Comments on manuscript

„Timing of adoption of clean technologies, transboundary pollution and international trade“

The paper considers two countries, each with a monopolistic firm. Firms use a polluting technology but can switch to renewables by incurring an investment cost. This clean technology has lower per-unit production cost. The firms are regulated by the regulator of their country, who can tax the dirty and subsidize the clean technology. The authors analyze and compare the cases of autarky and a common market, leading to several results that are summarized in 12 propositions.

There are two market failures – monopoly and environmental externalities – and the paper's results are driven by the interaction between these externalities. However, this is rarely worked out in a clear way. Moreover, the authors use very simple functional forms and calculate closed form solutions for certain parameter restrictions. Therefore, it would be all the more important to explain the results intuitively. The following more specific comments give some examples:

- The literature review is often too unspecific, simply citing papers that have been written on some topic. Moreover, I would suggest to reverse the order of presentation: First, explain the papers idea and main result. Thereafter compare it to the literature.

- Propositions 1 and 6 depend on a specific tax / subsidy schedule. This should be included in the propositions, which otherwise sound more general than they actually are.

- There are so many sub- and superscripts in the paper that it is very easy to get lost.

- Proposition 3 (under autarchy, the optimal adoption date for firms is earlier than socially optimal) is surprising. Early adoption has a positive effect on environmental damages and on output, which is too low due to the monopolistic market. Both effects are beneficial for social welfare; hence I would rather have expected the opposite result. It is important that the authors provide a clear intuition for their result. Moreover, the ranking changes with a common market (proposition 7). What is the intution for this result? Of course, there is a close relation to propositions 1 and 6. But these are not explained at an intuitive level either?

- The relation between the appendix and the proposition should be clarified (e.g., proof of proposition 2 ...).

- Propositions 4 and 8 are so obvious that they do not deserve the label of a proposition.

- @ eq. (38) and the related discussion: $q < 0$ suggests that one gets a boundary solution with $q = 0$. This should be clarified. Moreover, I don't find such a solution "unrealistic" as it is claimed in the text. In particular, the solution that maximizes aggregate welfare of both countries would look like this. The reason is simply that marginal cost of production are constant so that it would be most efficient if only one firm invests in the new technology.

- The socially optimal output levels are the same under autarky and under the common market (eqs. 5, 11, 28, 32). Why is this so? Similarly, what is the reason for the inversion of the ranking between the welfare gains and profits in proposition 1 and 6?

- The authors discuss proposition 10 as "surprising" but I think there is a straightforward intuition. In the common market there is more competition. Hence there is less reason to raise output by a low emission tax or a a high subsidy for renewables.

- The authors should discuss why the regulator can only subsidize output of renewables, but not the implementation of the clean technology. I find that this is an important point because the marginal cost of renewables are assumed to be lower than those of fossils. Subsidizing implementation of the clean technology would also make it easier to disentangle the optimal response to the two market failures of imperfect competition and environmental externalities.

- In my opinion there are too many propositions. The authors should work out their most important findings and focus on them.