Intertemporal Emissions Trading and Market Design: An Application to the EU-ETS

Based on joint work with Simon Quemin (LSE and CEC)

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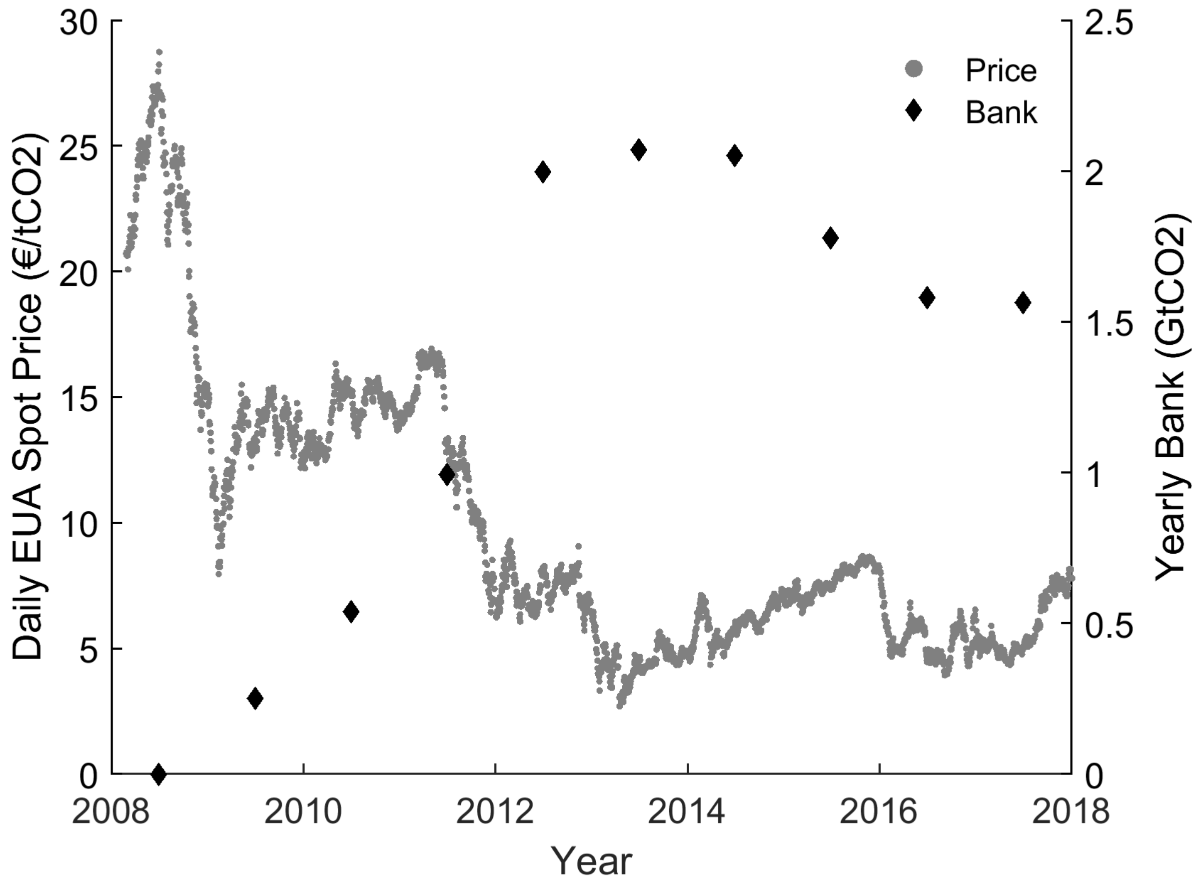
raphael.trotignon@chaireeconomieduclimat.org

Starting point: The EU ETS failure?



- The low price seems to coincide with accumulating unused EUAs
- But in a cap-and-trade system, early accumulation of unused allowances (banking) is not surprising (e.g. SO_2 C&T in the US)

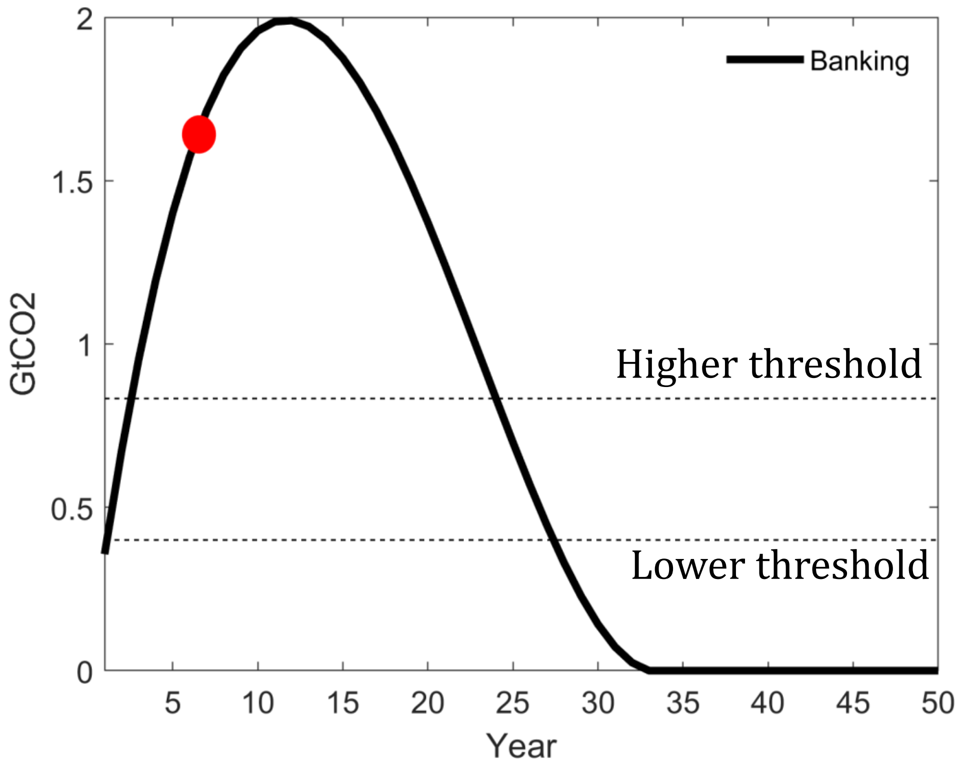
Starting point: The EU ETS failure?

- The « low price problem » is not resulting from the accumulation of « surplus » allowances

- Price reflect expectations, and the low price is much more due to the anticipation of scarcity (supply minus demand) being much lower than initially expected
  1. Economic crisis in end-2008, with lasting consequences
  2. Surge in the use of international offsets (CERs and ERUs) : over 1Gt over 2008-2012
  3. Rapid deployment of renewable energy (and energy efficiency) that reduced emissions inside the EU ETS perimeter, but not through the carbon price

- At the same time, the cap is fixed in advance and very difficult to correct in a reactive manner

EC's Response: the Market Stability Reserve



- EC's response consists of a strengthening of the cap linear reduction factor, and the creation of a « Market Stability Reserve » (MSR)
- The MSR is like a « banking collar » meant to drive banking into a predefined range, by automatically adjusting auctionned volumes

- The reserve can absorb and release allowances. It also has a cancellation provision which can lead to a significant cap change

Our article

- Our intuitions in this article :
  - The market indeed displays classic inter-temporal optimization based on anticipated scarcity
  - But it does not react as if it was reasonning over an infinite time horizon, it probably takes decision based on a smaller time horizon
  - The market stability reserves interracts with the inter-temporal decisions of the market, and the smaller horizon amplifies this effect, making the reserve act as a strong cap tightening mechanism (endogenous cap)
  - The reserve seems to be tweaked towards heavy allowances removal, not shock control, and its « stabilizing » capacities should be tested

The model

Intertemporal permit market: compliance required at times t = 1, 2, . . .

with unlimited banking and limited borrowing

Competitive trading and firms' production decisions are ignored

decentralized market equilibrium as a joint cost minimization (Rubin, 1996)

Future baseline emissions and cap are not perfectly anticipated

business cycles, reach of companion policies

Intertemporal arbitrage based on scarcity anticipations, revised

limited borrowing → non-linearity, no closed-form solution

Solve expected path dynamics for a first-order approximate solution as suggested – but not operationalized – by Schennach (2000)

The model

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At time t firm selects expected abatement path $\{q_\tau\}_{\tau \geq t}$ by

$$\min_{\{q_\tau\}_{\tau \geq t}} \mathbb{E}_t\Big\{\sum_{\tau \geq t} \beta^{\tau - t} C_\tau(q_\tau)\Big\} \text{ subject to}$$

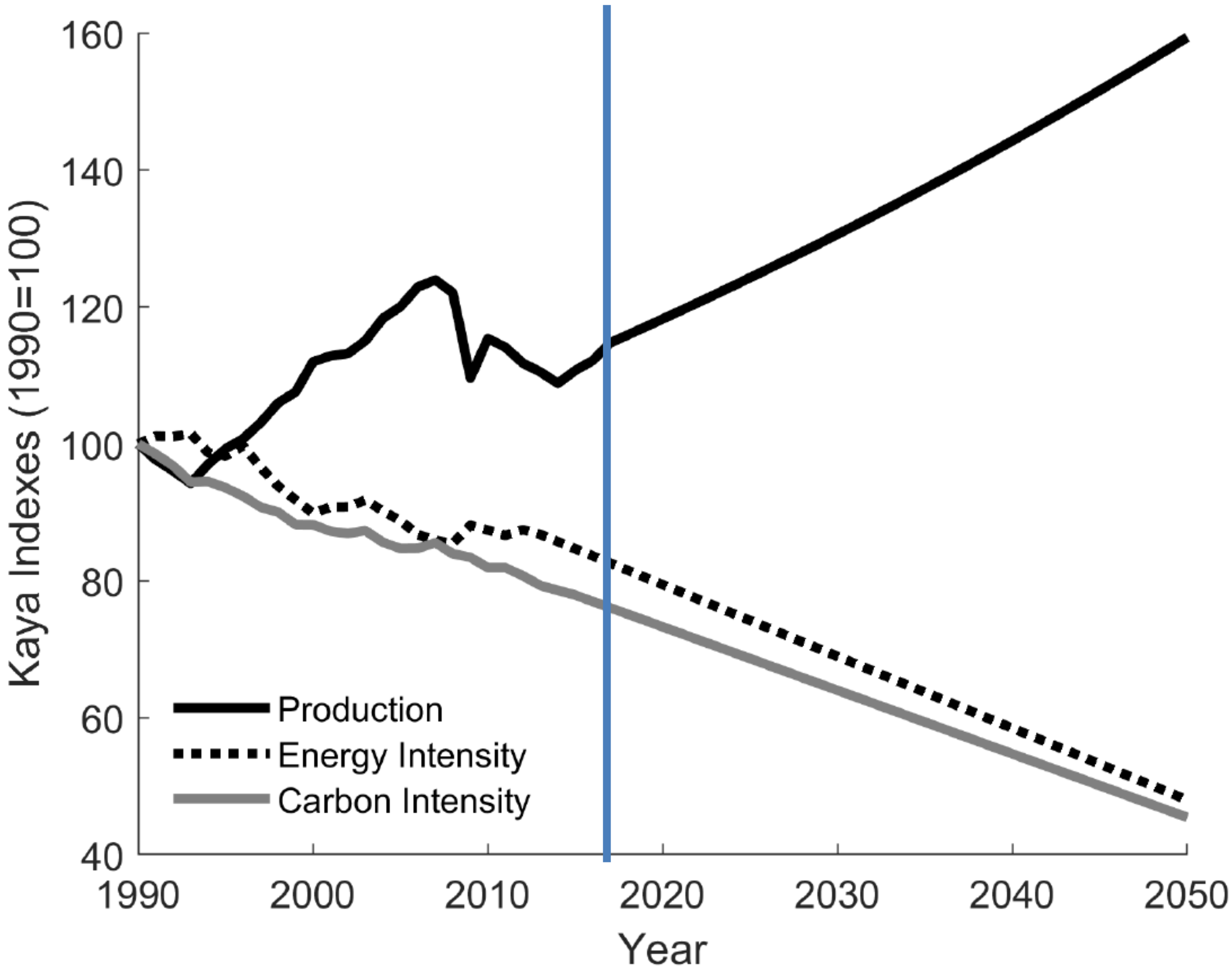
a set of feasibility conditions + law of motion

$$\text{and } \sum_{\tau \geq t} q_\tau = \mathbb{E}_t\Big\{\sum_{\tau \geq t} M_\tau \cdot (bau_\tau - cap_\tau)\Big\} - bank_{t-1}$$

M_T allows us to represent different form of "myopia" or limited/rolling time horizon for market participants

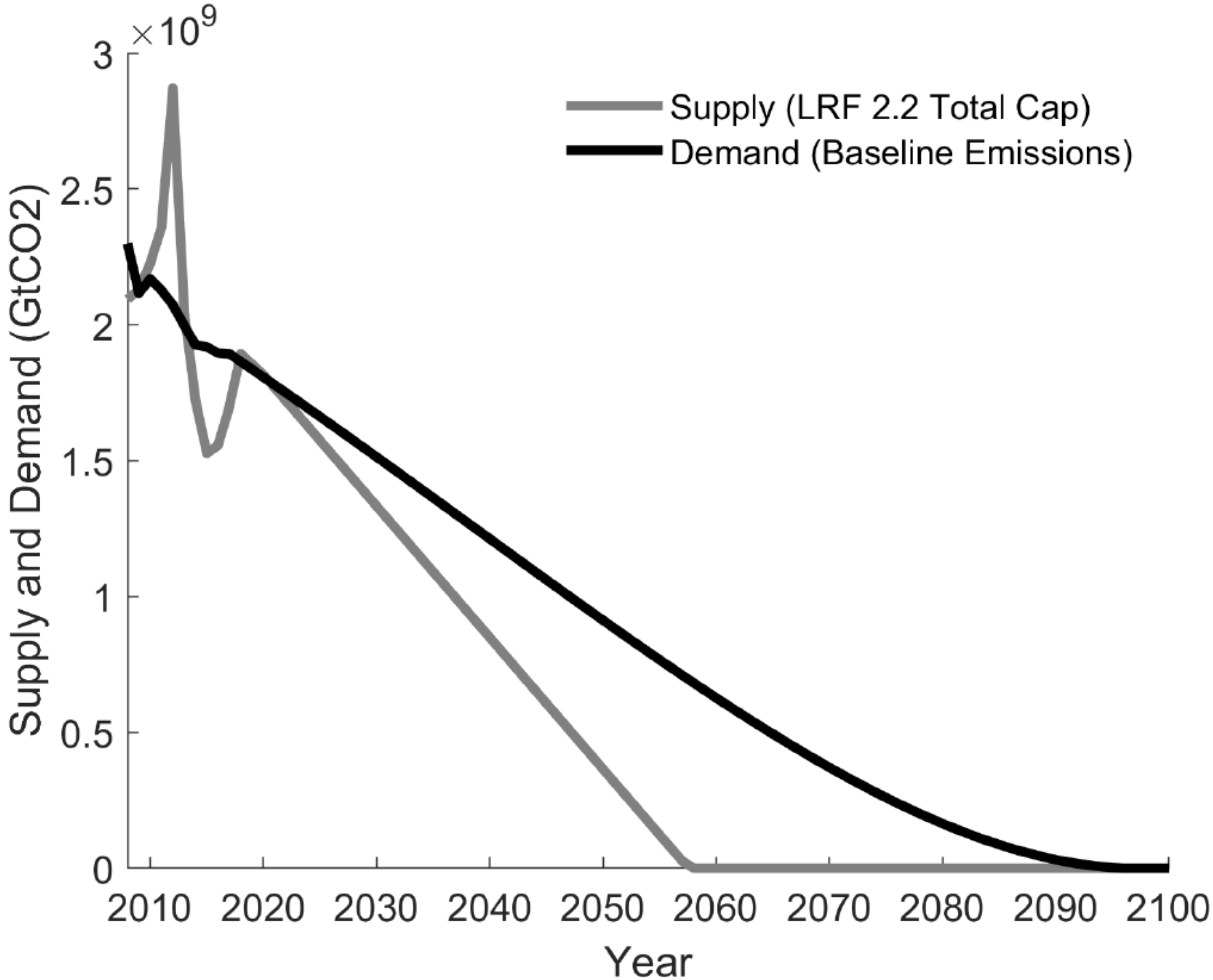
There is an interplay between the decisions based on expectations and the MSR actions over time (heuristic procedure described in the paper)

Calibration to EU ETS: baseline emissions



$$CO_2\ emissions = Production \times \frac{Energy}{Production} \times \frac{CO_2\ emissions}{Energy}$$

Realized baseline emissions and cap



Calibration to EU ETS

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- Calibrate interest rate *r* / horizon to match banking with OLS
- Next, calibrate marginal cost *c* to match spot prices with OLS

Myopia type	Interest rates and horizon	Marginal abatement cost
Infinite Horizon	$r = 7.06\%$ (std.dev=52.9 $MtCO_2$)	$c = 5.53 \cdot 10^{-8}$ €/$(tCO_2)^2$ (std.dev=3.86 €/tCO_2)
Rolling Horizon	$r = 3\%^\star$ $k = 5^\star$ $\Delta =$ 12 y (std.dev=72.4 $MtCO_2$)	$c = 5.90 \cdot 10^{-8}$ €/$(tCO_2)^2$ (std.dev=1.61 €/tCO_2)

- *r* = 7% in line with general returns on risky assets
- *r* = 3% central value for rates implied from futures' yield curves
- 12 years rolling horizon is coherent (Directive voted in 2003 up to 2012, in 2008 up to 2020, in 2018 up to 2030)

Results: the effect of the MSR (Infinite Horiz.)

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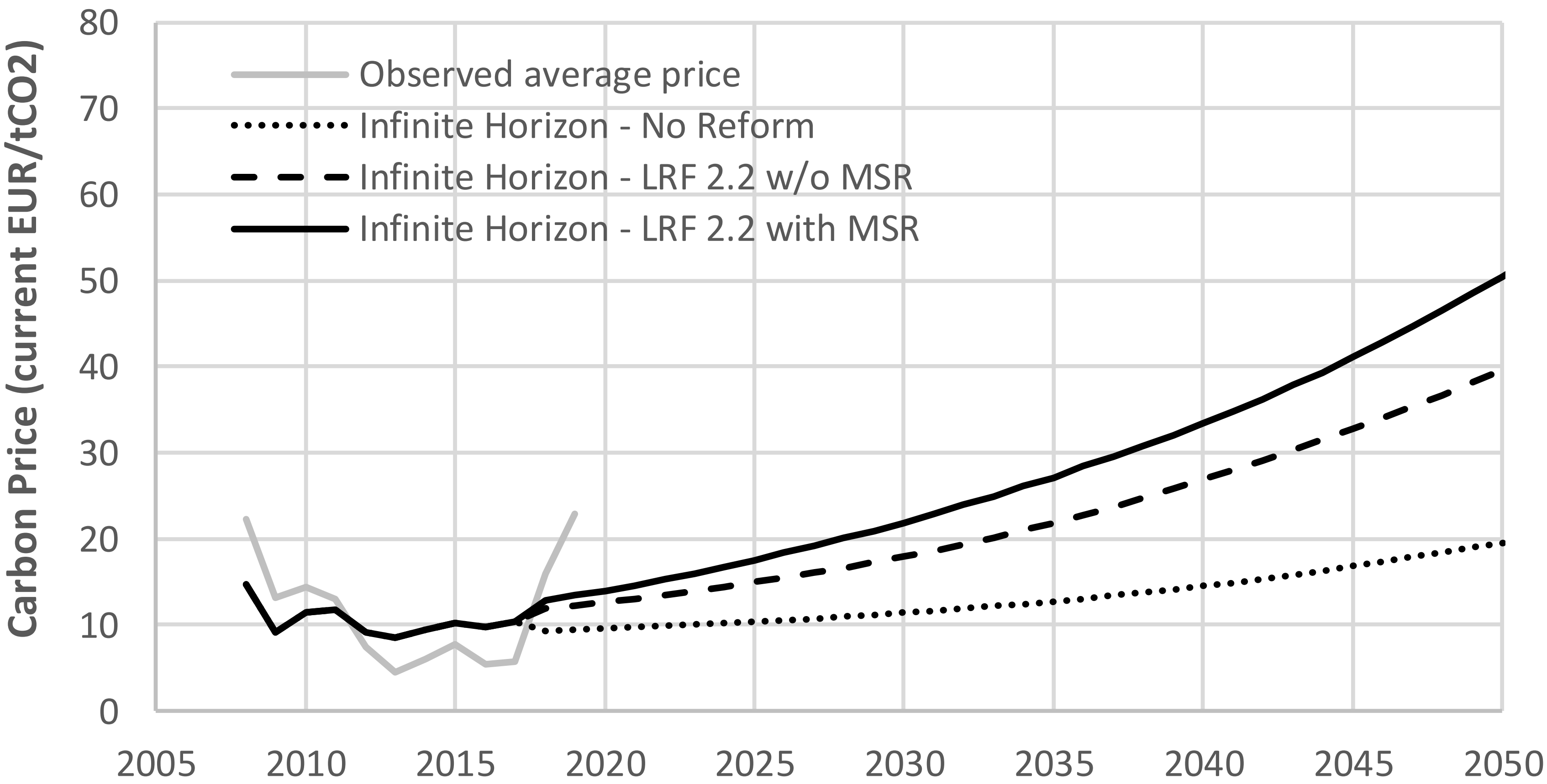

- In this setting, the reform makes prices higher mainly due to the revised cap
- MSR absorbs and cancel around 5 $GtCO_2$ by 2050

Results: the effect of the MSR (Rolling Horiz.)

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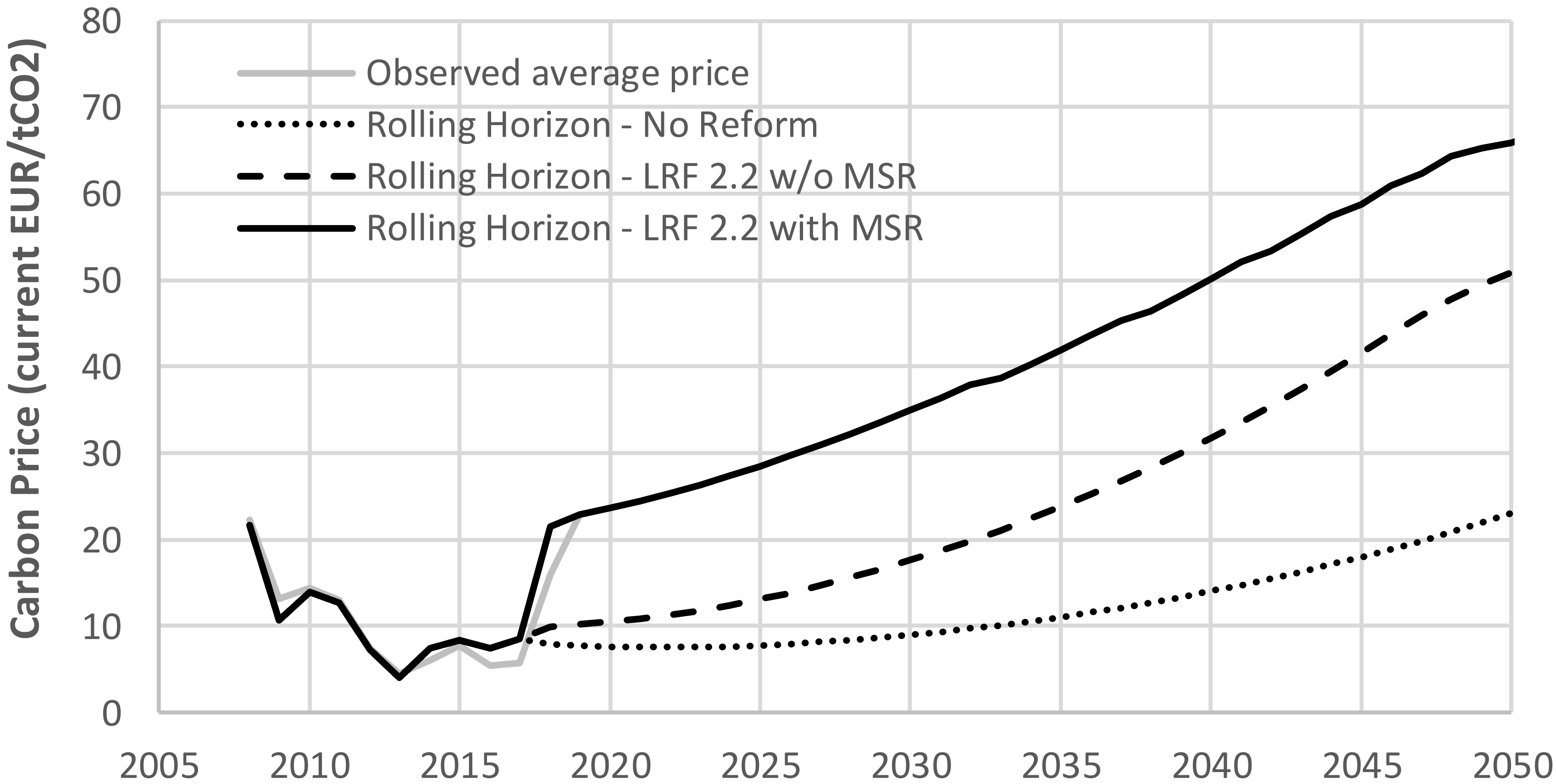
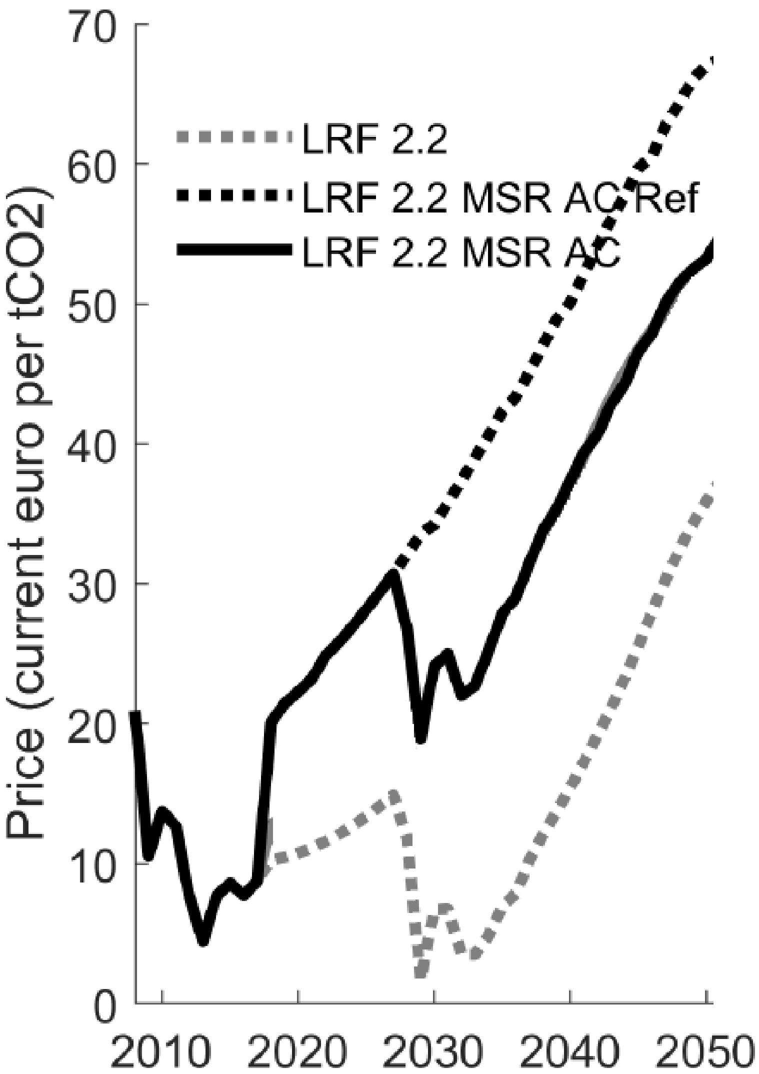


- In this setting, the reform makes prices higher mainly due to the MSR effect. In particular the recent surge in price is apparent
- MSR absorbs and cancel around 9 $GtCO_2$ by 2050

Results: dealing with exogenous shocks?



What would happen if history repeats itself?

- Economic crisis in 2028 similar to that of 2008
- In the paper, we also test the effect of different scenarios of renewable and EE developments.
- The MSR does not seem to be able to "control" such external shocks

Conclusion

- The market seems to display price behavior consistent with inter-temporal optimization based on (imperfect) anticipated scarcity

- But it does so over a smaller time horizon (around 12 years), reflecting the limited credibility of scarcity over such markets (political decisions, exogenous shocks…)

- The MSR interracts with the inter-temporal decisions of the market, and the smaller horizon amplifies its effects, making the reserve act as a strong cap tightening mechanism (between 5 and 10 $GtCO_2$ cancelled before 2050)

- The reserve « stabilizing » capacities seem limited, and the market is not « protected » from future shocks

Thank you for your attention

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