A dynamic theory of spatial externalities

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Résumé

In this paper, we revisit the theory of spatial externalities. In particular, we depart in several respects from the important literature studying the fundamental pollution free riding problem uncovered in the associated empirical works. First, instead
of assuming ad hoc pollution diffusion schemes across space, we consider a realistic spatiotemporal law of motion for air and water pollution (diffusion and advection). Second, we tackle spatiotemporal non-cooperative (and cooperative) differential games. Precisely, we consider a circle partitioned into several states where a local authority decides autonomously about its investment, production and depollution strategies over time knowing that investment/production generates pollution, and pollution is transboundary. The time horizon is infinite. Third, we allow for a rich set of geographic heterogeneities across
states while the literature assumes identical states. We solve analytically the induced non-cooperative differential game under decentralization and fully characterize the resulting long-term spatial distributions. We further provide with full exploration of the free riding problem, reflected in the so-called border effects. In particular, net pollution flows diffuse at an increasing rate as we approach the borders, with strong asymmetries under advection, and structural breaks show up at the borders. We also build a formal case in which a larger number of states goes with the exacerbation of pollution externalities.
Finally, we explore how geographic discrepancies affect the shape of the border effects.

Mots-Clés: Spatial externalities, environmental federalism, transboundary pollution, differential games in continuous time and space, infinite dimensional optimal control problems

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