

# Comments on The Time Evolution of the Social Cost of Carbon: An Application of FUND

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The paper considers the average annual growth rate of social cost of carbon (SCC) estimates between 2010 and 2100. The authors run the FUND integrated assessment model under a number of different specifications and report the average annual growth for the SCC under these different cases. The sensitivities include the discount rate, presence/type of equity weighting, socio-economic-emissions scenario, equilibrium climate sensitivity, form of the damage functions, and presence of CO<sub>2</sub> fertilization effects.

The paper is really more suited as a white paper presenting basic testing/diagnostic results from a standard sensitivity analysis using the modeling team's latest version of FUND. As it currently stands the paper does not provide a substantive contribution to the literature. The topic is interesting and there are certainly outstanding questions with regards to what drives the growth rate of the SCC, however, this paper falls well short of providing compelling evidence to help understand these driving forces beyond some basic identification using sensitivity analysis. When presenting the results of the sensitivity runs the authors do present hypotheses for what might be driving the results, but do not provide compelling theoretical/mathematical justification for the hypotheses or rigorous numerical analysis to support their claims. Such analyses would allow the paper to make a contribution by providing insight that is potentially generalizable to the broader discussion on the SCC and not restricted to a specific series of runs with one version of one model.

## 1 Additional Comments

- In section 3.2 and Figure 4 it appears that the entire socio-economic-emissions scenario is being changed between runs. While this is somewhat interesting the interpretation of the results is confounded by the fact that the different parts of the scenario are co-varying. What might be more useful is to consider varying only one component at a time to understand their relative importance in determining the growth rate. From Figure 4 it is not clear what the relative sensitivity of the growth rate is to the different variables. While these variables may co-vary in reality it would be beneficial for the reader to work up to that point by first starting with individual sensitivities and build the intuition, then moving to test the sensitivity of the growth rate to the covariance between the variables (of which there is substantial uncertainty moving into the future).
  - Are other aspects of the scenario allow to vary beyond just those plotted in Figure 4? For example do CH<sub>4</sub> or N<sub>2</sub>O emissions change across the scenarios? If so what affect do those variables have on the growth rate?
- The results presented in section 3.3 on the sensitivity analysis with respect to the equilibrium climate sensitivity are some of the most interesting in the paper, particularly the apparent parabolic shape of the growth rate with respect to the parameter. With some work the paper could provide a contribution to the understanding of what drives the growth rate of the SCC by working out either theoretically or through detailed numerical analysis what drives this behavior. Also looking at what equilibrium climate sensitivity is associated with the minimum growth rate and why that might be the case.

- In section 3.4 it is unclear as to what specific modifications to the model were made in order to implement these sensitivity analyses. It would be useful to provide the reader with an example of a damage function for a typical sector and discuss what these changes mean for that damage function.
- In section 3.4 it is not particularly clear whether this includes CO<sub>2</sub> fertilization effects to forestry or just agriculture.
- Figure 8 and the discussion in Section 4 focus on a cumulative distribution function of previous estimates of the SCC growth rate. However, the paper does not go into detail as to specifically what studies are included in this distribution. Are these the same studies mentioned in Section 1? Since length does not appear to be an issue it would be really useful for the reader if the authors would provide a table listing the study authors, model used, scenario used, discount rate, and estimated growth rate along with any other pertinent information.
  - Do these previous studies form an appropriately defined sample for creating such a cumulative distribution functions? For example, the growth rate estimated in this paper consider the SCC up until the year 2100. Do all of the other estimates in this distribution consider the average growth rate over this period?
  - Also what is driving this difference in growth rates? The paper discusses various characteristics of a model run that may influence the growth rate (e.g., scenario, damages function, equilibrium climate sensitivity, etc.), which makes the reader wonder how those results can be used to interpret this range of estimates.
- The final discussion brings up some very interesting points with respect to the logarithmic relationship between carbon concentration and radiative forcing and its relationship to the growth rate of the SCC. In some previous research I have done with colleagues it appears that this factor may actually be quite important. Understanding how much this effect pushes down on the growth rate along a reference path relative to some of the other effects and also the interaction between effects would be interesting.
- The simple example presented in “Referee Report 1” to a similar paper by Tomas Kogel submitted to this same special issue provides an intuitive and useful framework for understanding many of these issues. In fact that simple example is able to derive many of the results highlighted in this paper. While it would of course require substantially more work than that of the other reviewer’s comments the authors of this paper could most likely adopt a similar explanatory tool geared more towards the FUND model in order to build intuition for the reader.
- The horizontal axes in the figures are not readable in some cases.
- In Figure 2 the abbreviations in the legend do not appear to be defined.
- In Figure 4 the label on the vertical axis is unreadable.