
  - Total emissions are exogenous – determined by the EU policy makers
- This is often referred to as the waterbed effect
  - If you reduce emissions somewhere at a certain point in time, emissions will increase somewhere else and/or at another point in time (100% leakage)
- Perino (NCC, 2018): The waterbed is temporarily punctured



EU ETS: Efforts to increase the price

- Various efforts to increase the CO2-price
  - Reduced cap after 2020 $\rightarrow$ Reduced long-run cap by 0.6 Gt (until 2030)
  - Postponed supply of allowances via 'backloading' and MSR v.1 $\rightarrow$ Reduced short-run cap, but not long-run cap (?)
- MSR (Market Stability Reserve) v.1:
  - Whenever total banking exceeds threshold $\overline{B} = 833$ Mt, m allowances are placed in the MSR instead of being auctioned
  - Whenever total banking is below threshold $\underline{B} = 400$ Mt, n allowances are moved from the MSR to the market (via auctions)
  - Comparison (end of 2018): Banking: Around 1.5 Gt ; MSR: Around 1.5 Gt

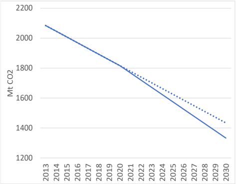
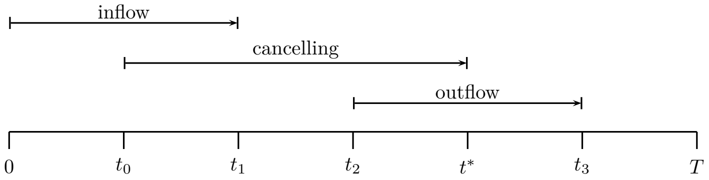


Figure: EU ETS cap 2013-2030

Market Stability Reserve

- MSR v.2 (2018): Allowances in MSR can be canceled (from 2024)
  - Whenever size of MSR exceeds threshold β_t, all allowances above β_t are canceled $\rightarrow$ Long-run cap is reduced
- Thresholds and flow of allowances:
  - Inflow: $\overline{B} = 833$ Mt; $m = 24\%$ (12%) of total banking
  - Outflow: $\underline{B} = 400$ Mt $n = 100$ Mt
  - Cancel: $\beta_t =$ No. of auctioned allowances next year (ca. 60% of annual cap)
- Likely timeline:



Previous literature

- Studies on MSR v.1:
  - Fell (JEEM, 2016), Perino and Willner (JEEM, 2016), Salant (JEEM, 2016), Kollenberg and Taschini (EER, 2019)
- Studies on MSR v.2:
  - Perino (NCC, 2018): Waterbed temporarily punctured – abatement policy today reduce long-run cap
  - Rosendahl (NCC, 2019): Brief comment to Perino about GP
  - Gerlagh and Heijmans (NCC, 2019): Loopholes for allowance burning ("Buy, bank and burn")
  - Several working papers and ongoing work (Gerlagh and Heijmans, 2018; Burtraw et al, 2018; Bruninx et al, 2019; Perino et al, 2019; Quemin and Trotignon, 2019)
- Studies of green paradox:
  - Sinn (ITPF, 2008), Gerlagh (CESifo, 2011), Bauer (NCC, 2018)

Analytical model of the EU ETS and MSR

- We set up a simple dynamic ETS model including the MSR specifics
- Equilibrium in the ETS market:
$$B_t - B_{t-1} = s_t - d_t(p_t; \lambda_t) - m_t + n_t$$
- B is banking, s is exogenous supply (annual cap), d is demand (= emissions), which is decreasing in the ETS price p and increasing in a demand shifter λ
- A reduction in λ_t can e.g. be due to an abatement policy in year t
- ETS price develops according to Hotelling's rule: $p_{t+1} = \delta p_t$
- No uncertainty and fixed duration T
- Distinct stages (cf. Figure above), and assume $B_T = 0$ and $M_T = 0$

Multiplicity of equilibria

Proposition (Multiplicity)

For any ETS with the characterics of the MSR (but with arbitrary values of parameters and exogenous variables), there exists a demand function such that at least two distinct equilibria exist with $p_1^* < p_2^*$.
Cumulative emissions will differ quite significantly: $E_2^* < E_1^* - \alpha \overline{B}$

- Moreover: Small shifts in demand can imply substantial shifts in cumulative emissions if close to threshold $\overline{B}$

Green Paradox

Proposition (Leakage)

A small shock in demand is dampened by the MSR if the shock is 'early':

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

A small shock in demand is reversed by the MSR if the shock is 'late':

$$\frac{dE}{d\lambda_t} < 0 \text{ if } t \geq t_1$$

- First part of proposition reiterates the finding by Perino (2018)
  - Note: Requires that the shock is temporary, not permanent
- Second part of proposition demonstrates a (even stronger) Green Paradox
  - Condition: The late shock in demand is known from the start
  - Time of announcement crucial
- Hence: Attempts to reduce future emissions may lead to a backlash

Model calibration

- Assume constant elasticity of demand function: $d_t(p_t; \lambda_t) = \Omega_t(p_t)^\sigma + \lambda_t$
- Assume linear shift in demand function over time: $\omega = (\Omega_t - \Omega_{t-1})/\Omega_{2018}$ (ω constant parameter)
- Assume real discount rate of 5%, and $T = 2050$
- The parameters Ω_0, σ and ω are disciplined using historic evidence:
  - Base case scenario with MSR should have initial price of 21 Euro/t
  - Base case scenario without MSR should have initial price of 7.5 Euro/t
  - Consistent with price-demand combination in 2018

Baseline scenario

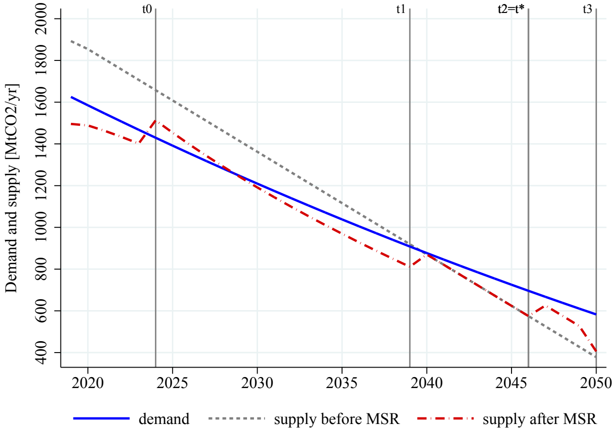


Figure: Market balance (p_t goes from 21 to 95 Euro/t in 2050)

Baseline scenario

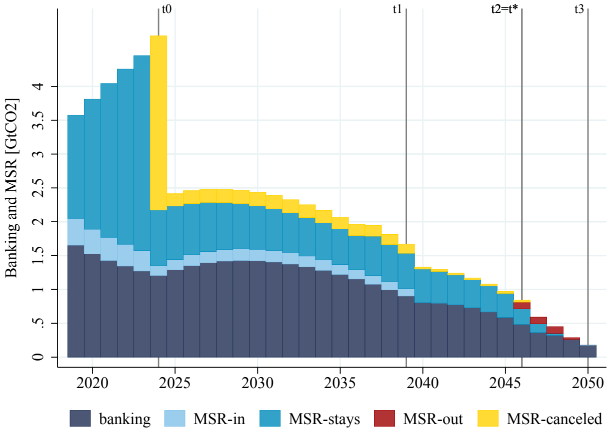


Figure: Stocks of allowances

Multiplicity of equilibria

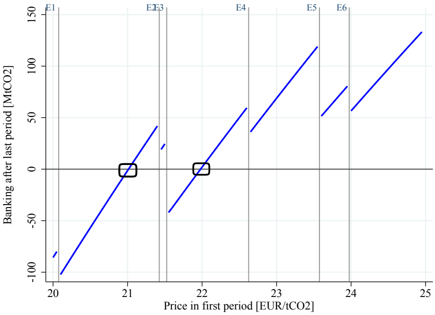


Figure: Banking in 2050, as dependent on initial price

- Equilibrium requires that banking in 2050 is zero - here we see two such equilibria for the same demand function
- In our Baseline scenario, the price starts at 21.0. If the price instead starts at 22.0, we also have an equilibrium
- Threshold $\overline{B}$ is passed at E3 and E5
- Threshold $\underline{B}$ is passed at all six events

Multiplicity of equilibria

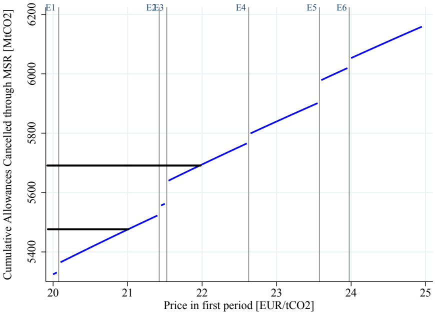


Figure: Cumulative cancellation of allowances, as dependent on initial price

- Cumulative cancellation jumps upwards when a threshold is passed
- Cumulative emissions are more than 100 Mt ($\alpha\overline{B}$) higher with $p_0 = 21.0$ than with $p_0 = 22.0$ (actually around 200 Mt higher)
- Which equilibrium will the market choose??

Abatement policies

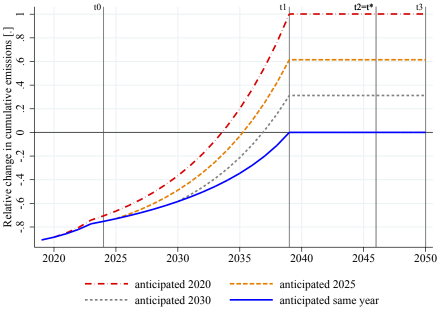


Figure: Effect of abatement policy on cumulative emissions

- Early abatement gives strong reduction in cumulative emissions (almost no waterbed effect)
- Abatement announced and realized same year always reduces cumulative emissions (until MSR inflow stops)
- Early announcement of late abatement increases cumulative emissions - Green Paradox

General Model Theorem

- Is this Green Paradox only a peculiarity of the EU ETS and its MSR?
  - (Important EU ETS issues are of interest anyway since it's so big)
- 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)

General Model Theorem

Theorem (Green Paradox)

For any ETS with a quantity-based (endogenous) cap, there exists an abatement policy $d\boldsymbol{\lambda} < 0$ *that induces a Green Paradox: Cumulative emissions increase.*

Conclusions

- Is the new MSR mechanism a good or a bad revision of the EU ETS?
- Good: Has reduced the long-run cap by ca. 2 years of emissions
- Good: Additional abatement today can reduce cumulative emissions
- Bad: Announcing future abatement today can give a backlash: Cumulative emissions may increase
  - Highlights the importance of anticipation and policy announcement
  - NB! The quantitative impacts are uncertain, and depends on model formulation and calibration
- Possible caveat: Our model is deterministic and ETS duration known
  - The demonstrated mechanism also relevant with imperfect foresight
  - Important question: To what degree are current decisions affected by future expectations?

Thanks for your attention!