Assessing the Implementation of the Market Stability Reserve

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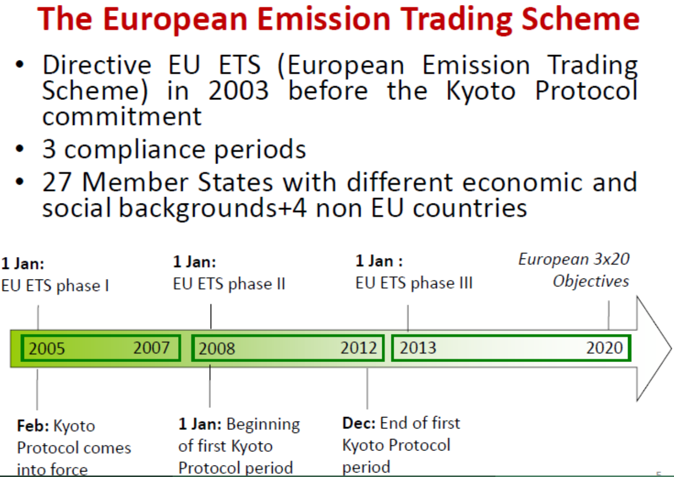
Market design

The EU ETS represents 45% of European greenhouse gas emissions; 13% of emissions from developed nations; 5% of the world's total GHG emissions.

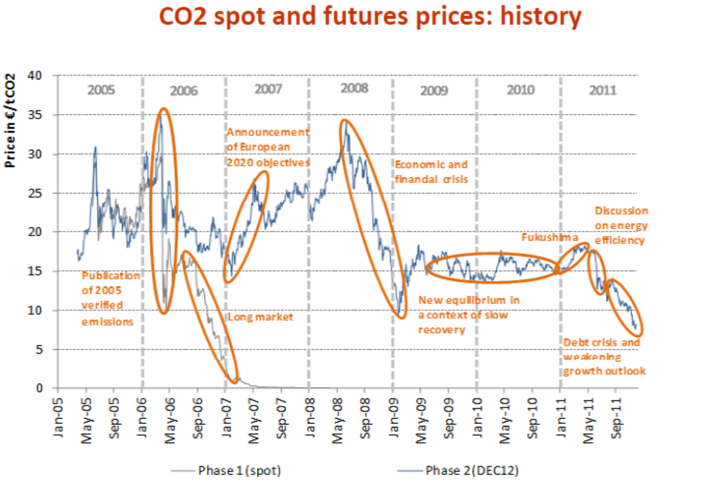


EU ETS coverage

- The EU ETS
  - sets an initial cap of 2.11 billions of Co2 Tons to about 11,400 industrial installations.
  - covers CO2,PFCs , N2O
- The cap is calculated to get emissions from covered sectors in 202o 21% lower than in 2005
  - the cap decreases 1.74% every year, as from Phase II
- The combustion sector (power and heat production, refinery, coke furnaces) represents approximately 65% of total allocations
- From 2008, EU ETS installations have also been allowed to use Kyoto offset credits up to a limit of 13.5% of their allocation

Carbon price: too low?

https://www.quandl.com/collections/futures/ice-eua-futures



Source: Climate Economics Chair from BlueNext and ICE ECX Futures

Motivation: what is the MSR?

- Regulatory response to low expectations regarding the future scarcity of permits:
  - **Economic crisis**, depressed output and therefore demand for emission permits. As an example, production in the **steel industry declined by 28 per cent from 2008 to 2009** (Eurostat, 2013).
  - Free allocated allowances banked.
- 24th February 2015 the European Parliament´s Environment Commitee supported by 57 to 10 the proposal put forward last February by the European Commission to annually remove ¨permits in circulation¨ based on certain trigger thresholds as from December 2018.
- Additionally, the 900 million tons being withheld during 2014-2016 (backloading) could be kept in the Reserve.

Assessment of the MSR design

- We build a microeconomic model (including the polluting output market) that captures the actual design of the MSR:
  - **Proportional to banking rule**: if permits in circulation higher than a threshold a share is placed in the reserve (starting in Dec 2018 if allowances in circulation per year are $\geqslant$ 833 million, 12% are placed in the reserve)
  - allowances in circulation: allowances issued minus total emissions from 2008 until the year in question (and minus the number of allowances already in the stability reserve): i.e. banking.
  - **Fixed rule**: MSR reinjection (if the allowances in circulation are below 400 million, 100 million are released from the reserve) or like backloading (i.e. withdrawal of a fixed amount).
    - *This is the case we illustrate today*

Research questions

Three building blocks

1. Benchmark model to study the impact of the MSR rules on private banking or the "allowance surplus".
2. Uncertainty: extension of the benchmark case to take into account demand fluctuations
3. MSR and the **option value of banking**
    - Main results: the MSR affects the value of waiting to bank in the future and that option to bank depends on the expectations regarding future economic activity (demand).

Related literature and other experiences

- **"Safety valve"**, initially suggested by Roberts and Spence (1976) and later developed in the context of climate policy by Pizer (2002): a cap-and-trade system is coupled with a price ceiling.
  - As long as the allowance price is below the safety-valve price, this hybrid system acts like cap-and-trade, with emissions fixed but the price left to adjust. Instead, **when the safety-valve price is reached the system behaves like a tax**, fixing the price but leaving emissions to adjust.
  - Philibert (2008) and Burtraw, et al. (2009): symmetric safety valve, also known as a **price collar**, which would limit price volatility on both the upside and the downside.
  - Fell and Moregerstern (2010) introduce **uncertainty** and couples the collar mechanisms to restrictions on banking and borrowing: a price collar can achieve costs almost as low as a tax but with less emissions variation.
- Cost Containment Reserve (CCR) introduced in RGGI in 2014 & Allowance Price Containment Reserve (APCR) in California-Quebec in 2013 but under the cap.

Recent (unpublished) papers on MSR

- Zetterberg *et al.* (2014) find that risk of price volatility is higher in the presence of the MSR due to the difficulty of predicting hedging needs.
- On the contrary, Fell (2015)'s simulations find that the MSR can decrease price volatility (but that its performance is very sensitive to parameters).
- Holt and Shobe (2015) that find that there is little benefit associated to the MSR but that a price collar may instead enhance efficiency.
- Other...
  - Pöyry, 2013; Trotignon et al., 2014: responds with a one year lag which could reduce the effectiveness of the instrument and potentially increase price volatility.
  - There is also concern that it will not erode the current surplus quickly enough: the reform could be complemented with the permanent retirement of allowances, otherwise the surplus would be present until 2028 (Mathews et al., 2014).
  - Grosjean et al. (2014): such rule cannot accommodate big unforeseen events.

Main reference: Kollenberg and Taschini (2015)

- Model the adjustments in permits availability in the short-run due to the existence of the MSR using a stochastic partial equilibrium framework.
- Their model and scope is very different from ours but some of the results are in line: the MSR substitutes private banking and reduces variability in allowance holdings by withdrawing (reinjecting) when the surplus is too high (low).

Assumptions

- 3-period-model
- *n* symmetric polluting firms subject to Tradable Emission Permits (TEP) regulation compete in quantities.
- Banking allowed from period 1 to 2 and from 2 to 3.

Benchmark model (withdrawing)

- Firms profits at each t:

$$\pi_{i,t} = (b_t - d_t \sum_{i=1}^{n} q_{i,t})q_{i,t} - c_t q_{i,t} - \sigma_t \left(e_t q_{i,t} + z_{i,t} - \sum_{1}^{t-1} z_{i,t} \right)$$

$$s.t. \sum_{i=1}^{n} \left(e_t q_{i,t} + z_{i,t} - z_{i,t-1}\right) \leq \alpha_t A - x_t$$

$$z_{i,T} = 0.$$

where $\left(b_t - d_t \sum_{i=1}^{n} q_{i,t}\right)$ is the inverse demand, c_t is the constant marginal costs, σ_t is the permits price, e_t is the polluting intensity of output, $z_{i,t}$ is private banking, A_t is the amount of permits auctioned by the authority and x_t is the MSR

Restrictions in the case of permits withdrawal

Focusing on the banking constraint, with $\alpha_1 = 1$:

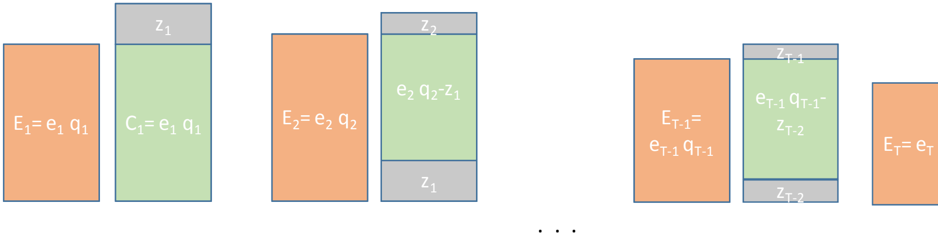
$$\sum_{i=1}^{n}\left(e_t q_{i,t} + z_{i,t} - \sum_{1}^{t-1} z_{i,t}\right) \leq A_t - x_t$$

$$\begin{array}{cc} t & \textit{Fixed rule: exogenous withdrawal} \\ 1 & \sum_{i=1}^{n}\left(e_1 q_{i,1} + z_{i,1}\right) \leq A, \\ 2 & \sum_{i=1}^{n}\left(e_2 q_{i,2} + z_{i,2} - z_{i,1}\right) \leq \alpha_2 A - x_2, \\ 3 & \sum_{i=1}^{n}\left(e_3 q_{i,3} - z_{i,2}\right) \leq \alpha_3 A - x_3. \end{array} \tag{1}$$

$$\begin{array}{cc} t & \textit{Proportional to banking withdrawal rule} \\ 1 & \sum_{i=1}^{n}\left(e_1 q_{i,1} + z_{i,1}\right) \leq A, \\ 2 & \sum_{i=1}^{n}\left(e_2 q_{i,2} + z_{i,2} - z_{i,1}\right) \leq \alpha_2 A - \zeta_2 \sum_{i=1}^{n} z_{i,1}, \\ 3 & \sum_{i=1}^{n}\left(e_3 q_{i,3} - z_{i,2}\right) \leq \alpha_3 A - \zeta_3 \sum_{i=1}^{n} z_{i,2}. \end{array} \tag{2}$$

with $z_{i,3} = 0 \ \forall i$.

The banking mechanism:



Solving the model

- Firms maximize intertemporal profits (Cournot competition):

$$\Pi_i = \sum_1^3 \frac{\pi_t}{(1+r)^{t-1}}$$

- Two-step-solution

1. We find the symmetric Nash equilibrium in quantities for each period.
2. We find optimal banking strategies from maximizing intertemporal profits, i.e. $\frac{\partial \Pi_i}{\partial z_{i,1}} = 0$, which gives intertemporal arbitrage:

$$\sigma_1 = \frac{\sigma_2}{(1+r)} = \frac{\sigma_3}{(1+r)^2}$$

This can be done since firms are non-strategic in the permits market.

- We check ex post positivity constraints and threshold restrictions that define the functioning of the MSR.

Equilibrium exogenous rule

(with parameters constant over time and withdrawal)
$\Gamma = A\left(1+\alpha_2+\alpha_3\right) - x_2 - x_3$

$$
\begin{aligned}
q_1^* &= \frac{1}{3+r\left(3+r\right)}\left(\frac{\Gamma}{ne}+\frac{r\left(3+r\right)\left(b-c\right)}{\left(n+1\right)d}\right), && (3)\\
z_1^* &= \frac{A\alpha_1}{n}-\frac{1}{3+r\left(3+r\right)}\left(\frac{\Gamma}{n}+\frac{r\left(3+r\right)e(b-c)}{\left(n+1\right)d}\right), && (4)\\
z_2^* &= -\frac{A\alpha_3+x_3}{n}+\frac{1}{3+r\left(3+r\right)}\left(\frac{\left(1+r\right)^2\Gamma}{n}-\frac{r\left(3+2r\right)e(b-c)}{\left(n+1\right)d}\right), && (5)\\
\sigma_1^* &= \frac{1}{\left(3+r\left(3+r\right)\right)e}\left(-\frac{\left(1+n\right)d}{ne}\Gamma+3(b-c)\right) && (6)
\end{aligned}
$$

Note: q_2^* and q_3^* have similar expressions

- Permits withdrawal increases the carbon price
- The previous equilibrium holds if some constraints on the parameters are imposed in order to get positive permits prices and banking
  - in particular, these constraints limit the value of the feasible permits allocation

- We assume that the demand constant in period 2 is still **b** with **probability** λ or $\mathbf{b_m}$ with a probability $(1-\lambda)$.
  - we note $b_m - b = \Delta$
- Uncertainty is resolved in period 2.
- We solve the model by maximizing *expected* discounted profits
- Permits prices in the equilibrium under uncertainty in the exogenous case are then defined by

$$\widehat{\sigma}_1^* = \sigma_1^* + \frac{2(1-\lambda)\Delta}{e(3+r(3+r))}, \quad (7)$$

$$\sigma_{2,b}^* = \sigma_2^* - \frac{2(1-\lambda)\Delta}{e(2+r)(3+r(3+r))}, \quad (8)$$

$$\sigma_{2,bm}^* = \sigma_{2,b}^* + \frac{2\Delta}{e(2+r)}, \quad (9)$$

$$\sigma_{3,b}^* = \sigma_3^* - \frac{2(1+r)(1-\lambda)\Delta}{e(2+r)(3+r(3+r))}, \quad (10)$$

- Equilibrium production

$$\widehat{q}_1^* = q_1^* + \frac{2(1-\lambda)\Delta}{(3+r(3+r))(1+n)d}, \quad (12)$$

$$q_{2,b}^* = q_2^* + \frac{2(1-\lambda)\Delta}{(3+r(3+r))(2+r)(1+n)d}, \quad (13)$$

$$q_{2,bm}^* = q_{2,b}^* + \frac{r\Delta}{(2+r)(1+n)d}, \quad (14)$$

$$q_{3,b}^* = q_3^* + \frac{2(1+r)(1-\lambda)\Delta}{(3+r(3+r))(2+r)(1+n)d}$$

$$q_{3,bm}^* = q_{3,b}^* - \frac{r\Delta}{(2+r)(1+n)d}, \quad (15)$$

...and banking

$$
\begin{aligned}
\widehat{z}_1^* &= z_1^* + \frac{2e(1-\lambda)\Delta}{d(1+n)(3+r(3+r))}, \\
z_{2,b}^* &= z_2^* + \frac{2e(1+r)(1-\lambda)\Delta}{d(1+n)(2+r)(3+r(3+r))}, \qquad (16) \\
z_{2,bm}^* &= z_{2,b}^* + \frac{\Delta er}{(n+1)(2+r)d}. \qquad (17)
\end{aligned}
$$

- When *first period banking is constrained to zero*, the links with the demand parameter variation are smoothed.
- This happens for prices at $t = 1$

$$\sigma_1^w = \frac{b-c}{e} - \frac{Ad(1+n)}{e^2 n}, \quad (18)$$

$$\sigma_{2,b}^w = \frac{2(b-c)}{e(2+r)} - \frac{d(1+n)(\Gamma - \alpha_3 A)}{e^2 n (2+r)}, \quad (19)$$

$$\sigma_{2,bm}^w = \sigma_{2,b}^w + \frac{2\Delta}{e(2+r)}, \quad (20)$$

$$\sigma_{3,b}^w = (1+r)\,\sigma_{2,b}^w, \quad (21)$$

$$\sigma_{3,bm}^w = (1+r)\,\sigma_{2,bm}^w, \quad (22)$$

...quantities at $t = 1$

$$\begin{aligned}
q_1^w &= \frac{A}{en}, && (23)\\
q_{2,b}^w &= \frac{(b-c)\,r}{d\,(1+n)\,(2+r)} + \frac{\Gamma - \alpha_3 A}{en\,(2+r)}, && (24)\\
q_{2,bm}^w &= q_{2,b}^* + \frac{r\Delta}{(2+r)\,(1+n)\,d}, && (25)\\
q_{3,b}^w &= -\frac{(b-c)\,r}{d\,(1+n)\,(2+r)} + \frac{(1+r)\,(\Gamma - \alpha_3 A)}{en\,(2+r)} \\
q_{3,bm}^w &= q_{3,b}^w - \frac{r\Delta}{(2+r)\,(1+n)\,d}, && (26)
\end{aligned}$$

...banking

$$\widehat{z}_1^w = 0, \quad (27)$$

$$z_{2,b,x}^w = \frac{(1+r)(\alpha_2 A - x_2) - (\alpha_3 A - x_3)}{n(2+r)} - \frac{(b-c)\,er}{d(1+n)(2+r)}, \quad (28)$$

$$z_{2,bm,x}^w = z_{2,b,x}^w - \frac{\Delta er}{(n+1)(2+r)\,d}. \quad (29)$$

Option to wait

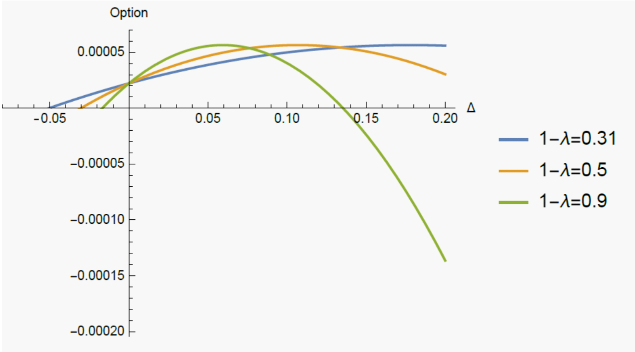
- We consider the decision on banking as a partially reversible investment
  - firms can decide to wait to bank as from period 2
- Option to wait = expected discounted profit with MSR under the assumption $z_1^* = 0$ - expected discounted profit

$$OW_x = E(\Pi_i / z_0 = 0) - E(\Pi_i).$$

- Since we model a given technology (no low carbon investment so far), firms bank permits only if they expect permits to be more expensive in the future ($OW_x < 0$).

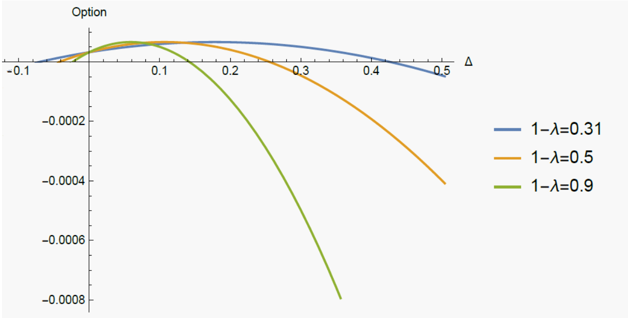
Option to wait: generated by the uncertainty

Valeurs communes
$b = 1.7; c = 1; e = 1; d = 1; \alpha_1 = 1; \alpha_2 = 0.9; \alpha_3 = 0.6; r = 0.05;$
$\lambda = 1 - \delta; n = 6; x_3 = 0; A = 0.18$
x2=0 benchmark



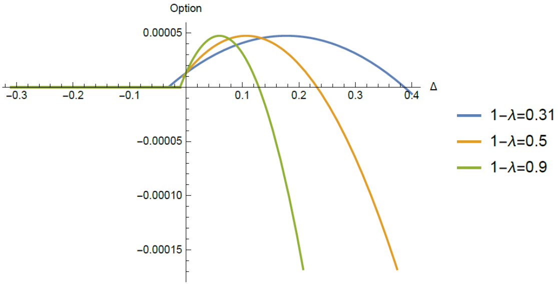
The MSR "amplifies" the option to wait: withdrawal

$x_2 = -0.01$

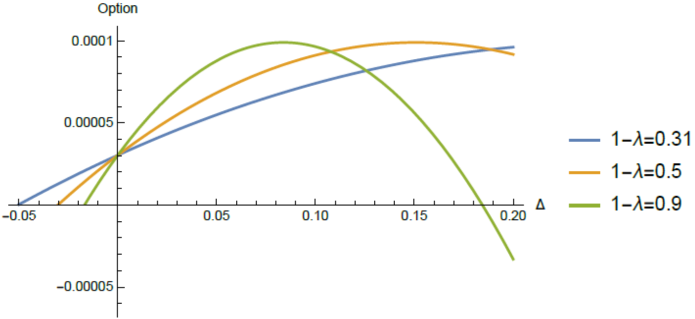


The MSR "amplifies" the option to wait: injection

$x_2 = 0.01$



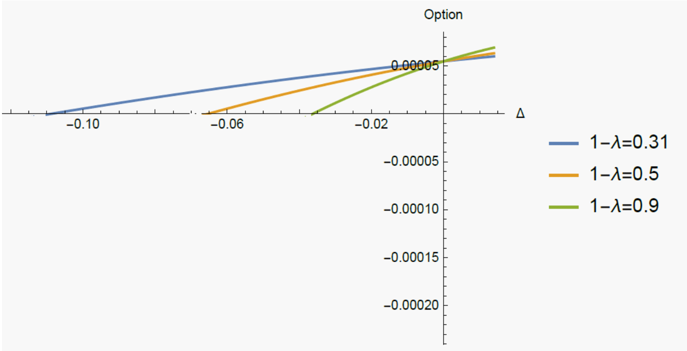
The option to wait increases in the proportional withdrawal case



Conclusion

- THE RULE MATTERS: Contrary to what we could expect the fact of considering an endogenous way of widthrawing permits does not simply crowds out private banking but instead interacts with it affecting permit prices and production.
- Our ANALYSIS WORTHY: When modeling uncertainty we find that banking can be considered as a partially irreversible investment how the profitability of waiting depends on the uncertainty itself.
  - Further work: investment in abatement technology

x2 < 0 : x2 = -0.03


Option
0.00005
-0.10
-0.06
-0.02
Δ
-0.00005
-0.00010
-0.00015
-0.00020
1−λ=0.31
1−λ=0.5
1−λ=0.9