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Interactive comment on "The impact of uncertainty on optimal emission policies" *by* Nicola Botta et al.

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The results presented in our contribution naturally raise an important question and a legitimate methodological criticism.

We have not expanded on this question (and on the related criticism) in the manuscript, we thought that it would be a good subject for an interactive discussion.

In our contribution, we have argued that uncertainties about the implementability of decisions on emission reductions (or increases) call for more precautionary policies but uncertainties about the implications of exceeding critical cumulated emission thresholds make precautionary policies sub-optimal.

If recognized, such results have obvious consequences both for emission policy mak-

ing and for scientific research planning: if one accepts that turning political decisions into effective legislations is intrinsically uncertain, our study provides a very strong argument in support for precautionary policies and early (earlier) emission reductions.

Similarly, if one wants to justify precautionary policies under uncertainties about the implications of exceeding critical cumulated emission thresholds, one has to try to reduce such uncertainties, e.g. through research programs specifically aimed at sharpening our understanding of potentially dangerous climate thresholds.

Our results are rigorous in the sense that the optimal emission policies our conclusions rely upon are provably optimal. The stylized emission problem for which we have computed such policies, however, is defined in terms of a small but not empty set of parameters. In particular, the value of policy sequences (optimal or not) crucially depend on the problem rewards that is, on

- $badOverGood$
- $lowOverGoodUnavailable$
- $lowOverGoodAvailable$
- $highOverGood$

The optimal policy sequences discussed in section 5 have been computed for the specific (albeit stylized) emission problem in which these parameters take the values 0.5, 0.1, 0.2 and 0.3, respectively.

Are our conclusions only valid for these specific values?

Rather than trying to substantiate our findings with a (necessarily rudimentary) sensitivity analysis, we can try to achieve a better analytical understanding of the role of the above parameters on optimal policy sequences.

We have defined the reward function of our stylized problem at page 15 of Section 4 "A stylized sequential emission problem". From the definition we can immediately deduce that, at each decision step, the costs of selecting low emissions are greater or equal to

$$highOverGood - lowOverGoodAvailable$$

Remember that $lowOverGoodUnavailable$ is the ratio between the benefits of low emissions and the benefits of being in a good world when effective technologies for reducing GHG emissions are unavailable.

Similarly, $lowOverGoodAvailable$ is the ratio between the benefits of low emissions and the benefits of being in a good world when effective technologies are available.

We obviously require $lowOverGoodUnavailable$ to be smaller or equal to $lowOverGoodAvailable$ (effective technologies for reducing GHG emissions diminish the costs of low emissions) and $lowOverGoodAvailable$ to be smaller or equal to $highOverGood$ (low emissions cost more than high emissions).

Thus, the difference between $highOverGood$ and $lowOverGoodAvailable$ represents the minimal costs (e.g., due to missed growth, higher GHG filtering and sequestration costs, taxes, etc.) implied by low emission measures.

By contrast, the costs (damages from climate change) that can be avoided by keeping the world in a good state are expressed, in our stylized decision problem by the difference

$$1 - badOverGood$$

Thus, if $1 - badOverGood$ is smaller or equal to $highOverGood - lowOverGoodAvailable$, selecting low emissions never pays off. Therefore,

$$crBadOverGood = 1 - (highOverGood - lowOverGoodAvailable)$$

is an important threshold in the parameters space of our emission problem: for values of $badOverGood$ between $crBadOverGood$ and one, selecting low emissions cannot be optimal: in this interval, optimal policies will recommend high GHG emissions.

Are there other important thresholds in the problem's parameter space? We do not know. As mentioned above, the results discussed in section 5 have been computed with $badOverGood$ equal to 0.5 and $crBadOverGood$ equal to 0.9.

Additionally, we have computed optimal policy sequences for some values of $badOverGood$ between 0.5 and 0.91. These results confirm the analysis presented above and support the conclusion that uncertainties about the implementability of decisions on emission reductions call for more precautionary policies but uncertainties about the implications of exceeding critical cumulated emission thresholds tend to make precautionary policies sub-optimal.

Perhaps you have a set of parameters values for which you would like to see how optimal policies look like for the cases discussed in section 5?

In this case, please let us know. We will compute the policies and post the results.

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