Emission pathways, climate sensitivity risks and the 2°C target

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Paper: Ekholm 2014, Hedging the climate sensitivity risks of a temperature target, Climatic Change 127, pp. 153-167

Setting:

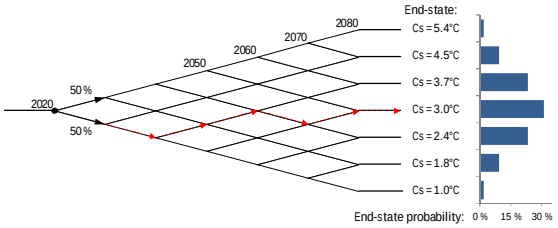
- How to limit temperature increase to 2°C cost-efficiently as there is considerable uncertainty climate sensitivity?
- This uncertainty decreases gradually through learning.
- Emission pathways can be sequentially readjusted to adapt to this new information, e.g. here in 10 year timesteps.

Approach:

- Analytical optimality conditions to for carbon pricing
- Stochastic scenarios with the SCORE model to estimate: 1) emission and price pathways, 2) emissions in 2020

Assumed information process for climate sensitivity (Cs):

- A binomial lattice for the timeframe 2020-2080
- True value of Cs known in 2080 with certainty
- End-state probabilities from Knutti and Hegerl (2008)



Carbon pricing under cost-efficient mitigation:

- Cost-efficiency implies near-exponential price growth

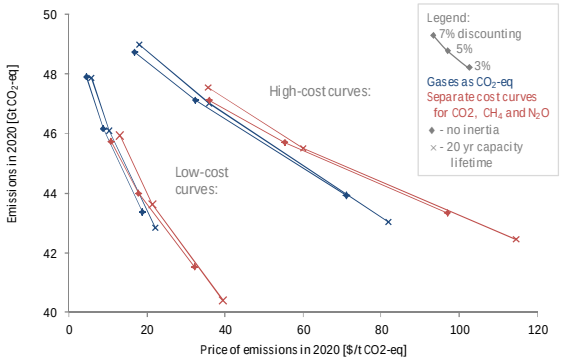
Current marginal abatement cost | Future marginal abatement cost | Reductions' marginal impact to the 2°C limit

$$c'_t(r_t) = \beta E_t\left[c'_{t+1,s}(r_{t+1,s})\frac{\sum_{\tau=t+1}^{\infty}\left(I_s(t,\tau)\beta^{\tau-t-1}\lambda_{\tau,s}\right)}{\sum_{\tau=t+2}^{\infty}\left(I_s(t+1,\tau)\beta^{\tau-t-1}\lambda_{\tau,s}\right)}\right]$$

Discount factor

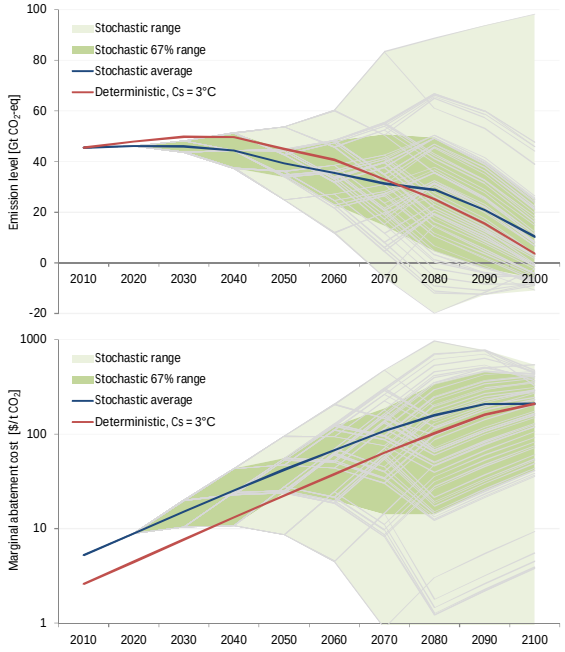
Optimal emission and price levels in 2020?

- Optimal levels are sensitive to the assumptions of discount rate and future emission reduction costs



Stochastic scenarios:

- Emission and price paths that adapt to new information on Cs
- If new information suggests higher realizations of Cs, emission pathways are revised lower– and vice versa
- In principle, possible to remain below 2°C with certainty
- Greatly diverging future pathways, subject to the Cs realization



Conclusions

- The hedging of uncertainty in climate sensitivity towards the 2°C target warrants more ambitions early action than what a deterministic case exhibits
- Possible to meet the 2°C target with certainty through sequential decision making, though some of the tail-risk of Cs uncertainty is not captured here
- Future pathways towards 2°C depend on the realization of Cs; possible pathways diverge greatly in terms of emission levels and pricing
- Near-term guidance dependent on uncertain assumptions, to which no solid answers exist

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