A macroeconomic input-output model with an integrated energy system

Topic: Enriched IO Models
Author: Kurt KRATENA

(i) the research question
Energy and climate scenario analysis requires a full coverage of energy system flows and CO2 emissions arising from these flows. Scenarios of energy transition also need to describe the driving economic forces of energy demand (short-run behavioural and long-run technological change) as well as the economic feedbacks of structural change in the energy sector and of climate policies. That can be carried out in an input-output framework where variables in monetary units are consistently linked to physical units and the long-run dynamics of energy demand are explained. Extending the IO framework towards a macroeconomic model with consumption of different household types, investment, energy demand of firms and households, the public sector and the labour market allows for deriving socio-economic impacts of climate policies that, in turn, feed back to the energy system.

(ii) the method used
A standard national input-output model is extended via a full and consistent integration of the energy system. This extension is enabled by linking it to partial bottom-up energy models. The model is demand-driven but incorporates relative prices and supply-side restrictions in factor markets as well as closure via a public budget constraint. The modelâ€™s focus is energy demand and CO2 emissions. Energy demand of firms treats energy (E) as part of intermediates (M) in a KLM framework and is capital-stock specific. The IO core of the model is used to identify energy and non-energy industry linkages (in both quantities and prices). In this way, investments can shift the output shares across different energy-related technologies (e.g., from blast-furnace to electric-arc steel). Thus, industry energy intensity is jointly determined by investments and energy efficiency improvements. This mechanism is consistently linked to the IO structure by applying a two-layered framework, i.e., energy flows are measured in both monetary and physical units. Insofar as climate policy analysis is concerned, the model includes ten different household/labour types (five quintiles of income classes further differentiated by urban and rural locations).
(iii) the data used
The modelling approach combines SUT data for Austria with detailed data from Household Budget Surveys matched to EU SILC, and energy balance data. Physical data from partial energy models are fed in as well.
(iv) novelty of the research
The energy modelling approach for firms and households deviates from the treatment of energy demand in standard energy/environment CGE models by including. It is better suited for describing the dynamics and radical changes accompanying energy transition processes. All the consequences in the energy system are fully reflected in the IO framework.