Extending a standard accounting framework to account for non-linear technological change

Topic: Input-output and sectoral macro-econometric modelling: Part of the same family
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(1) Research question
Innovation theory has shown that technological change tends to come in waves. Rates of adoption of new technologies are highly non-linear and have been shown to follow an S-shaped pattern as products move from niche market positions to rapid uptake and, eventually, market saturation. Existing macro-sectoral economic models, which typically build on a linear input-output core, are not well equipped to deal with the diffusion of new products and non-linear technological change. For example, optimisation models assume instant take-up if products become cost-competitive and econometric approaches require historical data that will be missing for new products. At the same time, modellers are grappling with attempting to model technological transitions, notably the transition to a low-carbon economy. Conventional models have repeatedly underestimated the rates of uptake of new low-carbon technologies. Modelling technological change correctly becomes particularly important for problems related to energy, greenhouse gas emissions and sustainability, where other econometric or input-output methodologies would generate inaccurate estimates of energy intensity and environmental damage variables.

(2) Method used
This paper introduces a new modelling approach of technology diffusion. It shows how such a model may be linked to an input-output model and discusses consistency with the assumptions that underpin macro-econometric and Computable General Equilibrium (CGE) models. We use a system of coupled non-linear finite differences equations to simulate S-shaped diffusion curves for the diffusion and phase-out of technologies in energy-intensive technologies (power generation, transport, industry, household heating). This enables to better estimate the energy and greenhouse gas intensity of technology.

(3) Data used
We use a combination of energy statistics and manufacturer data.

(4) Novelty of the research.
We conclude this paper with some examples of the benefits of such a combined modelling framework, focusing particularly on the interactions of technology with the economy and input-output structure. We show how the approach was applied to produce the estimates of the value of stranded fossil fuel assets that were covered extensively by the British media in 2018 (https://www.nature.com/articles/s41558-018-0182-1).