Bioeconomy-related instruments and SDGs: Assessing synergies and trade-offs through economy-wide modelling

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The bioeconomy is increasingly promoted as a pathway to reduce dependence on fossil resources while supporting economic development through the production of bio-based energy, materials, and chemicals, and through improved circular use of biomass. Because it connects food systems, industry, land use, and trade, bioeconomy strategies have the potential to influence multiple Sustainable Development Goals (SDGs) simultaneously.
As a transversal, cross-cutting policy area, different policy agendas will operate simultaneously within the same biomass- and land-constrained system. As interventions in one domain can generate indirect effects in others, with effects transmitted across supply chains via prices, income, trade, and land allocation, the net implications of these policies cannot be considered in isolation (Philippidis et al., 2023). Robust system-wide assessments are therefore needed to align the bioeconomy and food system development, thereby supporting policy coherence to advance broader sustainability and competitiveness agendas, such as the fulfilment of the SDGs.
While many studies quantify system-wide pathways or the impacts of individual measures in these fields, comparatively fewer evaluate comprehensive, multi-instrument policy packages in an SDG framework (see Christensen et al., 2022). This study assesses the impacts of selected bio-based solutions on the Sustainable Development Goals (SDGs), focusing on identifying potential trade-offs and synergies. The analysis leverages a global Computable General Equilibrium (CGE) model, MAGNET, to evaluate the effects of dietary shifts, food waste reduction, and the upscaling of bio-based chemicals and plastics in the EU on various SDG indicators, including SDG 2 (Zero Hunger), SDG 8 (Decent Work and Economic Growth), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 15 (Terrestrial Ecosystem). For this purpose, a layered approach is taken into account:
â€¢ Scenario 1: 50% implementation of the Lancet diet
â€¢ Scenario 2: Scenario 1 + reducing food waste and losses
â€¢ Scenario 3: Scenario 2 + 20% grey waste drop and recycling into green, glass, and paper
â€¢ Scenario 4: Scenario 3 + upscaling bio-based chemicals and plastics (low technological return on productivity, 2.5% ROR)
â€¢ Scenario 5: Scenario 3 + upscaling bio-based chemicals and plastics (high technological return on productivity, 10% ROR)
Selected preliminary results include:
- A partial transition to a plant-based diet in the EU (Scenario 1), such as the EAT-Lancet diet, does not harm (and even improves) outcomes in SDG 2-related targets, such as reduction in food prices, an increase in the share of calories from fruits and vegetables, and a decrease in the consumption of animal products, while reducing EU demand-driven emissions and land footprints.
- Increasing efficiency in the use of biomass resources in the EU, via reducing food waste and losses (Scenarios 2 and 3) further improves environmental outcomes, reduces both emissions and land footprints, while yielding similar macro- and socio-economic outcomes to Scenario 1.
- Environmental and socioeconomic outcomes from upscaling bio-based chemicals in the EU, in parallel to dietary shifts and improvements in biomass efficiency use (Scenarios 4 and 5), have limited macroeconomic impacts (slight reduction in GDP per capita). Land footprint is slightly increasing with regard to Scenarios 2 and 3, but it remains 1% lower than that of the baseline. Emissions footprint is lower, although this effect is explained by the lower overall economic activity in these scenarios. Overall, the higher efficiency gains in the high-tech scenario help reduce these

trade-offs.

The analysis has important policy implications for sustainable development and advances the SDGs. While the results confirm that synergies are predominant in most of the selected bio-based solutions, trade-offs are also identified. The outcomes of upscaling bio-based chemicals and plastics illustrate the nature of these trade-offs, which are also dependent on assumptions on productivity gains from investments. The study's findings suggest that a comprehensive approach to sustainable development is needed, identifying potential synergies, but also managing potential trade-offs between different policy interventions. By evaluating the impacts of different scenarios on the food system, economy, and environment, policymakers can make informed decisions about how to promote sustainable development and achieve the SDGs.