Incorporating Resource Efficiency Indicators to Climate Change Scenarios

Insights from Recent GINFORS Simulations

Extended Abstract

The concept of Shared Socio-economic Pathways (SSPs) originated from IPCC activities for projecting future climate change. It has been developed along the dimensions of challenges to mitigation and to adaptation and is thus being frequently applied in emission and climate scenario studies. Environmental studies focussing on other challenges than climate change, however, have not discussed the implied environmental pressures of individual SSP scenarios very intensively until now. Referring to the significant and still growing importance of resource efficiency measures for national as well as international political agendas, this circumstance might be perceived as rather astonishing. At least, it hints to remaining research tasks in the ecological economics literature. Our paper summarises recent own research activities which are intended to bridge this gap: We present results from model-based simulation studies which have been carried out on behalf of the German Ministry of the Environment and the German Environmental Agency in order to advance national resource policies.[1] The simulation setup under consideration integrates the environmental dimension of global resource extractions to the SSP framework. For this, a global Multi-Region Input-Output (MRIO) model has been calibrated to two selected SSP scenario (SSP1, Sustainability; SSP3 Fragmented World) figures. The applied modelling framework is given by the GINFORS model.

From a methodological viewpoint GINFORS might be characterised as a dynamic Input-Output simulation model which is based on a comprehensive MRIO database. GINFORS evolved from the COMPASS model (see Meyer & Uno, 1999, or Uno, 2002, for references with regards to the COMPASS model) in the course of the MOSUS project.[2] As a global input-output simulation model, aims and scope of the GINFORS model are generally closely related to GTAP applications. However, whereas the later follows a standard Computable General Equilibrium (CGE) approach, GINFORS does not rely on long run equilibria of competitive markets or Say's law for a macroeconomic closure. Moreover, GINFORS assumes that agents have to make their decisions under conditions of bounded rationality on imperfect markets.

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[1] Results presented within this paper have been developed within the scope of the PolRess project. See www.ressourcenpoltik.de for further information.

[2] The MOSUS project was funded by the Fifth Framework Programme (FP5) of the European Union. In this project GINFORS was used to simulate sustainability scenarios until 2020. See http://www.mosus.net/ for details.

GINFORS in contrast to many other models (e.g. E3ME) is a model that covers the whole world. In GINFORS$_3$, the latest model version which was developed 2012-2014, even the region "Rest of World" is represented by a fully employed IO-model. Therefore all direct and indirect effects can be endogenously incorporated in our scenario analyses and there is no need for assumptions like "domestic technology" to derive, e.g., figures for the resource inputs in raw material equivalents. Overall, this model enables us to simulate global developments until the year 2050, especially with regards to:

- the evolution of 35 industries in 38 national economies and a Rest of World region,
- international patterns of trade for 59 products,
- the resulting effects on main economic aggregates of national economies (e.g., public debt or disposable income of private households),
- emissions stemming from 28 energy carriers,
- and the use/extractions of natural resources (incl. water and agricultural land).

Material extractions (in thousands of tons) for 7 kinds of abiotic resources and for 2 kinds of biotic resources for 38 individual countries and a Rest of World region are consistently interlinked with the respective economic activities (in monetary terms at constant prices) given by the dynamic MRIO-system. In addition GINFORS$_3$ emphasises the nexus of growing demand for crops (i.a. due to bioenergy uses, a growing world population) in a world of limited land availabilities facing the impacts of climate change on agricultural activities.

In summary GINFORS$_3$ incorporates not only the endogenous explanation and simulation of detailed economic structures around the world as well as the interconnections between the economies due to more and more globalized trade patterns, but shows the embedment of these processes in the global earth system.

Confronting this elaborated system with external expert knowledge about possible futures gives new insights to the major global challenges: Are the SSPs really consistent, if we consider the resulting impacts on resource needs or will we quickly (further) exceed the planetary boundaries?

The presented results have been developed in the course of several international FP7 reserch projects as well as national projects on economic impacts of climate change and ressouce scarcity. Our paper focuses on own research activities within the scope of the PolRess project,[3] where the GINFORS$_3$ model has been calibrated to selected key SSP scenario figures (SSP1, Sustainability; SSP3 Fragmented World). For both scenario implementations we present dynamic projections of global resource

[3] See www.ressourcenpoltik.de for further information.

extractions until the year 2050 and discuss the potentials of different national policy measures in order to increase German resource efficiency.

Relevant Links:

- Distelkamp, M. & Meyer, M. (2014): Report about resource reduction cost curves for material consumption in different MS and sectors. POLFREE Deliverable 1.4, Osnabrück.
- Meyer, M., Distelkamp, M., Ahlert, G. & Meyer, B. (2013): Macroeconomic Modelling of the Global Economy-Energy-Environment Nexus - an Overview of Recent Advancements of the Dynamic Simulation Model GINFORS. GWS Discussion Paper 13/5, Osnabrück.
- Meyer, B. & Meyer, M. (2013): Impact of the current economic instruments on economic activity. Understanding the Existing Climate Policy Mix. Report on Task 2.6 of CECILIA2050, project funded under the European Union's Seventh Framework Programme, Osnabrück.
- Meyer, B., Meyer, M. & Distelkamp, M. (2012): Modeling green growth and resource efficiency: new results. Mineral Economics, 24(2), pp. 145-154.