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From my perspective

Critical review of: "Making or breaking climate targets — the AMPERE study on staged accession scenarios for climate policy"

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ABSTRACT

This critical review of the integrated assessment modeling (IAM) research underlying the AMPERE study is also relevant to many other IAM-based model comparison papers. One of the main symptoms of the serious methodological problems of these studies is that the results produced by different models for what are portrayed as the "same" scenarios differ quite substantially from each other. While the authors of the AMPERE study correctly raise the important question of whether these differences are due primarily to differences in model structures, or to differences in the sets of input assumptions for the "same" scenario used by different research teams, they never address this question in a logically systematic and credible way. In fact, they cannot and do not arrive at an answer, since each modeling team generally relies on a single but different set of most input assumptions for the same scenario. Finally, the research teams involved in the AMPERE project, and other similar projects, fail to understand the fundamental impossibility of forecasting net mitigation costs or benefits over the long run given both the practical and deep uncertainties implicit in both the equations comprising these IAMs, and the input assumptions on which they rely.

1. Introduction

The AMPERE project was a major EU-funded research effort to try to determine the economics and, therefore, the desirability of "staged accession" scenarios to mitigate climate change at the global level through 2100, with a focus on the European Union as the key actor. The results of this research are presented in the TFSC article under review here (Kriegler et al., 2015). Staged accession scenarios appear to involve various regions of the world taking action to mitigate climate change in different ways and at different times, rather than collectively at the same time. This project produced several mitigation scenarios for analysis and comparison to a reference policy case. The details of these mitigation scenarios are not important for our critical analysis here. Instead, what is important is the project's focus on the differences in the long-run economic results for different mitigation scenarios when compared to the reference policy case, especially the results for the EU and China. These economic results include the present value of the GDP and other economic costs and benefits computed by the models, as well as the cost of carbon prices computed in different scenarios.

The purpose of this critical review, which is unusual within the literature on the economics of mitigating climate change, is to try to enumerate the major weaknesses of the AMPERE project in attempting to apply credible methodologies for analyzing the results of this type of modeling study. One goal of this critique is to encourage the various integrated assessment modeling teams around the world to reconsider their research priorities in light of the types of problems identified here. If integrated assessment models of the types utilized in this major EU project are going to be used in the future to assist policy makers, the ways they are used, as well as the models themselves, will require major modifications.[1] And while the issue of TFSC in which this overview of the AMPERE study was published also contains many other articles on related topics, I

[1] This paper will not address the model flaws, some of which are addressed in reference 2, and other papers referenced in that paper.

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will focus attention on this single overview paper as representative of the others. Note that the critique of this overview paper follows directly from the broader critique of many IAM team research efforts to assess the economics of mitigating climate change over the long run as described in much greater detail in my previous TFSC paper (Rosen and Guenther, 2015). Note that there is considerable overlap in these sets of research teams that have published research papers in this field in TFSC and many other journals, as well as between the ones referenced in the Stern Report, the various IPCC assessments, and the AMPERE project. These sets of research teams often publish joint research articles.

2. Methodological claims in the TFSC article

The findings for the AMPERE study were based on a set of "coordinated scenario" runs using eleven global "energy-economy" integrated assessment models, broadly grouped into four different types (Kriegler et al., 2015, page 1). The article also points out that the models differ from one another in "numerous" ways (Kriegler et al., 2015, page 2). Some of the ways in which the models differ include the level of technological detail in the energy sector, the substitutability of energy forms, and the representation of greenhouse gases (Kriegler et al., 2015, page 2). However, the only aspects of the eleven models that were harmonized to each other were the GDP and population growth rate assumptions for the various regions of the world for the scenarios modeled. In spite of the lack of cross-model structural consistency, the article then claims that the numerous differences in model structure and input assumption values that reflect the differences in choices made by the eleven different modeling research groups is "not a drawback, but a feature of model comparisons, since it allows us to explore the associated range of uncertainties" (Kriegler et al., 2015, page 4). On the other hand, the article admits that this does not imply that the range of assumptions implicit or explicit in these model runs "necessarily cover[s] the entire range of [reasonable?] possibilities."

Of course, saying that a feature of model comparison research projects in the past was that various groups of model outputs which involve sets of very different model structures and input assumptions have been directly compared is not saying much. That something has been done in the past does not mean it is a good idea for the purposes of learning important lessons about the economics of mitigating climate change. Thus, I will focus on the claim that comparing the outputs of many different models of the types used in the AMPERE study allows for a reasonable exploration of the associated range of uncertainties in the results, namely the results which derive from the various models and specific sets of input assumptions included in the study. Unfortunately, however, from the perspective of a reader of this paper, each model is essentially a proverbial "black box". The reader can have little idea as to what is going on inside the "black box" based on the information presented in the TFSC article (Kriegler et al., 2015). To get a somewhat better, but still not complete idea, of how the different models function, one would have to undertake a major research project consisting of trying to find documentation of all the eleven models on the websites of the research teams. However, a reasonably complete set of the important input assumptions, especially cost assumptions, used in this paper cannot be found anywhere, including in the supplementary online material that was published with the paper.

Naturally, running different models with different input assumptions could, in theory, allow one to explore a reasonable range of uncertainties inherent in the model outputs, but, unfortunately, the article under review does not perform any such explorations in a scientifically credible and systematic manner. In fact, no sensitivity analyses based on varying key cost input assumptions are presented at all. To perform a scientifically credible exploration of the uncertainties in results due to the different model structures themselves, one would have to develop a comprehensive research plan to systematically run all the models with the same sets of input assumptions, and one would then need to vary those sets of input assumptions in clever ways to cover the credible range of each type of input assumption.[2] Obviously, since there are dozens, if not hundreds, of key input assumptions for each model, there would be tens of thousands of credible combinations of such input assumptions. This implies that one would need to run a carefully chosen sub-set of input assumptions through the models in order to span a reasonable range of output results for each model, for each scenario. How to reduce the number of combinations of input assumptions to a reasonable sub-set for the research proposed is, itself, a research challenge. Since this type of systematic and comprehensive exploration of uncertainties was not done in this AMPERE study, what did the study accomplish from a scientific perspective? The answer is, as I will show, "not much", but worse still, many key issues were ignored that should have been addressed.

3. Analysis of AMPERE study results

The report on the AMPERE study first presents economic results from the models in the form of CO2 prices in the reference policy case for different regions of the world in the year 2030 (Kriegler et al., 2015, Fig. 1.a.). There, one finds the results for ten of the IAMs plotted for eight regions of the world. Immediately, one can see, as the text acknowledges, that there are "large variations in carbon price projections" between the models (Kriegler et al., 2015, page 6). The authors then address a few possible reasons for these large differences. The first reason given is that the carbon prices depend "on model structures and the availability of mitigation options." This is obviously part of the answer, due to simply considerations of logic. Thus, the authors are not saying anything new in giving this reason that is learned from this research. One key, but unanswered question, is to what extent are these differences in carbon prices due to different model structures and the different assumptions as to mitigation option availability.

One key question that also should have been addressed is what particular *features* of the model structures lead to such big CO2 price differences. Moreover, when the article cites different assumptions about the "availability" of mitigation

[2] An example of a single parameter sensitivity analysis would be to vary the input assumptions for the capital cost of new nuclear plants in order to show how this changes the mix of mitigation technologies implemented in a given scenario, and how it affects the cost of mitigation. A reasonable range for this parameter might go from an extremely optimistic low value of $5000 per kw to a high of $15,000 per kw of capacity, for example. All the models require as input assumptions the capital costs of such mitigation options.