INNOVATION DYNAMICS IN MULTI-SCALAR SYSTEMS OF CITIES

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Urban dynamics and innovation

- Cities are central for innovation in social systems [3] and future sustainability [2]
- Urban innovation systems now span from local clusters to global networks
- Innovation dynamics in systems of cities follow complex patterns across scales

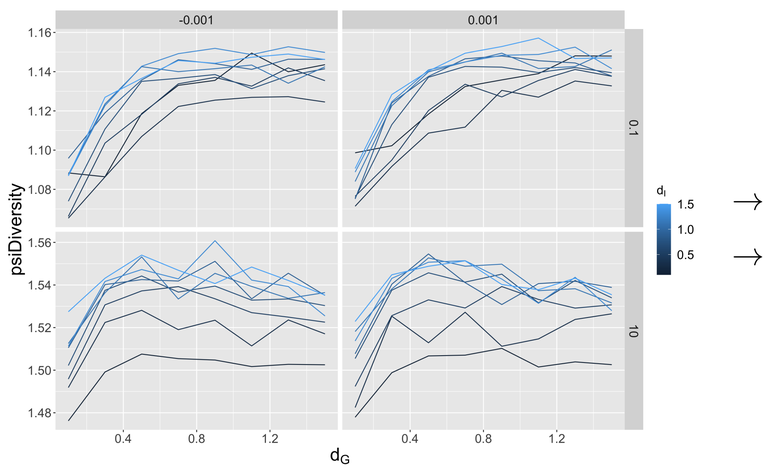
Towards multi-scalar models

- Multi-scalar models necessary to design sustainable territorial policies [5]
- "Artificial cities" [4] and urban simulation approaches focus on a single scale

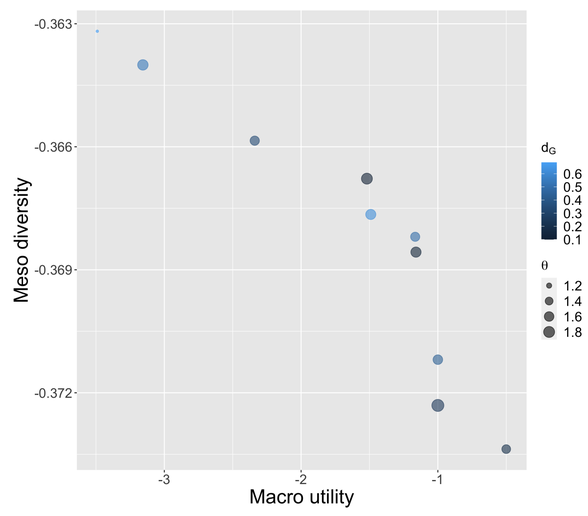
$\rightarrow$ a new **simulation model** coupling innovation diffusion dynamics **between cities** (macro scale) with research cluster dynamics **within urban areas** (meso scale)

Simulation model

Model exploration



Optimisation

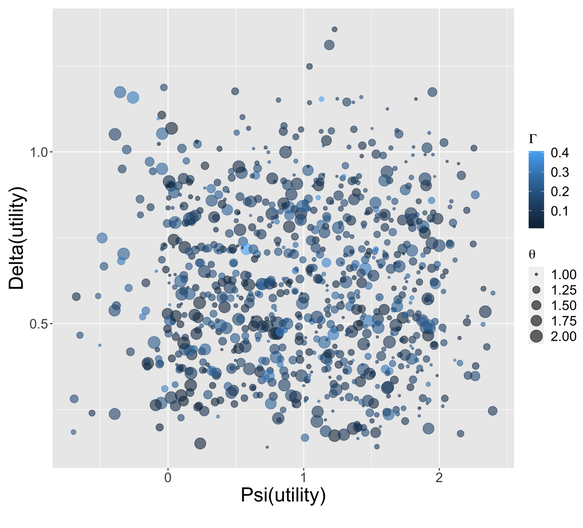


Bi-objective optimisation of indicators at both scales: aggregated utility at the macro scale and diversity of innovations within urban areas; achieved using a **NSGA2 algorithm** with a population of 200 and for 10,000 generations.

$\rightarrow$ low number of points on the Pareto front, corresponding to diverse geographical regimes (value of d_G capturing spatial interactions)

$\rightarrow$ such optimisations can in practice be used to reconcile conflicting stakeholders at different scales

Diversity search



Application of the **PSE diversity search algorithm** [1] to obtain the feasible space of emergence regimes

$\rightarrow$ downward causation always occurs ($\Delta > 0$)

$\rightarrow$ many regimes with causal emergence ($\Psi > 0$) and with autonomy between scales ($\Gamma \sim 0$)

$\rightarrow$ scale coupling is confirmed useful as strong emergence is captured

Discussion

- Possible extensions and refinements include more detailed economic processes
- Future application on real urban systems requires innovation data across scales

References

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