Resource scarcity, circular economy and the energy rebound: a macro-evolutionary Input-Output model

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In this paper, we propose an Agent-Based Stock-Flow Consistent model combined with an Input-Output structure of production. In the model, heterogeneous firms interact in the energy, material, capital and consumption markets. Materials for production of consumer goods can be manufactured using non-renewable or recycled resources. We examine the conditions under which the circular economy emerges through market mechanisms, as well as it can be a source of the rebound effect. An important novelty of our approach is that recycling and mining sectors employ different types of capital for production. Capital firms constantly engage in innovations to improve their technological features. This way we endogenize changes in technological coefficients of the Input-Output tables and we include time-consuming and long-term factor substitutability. We show that sectoral interdependencies along the value chain can render the energy rebound effect due to the circular economy (CE) even if energy intensity of the recycling process is lower compared to mining. Finally, we assess the role of different macroeconomic policies, namely mission-oriented innovation policies (MOIPs) and environmental taxation in fostering the CE transition, while mitigating the rebound effect. We find that the combination of MOIPs and active fiscal policy is the most effective in promoting the circular economy, preserving employment and ensuring a sustainable growth path.