Material Requirements and Emission Footprints of Low-carbon Technology Diffusion â€“ Combining a Dynamic MRIO Approach with Elements from System Dynamics Modelling

Topic: (9.2) Dynamic IO Modeling and Analyses of Capital Formation
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To reduce the increase of global temperatures to maximal 1.5 degrees, countries need to start acting as soon as possible. There is no time to wait for a new break-through technology; rather existing low-carbon technologies (LCTs) should diffuse as quickly as possible. Using input-output analysis, we show the direct and indirect environmental effects of the transition to a low-carbon development path considering not only the environmentally friendly use-phase of the LCTs, but also the environmental effects of building the technology stock.
We first develop a dynamic version of multi-regional supply-and-use table (SUT) system of EXIOBASE [1] up to the year 2050. In a second step, we explicitly model the transition to LCTs (using the example of the electricity industry) and their effect on the structure of the global economy. Different parts of the global SUT system that are adapted as suggested in [2]: final and intermediate demand for the different types of electricity, the input structure of those industries producing the new technologies and final demand for gross capital formation.
The capital stocks and flows of LCTs as well as the main materials required by these are modelled using elements from the system dynamics approach (as used for example in the WORLD3 model in [3]). To this end, the current technology stock, its size, age and expected life span, as well as the technology stock required to achieve the emission reductions is considered. Net operating surplus from the MRIO model and natural resource stocks and related rates of exploitation of those set limits on technology production possibilities.
The results show that the transition has different impacts on different environmental stressors, but that the environmental pressure will significantly decrease in the long-run with a transition to a low-carbon development pathway.
References
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[3] Meadows, D. H., Meadows, D. L., Randers, J. & Behrens, W. W. The Limits to Growth. Chelsea 205, (1972)