Transregional Land-Use Effects of Biofuel Policies – Agent-Based Economic Analyses with the ILUC-MAP Model

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Biofuel promotion policies, such as the EU Renewable Energy Directive (RED) and the US Renewable Fuels Standard 2, aim at encouraging the diffusion of biofuels as a low-carbon alternative to fossil energy sources. These policies can, however, also cause adverse (indirect) land-use change (LUC) impacts in countries around the world. This can pose a great threat to natural ecosystems and might even offset the positive climate effects of biofuels. The pursuit of biofuel policy objectives will, therefore, often require combining promotion policies with suitable land-use governance instruments, such as the RED's sustainability certification regime.

The partial equilibrium (PE), computable general equilibrium (CGE), and integrated assessment models currently used to inform biofuel policy-making were, however, mainly developed for the analysis of fungible environmental externalities, such as greenhouse gas emissions. While these models are very efficient at capturing the trade effects of biofuel policies, they have shortcomings in simulating the non-fungible spatial and dynamic aspects of LUC. This is especially relevant for assessing the effectiveness and efficiency of governance instruments in mitigating adverse land-use effects of biofuel promotion. To overcome these shortcomings, Rounsevell et al. (2014) have recently advocated the coupling of neoclassical trade models with agent-based models (ABMs).

Adopting Rounsevell et al.'s recommendation, we have developed a conceptual model named ***M**ulti-**A**gent **P**latform for the Analysis of **I**nternational Trade and **L**and-**U**se **C**hange* (ILUC-MAP). The ILUC-MAP model starts with assumptions closely based on a standard analytical PE model of the neoclassical trade and environment literature. ILUC-MAP then allows for a gradual relaxation of these assumptions to incorporate a more detailed representation of the out-of-equilibrium dynamics and spatial interactions that characterize real-world land-use systems. The model is tested by replicating analytical findings of the trade and environment literature. Subsequently, we analyze and compare the welfare and land-use consequences of combining biofuel promotion with various governance instruments.

Our policy analyses aim at testing the robustness of the predictions and implications of current biofuel policy models to deviations from their simplifying assumptions about the land-use system. With our systematic analysis of the gradual introduction of ABM

elements into an analytical PE framework, we also hope to contribute to theory development for the integration of ABMs into empirical CGE and PE models.

Rounsevell, M.D.A. Arneth, A., Brown, D.G., de Noblet-Ducoudré, N., Ellis, E., Finnigan, J., Galvin, K., Grigg, N., Harman, I., Lennox, J., Magliocca, N., Parker, D., O'Neill, B., Verburg, P.H. and Young, O. (2014). Towards decision-based global land use models for improved understanding of the Earth system. *Earth System Dynamics (5): 117–137.*