An evolutionary theory for the spatial dynamics of urban systems worldwide

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How to explain urban growth?

- Apparent direct causes : intentions/actions from urban actors (policies, locational strategies from firms, residential migrations…)
- But statistical observation (thousands of cities, over centuries) : each city has a probability of growing similar to other cities belonging to the same territorial system

= « distributed growth » on the long run with many local and temporal fluctuations

Gibrat's model

(« proportional » growth = growth rates are equiprobable ∀ city size and not correlated with previous rate)

Good fit ➔ double explanatory gain:

- Persistancy of urban spatial patterns and hierarchies
- The statistical shape of urban sizes distribution (Zipf's law or lognormal ≈ H. Simon ≠ P. Krugman) as generated from growth process

(Gibrat, 1931, Robson, 1973, Pumain, 1982)

Testing the evolutionary urban theory

How are stylized facts on systems of cities robust and general ?
→ empirical study with the new Global Human Settlement layer dataset

How can dynamical models of urban systems be applied in the context of the evolutionary urban theory ?
→ test of six dynamical models, based on geographical interactions between cities but different dimensions, on different systems of cities and worlwide

A new source of data on global urbanization

- **GHSL** (Global Human Settlement Layer) : GEO Human Planet Initiative (European Commission)
- Built up area from satellite images 40 m + population data 250 m ➔ 1 km^2 grid
- 13 000 urban areas > 50 000 inhab.
- Surface, population in 1975, 1990, 2000, 2015
- GDP, Green surfaces Pollutants 1990-2015

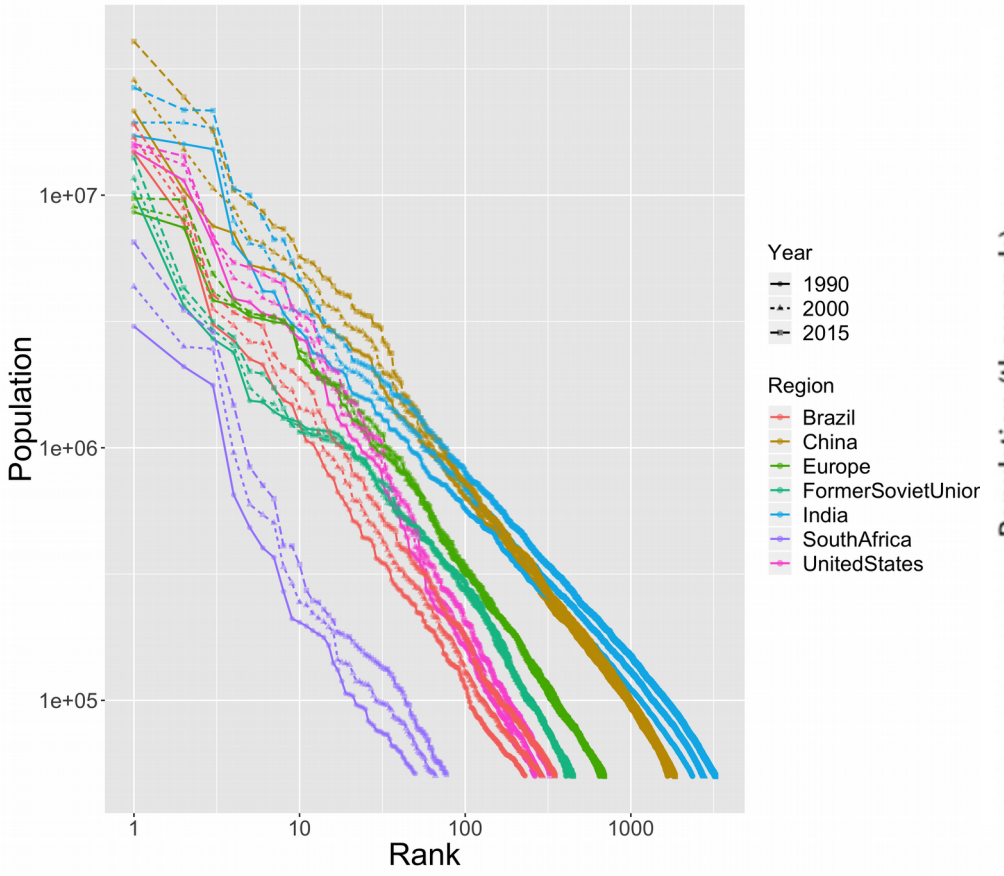
Urban systems summary

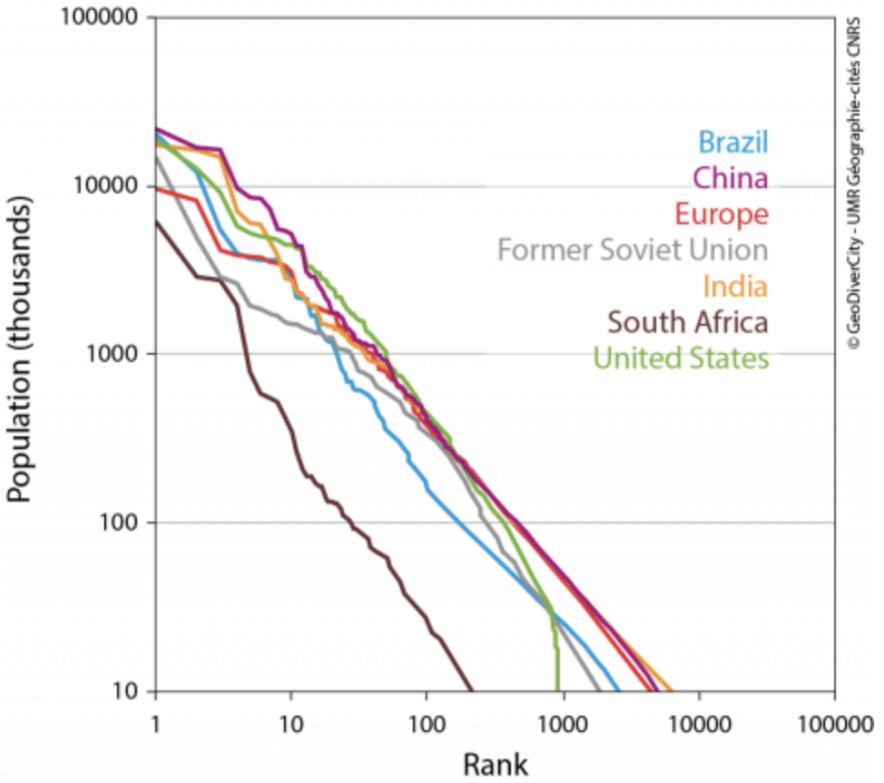
Summary statistics in 2015 for urban systems [Pumain et al., 2015]

System	Pop (M)	Pop geodiv.	Cities	Rank-size
Europe	188	291	693	0.94
China	567	481	1850	0.91
Brazil	112	161	349	0.99
India	703	427	3248	0.78
South Africa	25	25	77	1.05
US	153	324	287	1.16
FSU	120	174	450	0.92

Urban systems hierarchy

Reproducing results of [Pumain et al., 2015] for large urban systems

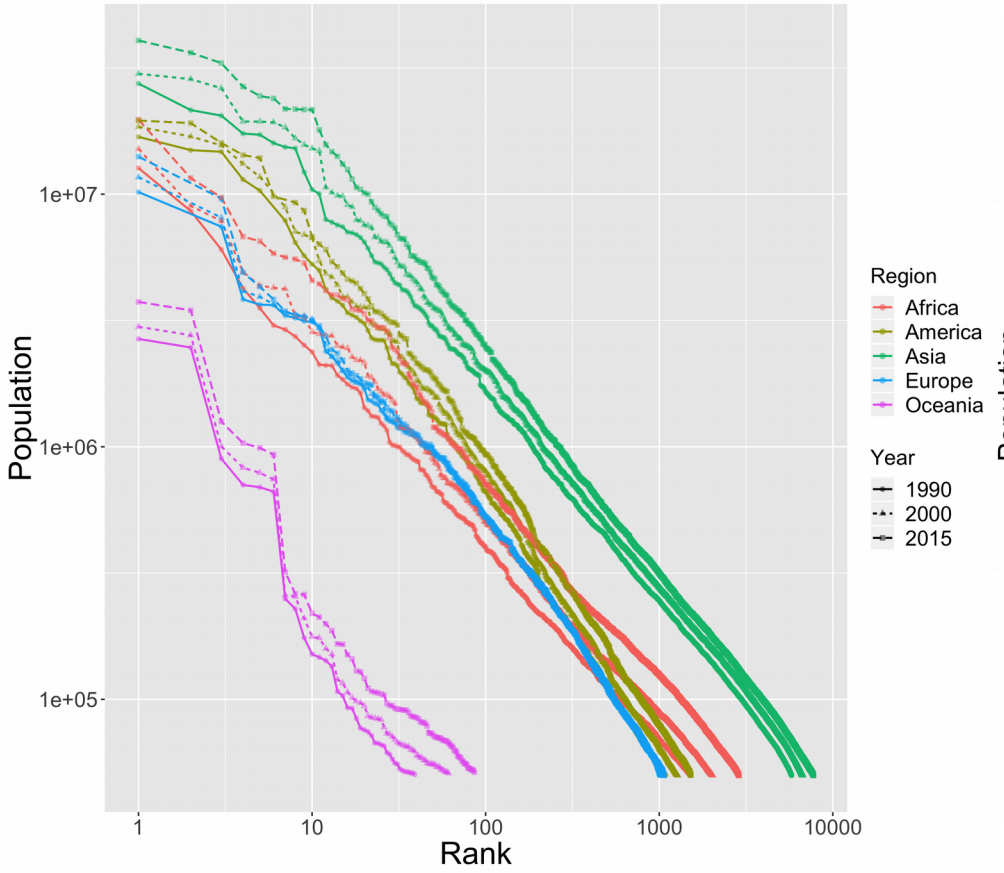


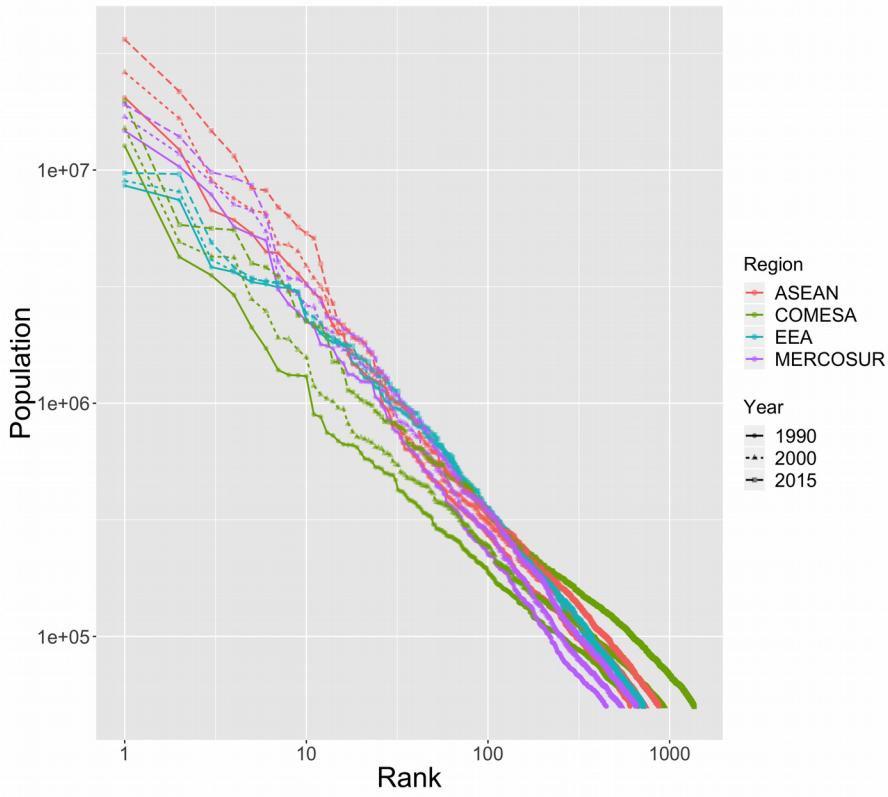


→ Robustness of qualitative stylized facts to the database

Rank-size by continents or trade areas

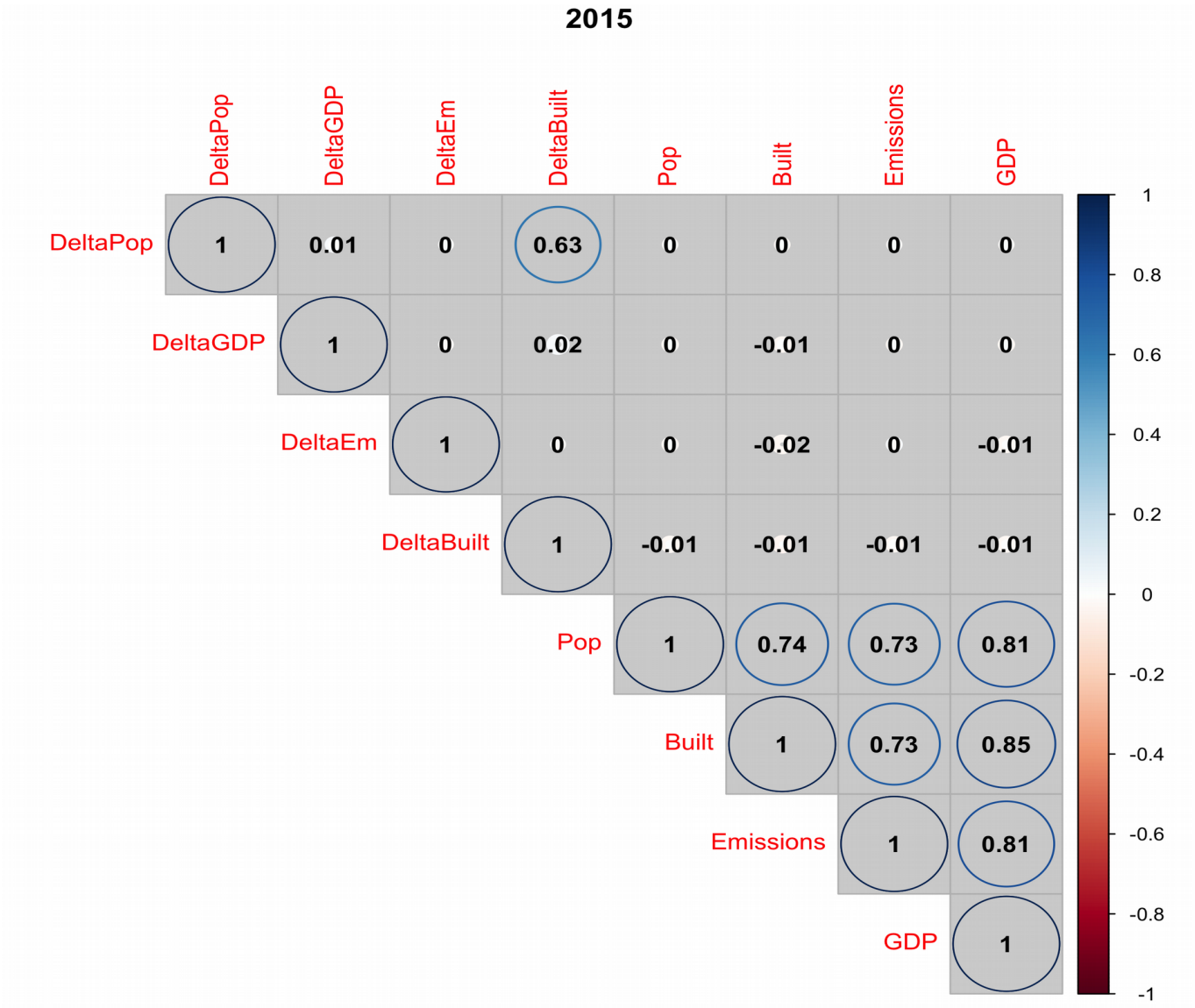
Reproducing results of [Pumain et al., 2015] for large urban systems



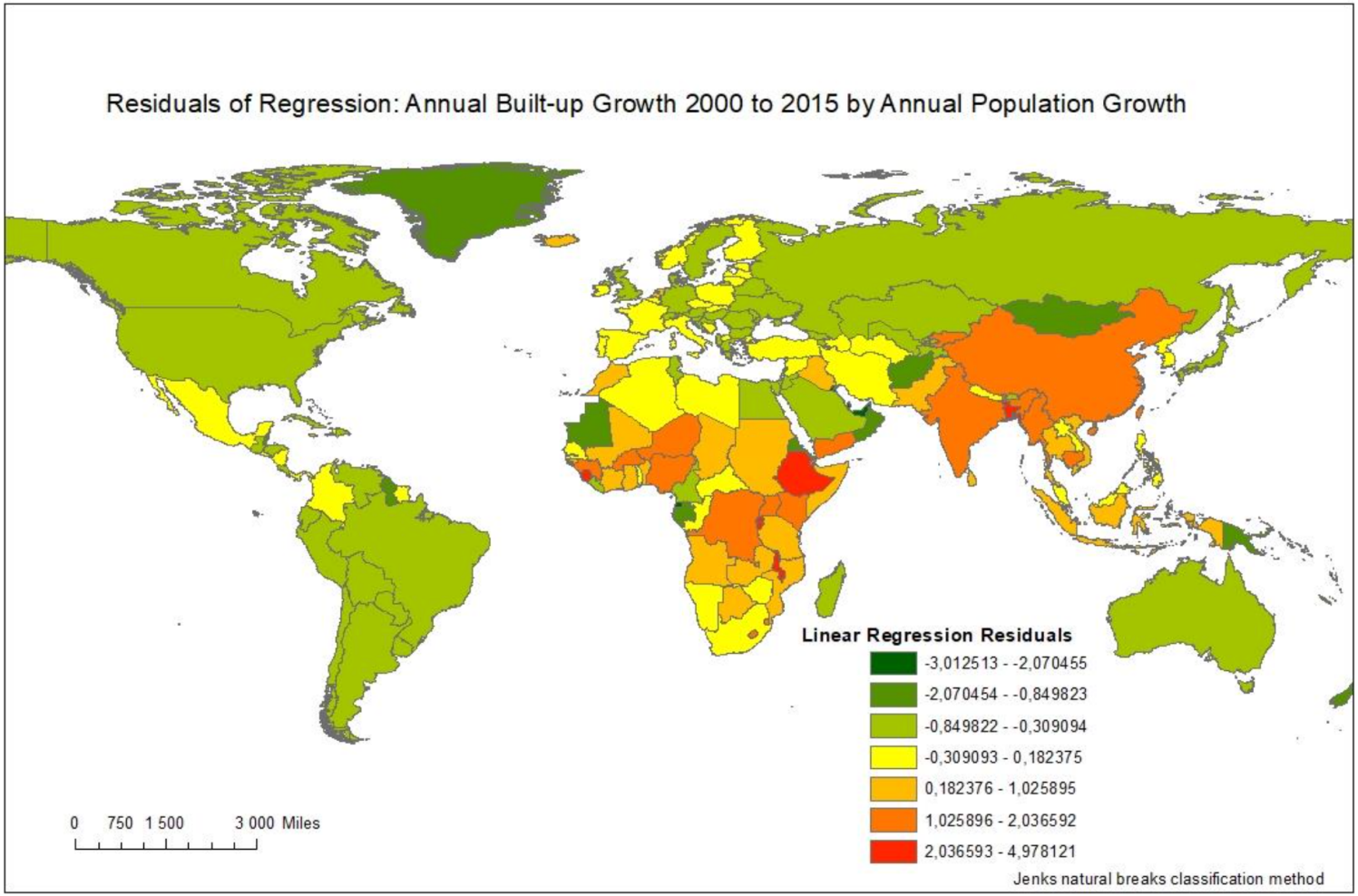


→ Possibility to extend analysis to other consistent geographical ensembles

Correlations between urban indicators

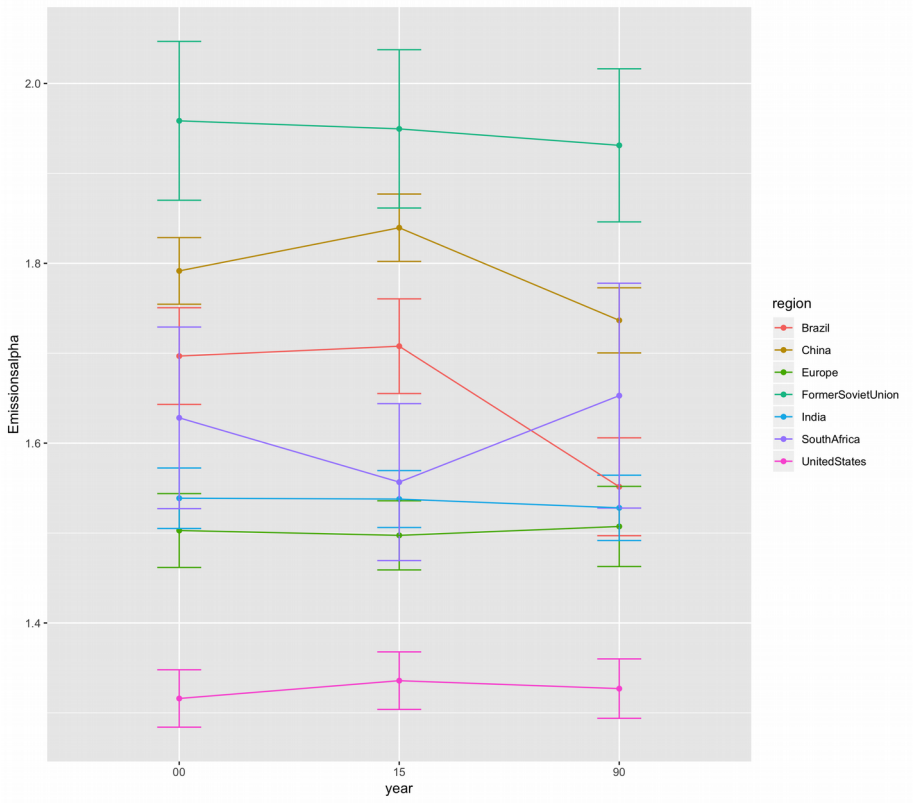


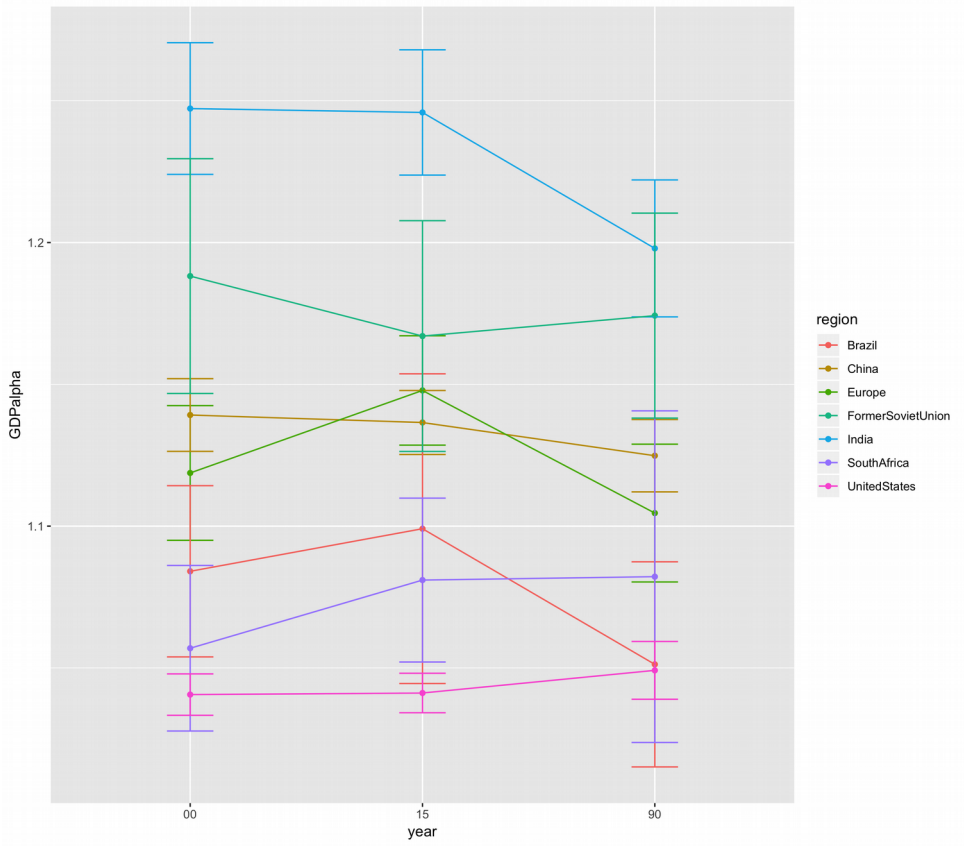
Linking urban growth and built-up area growth



Geographical structure in the relation between population growth and built-up area growth

Evolution of scaling exponents





All indicators are stable in their confidence range