Cities and governance for sustainability: limits and possibilities

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Under the Thumb of Physics? How Predictable are Urban Quantities and what is the Scope for Local Governance?
Scaling laws tell us what contributes to change in urban quantities

\[ Y = Y_0 N^\beta e^{\xi_i} \]

- Social output as a sum of social interactions
- \( F(\text{strength/quality of interactions; cost of transport}) \)
- Residuals in the log-log plot, indicating individual cities’ deviations from scaling law
Scale-independent ranking

Figure 1. Urban Agglomeration effects result in per capita nonlinear scaling of urban metrics. Subtracting these effects produces a truly local measure of urban dynamics and a reference scale for ranking cities. a) A typical superlinear scaling law (solid line): Gross Metropolitan Product of US MSAs in 2006 (red dots) vs. population; the slope of the solid line has exponent \( \beta = 1.126 \) (95% CI [1.101,1.149]). b) Histogram showing frequency of residuals, (SAMIs, see Eq. (2)); the statistics of residuals is well described by a Laplace distribution (red line). Scale independent ranking (SAMIs) for

Bettencourt et al. 2010
Where human agency, institutions and local factors come into the picture

\[ \log Y_i = \beta_0 + \beta_1 \log N_i + \xi_{j_i} + \zeta_i \]

- **common intercept**
- **scaling exponent**
- **factors specific to the city:** policies; location; ethnic relations; history etc...
- **factors common to cities in group j:** political regime? climate? culture? dominant industrial sector? transport technology?

Much information lies in the deviations from scaling
Cities and Environmental Impacts: a Multi-Scale View
Footprint of cities

▪ 70-80% of all carbon dioxide emissions are estimated to take place within city boundaries (IEA).
▪ Residence and cars: almost 40% of total U.S. carbon dioxide emissions.
▪ Hence, where people locate matters (city center versus periphery, climate zone, electricity region).
Emissions and new urban developments

- 30-60% of GHG emissions are estimated to take place within city boundaries (Satterthwaite, 2008)
- Residence and cars: almost 40% of total U.S. carbon dioxide emissions (EIA)
- Hence, where people locate matters (city center versus periphery, climate zone, electricity region)
What is the emission from new developments?

- Glaeser and Kahn estimate the emissions from private and public transport, residential heating and electricity for each census tract in each metropolitan area.
- Use this to consider the impact of recent residential development.
- High emission cities almost all in the South and best performing mostly in CA.
Lower emissions can be paired with policies that push development in dirtier areas

Glaeser and Kahn, 2008
Local versus global impact: the problem with per capita measures

- If \( Y = Y_0 N^\beta \), then \( \frac{\Delta y}{y} \sim (\beta - 1) \frac{\Delta N}{N} \)

- A change in per capita measure can reflect a change in scale OR change in scale-independent factors

- If global scale is constant, local improvement (as measured in per capita) may not contribute to global improvement
Intensive vs extensive margin with $\beta > 1$
Intensive vs extensive margin with $\beta < 1$
more collective action needed beyond the city

Size of scope 1 (under direct control of local government) depends on scale (N) and scope of city’s activities and affects the contribution of the city to global sustainability

Method for inventory of GHG, Kennedy et al. 2010
Another Example: Ecosystem Appropriation

- Require 200 x their own area
- 70% of the Baltic sea area, 15% of the ag land and 5% of the forest land
- Is this sustainable? Depends on population size, available area, how area scales with population

Folke et al. 1997
Telecoupling/Teleconnections

Seto et al. 2012

Liu 2013
- Not clear that activities in the boundary of the city are always those most influenced by the city’s policies
- We should track/seek global improvements, not local per capita improvements
- While efficiency is important, we are faced against absolute (intensive) constraints in resource use
- Scaling relations are important to appropriately trace contributions of the intensive and extensive margins and understand global quantities
Constraints and opportunities in local government
Factors to consider

- Authority (jurisdictions)
- Financial capacity
- Collective capacity
- Human capacity (e.g. govt employees)
- Dynamic control:
  - macro-economic trends
  - lock-in of infrastructure, culture etc...
  - competition/cooperation with other cities, and mobility
Authority

*authority*: the right to select actions affecting part or the whole of an organization (Simon)
Shared responsibilities

Who is leading these sectors?

<table>
<thead>
<tr>
<th>Sector</th>
<th>Below City</th>
<th>City</th>
<th>Metropolitan</th>
<th>State</th>
<th>National</th>
<th>Other</th>
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<tbody>
<tr>
<td>Spatial planning</td>
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<td>32</td>
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<td>Culture</td>
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<td>25</td>
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<td>25</td>
<td>6</td>
<td>16</td>
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<td>Housing</td>
<td>2</td>
<td>14</td>
<td>2</td>
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<td>Social services</td>
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<td>4</td>
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<td>13</td>
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<td>11</td>
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<td>8</td>
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<td>10</td>
<td>1</td>
<td>14</td>
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<tr>
<td>Health</td>
<td>8</td>
<td>2</td>
<td>16</td>
<td>19</td>
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</table>

Who is leading these transport sectors?

<table>
<thead>
<tr>
<th>Sector</th>
<th>Below City</th>
<th>City</th>
<th>Metropolitan</th>
<th>State</th>
<th>National</th>
<th>Other</th>
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</thead>
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<td>1</td>
<td>3</td>
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<td>4</td>
<td>23</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td></td>
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<tr>
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<td>19</td>
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<td>2</td>
<td>1</td>
<td>1</td>
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<td>Taxi</td>
<td>2</td>
<td>16</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Bus operations</td>
<td>1</td>
<td>16</td>
<td>5</td>
<td>7</td>
<td>2</td>
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<td>Traffic management</td>
<td>2</td>
<td>17</td>
<td>1</td>
<td>5</td>
<td>7</td>
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<td>Main roads/larger streets operations</td>
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<td>15</td>
<td>2</td>
<td>7</td>
<td>6</td>
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<tr>
<td>Underground/metro operations</td>
<td>6</td>
<td>4</td>
<td>6</td>
<td>3</td>
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<tr>
<td>Underground/metro infrastructure</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td></td>
<td></td>
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<tr>
<td>Suburban rail operations</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td></td>
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<tr>
<td>Suburban rail infrastructure</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>9</td>
<td></td>
<td></td>
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<tr>
<td>Highways operations</td>
<td>5</td>
<td>1</td>
<td>8</td>
<td>15</td>
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<tr>
<td>Highways infrastructure</td>
<td>4</td>
<td>1</td>
<td>8</td>
<td>18</td>
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</tr>
</tbody>
</table>
Financial resources of cities

Percentage of city budget from different tiers of government

**Financially independent cities**
18 cities including Gothenburg, Montreal, Philadelphia
- City contribution 50-75%
- Other contribution 25-50%

**Nationally funded cities**
9 cities including Mexico City, La Paz, Madrid
- National contribution 50-95%
- Other contribution 5-50%

**State dependent cities**
3 cities including Artik, Ghent, Istanbul
- State contribution 50-85%
- Other contribution 15-50%

**Cities dependent on multiple sources**
10 cities including Rio de Janeiro, Port Harcourt, Villa el Salvador
- National contribution 0-35%
- Supranational contribution 0-45%
- City contribution 0-50%
- Other contribution 0-25%
Local US Governments

- General Purpose Governments
  - Counties
  - Municipalities (~20000) and townships
- Special Purpose Governments (~50000)
  - Special districts
  - School districts
  - Regions (Metropolitan Councils)

![Graph](#)

- Count of MSAs
- \# local govts
Local governments in India

fiscal power: ~ 10% own revenue; responsible for allocating 40% of state revenue
policy responsibility: - identify beneficiaries of welfare programs
- maintenance and production of water system, roads, drainage, lights
Chinese case: extensive decentralization

- Decisions central to economic reform delegated to local and provincial governments
- Open coastal cities and special economic zones: autonomous control of foreign investment, taxes etc...
- Direct elections in city districts, villages
Sharing of responsibility can limit impact of city leadership

- Mayors’ policy preferences marginal impact on local city policies US
  (Gerber Hopkins 2011)
Collective capacity: institutions

China's village elections had a significant positive impact on local public good provision.
Introduction of village elections in China elections had large impacts on village policies (Martinez-Bravo et al. 2011)

Availability and diffusion of information on performance of local governments very important to their performance (Ferraz and Finan, 2008 Brazil corruption experiment)
Collective capacity: e.g. ethnic diversity

EthnicFrac = 1 - \( \sum_i Race_i^2 \)

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Regressions</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>1 (no controls)</td>
<td>6 (all controls)</td>
<td>#obs</td>
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<tr>
<td>City</td>
<td></td>
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<tr>
<td>Share of spending on roads</td>
<td>-0.098</td>
<td>-0.083</td>
<td>1020</td>
</tr>
<tr>
<td></td>
<td>(-8.69)</td>
<td>(-6.38)</td>
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<tr>
<td>Share of spending on sewerage and trash pickup</td>
<td>-0.047</td>
<td>-0.079</td>
<td>1020</td>
</tr>
<tr>
<td></td>
<td>(-2.97)</td>
<td>(-4.34)</td>
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<tr>
<td>Share of spending on police</td>
<td>0.057</td>
<td>0.099</td>
<td>1020</td>
</tr>
<tr>
<td></td>
<td>(4.58)</td>
<td>(7.37)</td>
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<tr>
<td>Share of spending on fire protection</td>
<td>-0.002</td>
<td>-0.004</td>
<td>1020</td>
</tr>
<tr>
<td></td>
<td>(-0.18)</td>
<td>(-0.40)</td>
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<tr>
<td>Spending on roads per capita</td>
<td>-36.4</td>
<td>-37.0</td>
<td>1020</td>
</tr>
<tr>
<td></td>
<td>(-4.30)</td>
<td>(-3.59)</td>
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<tr>
<td>Metro</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Share of spending on roads</td>
<td>-0.076</td>
<td>-0.058</td>
<td>304</td>
</tr>
<tr>
<td></td>
<td>(-9.14)</td>
<td>(-4.84)</td>
<td></td>
</tr>
<tr>
<td>Share of spending on police</td>
<td>0.024</td>
<td>0.020</td>
<td>304</td>
</tr>
<tr>
<td></td>
<td>(4.26)</td>
<td>(2.39)</td>
<td></td>
</tr>
<tr>
<td>Share of spending on education</td>
<td>-0.145</td>
<td>-0.174</td>
<td>304</td>
</tr>
<tr>
<td></td>
<td>(-4.21)</td>
<td>(-3.62)</td>
<td></td>
</tr>
<tr>
<td>Share of spending on health</td>
<td>0.219</td>
<td>0.269</td>
<td>304</td>
</tr>
<tr>
<td></td>
<td>(5.46)</td>
<td>(4.03)</td>
<td></td>
</tr>
<tr>
<td>Share of spending on welfare</td>
<td>-0.030</td>
<td>-0.047</td>
<td>304</td>
</tr>
<tr>
<td></td>
<td>(-1.73)</td>
<td>(-2.62)</td>
<td></td>
</tr>
<tr>
<td>Spending on roads per capita</td>
<td>-137</td>
<td>-111</td>
<td>304</td>
</tr>
<tr>
<td></td>
<td>(-7.19)</td>
<td>(-4.44)</td>
<td></td>
</tr>
</tbody>
</table>
Human capacity: does it scale?

Relationship between MSA size and public employees US

β = .56
Dynamic control: lock-in and legacies

- Different tax regime in British colonial time across latitudinal line have persistent effect on local bureaucratic capacity (Berger 2009)
- Number of slaves exported from a country during slave trade associated with lower levels of trust today (Nunn, 2007)
Competition between local governments

Dallas makes bid for Boeing

Published: Saturday, April 07, 2001

Associated Press

Chicago touts its cosmopolitan lifestyle and Lake Michigan. Dallas boasts of no state corporate or income tax and lots of political clout, and Denver its breathtaking mountain vistas and a highly educated workforce.

Photos

And they all have plenty of Starbucks coffee.

It's a full-on bidding war for the Boeing Co., which after eight-plus decades is moving its headquarters out of Seattle. The winning suitor will get 500 front-office workers a small blip in employment in cities so large and there's been a hint of more jobs down the line.

Chicago won with bid of $63 million
Opportunities

- We just enumerated many limits

BUT

- Local governments is where the actual work of government gets done (60% of the public workforce in the US)
- Cities are where many policy ideas get translated into physical reality
- Cities are also where the ideas and information are generated
# Levels of human governance vs spatial levels

<table>
<thead>
<tr>
<th>Spatial levels of political jurisdictions</th>
<th>Conceptual levels of human choice</th>
<th>Operational-choice level</th>
</tr>
</thead>
<tbody>
<tr>
<td>International</td>
<td>International treaties and charters and their interpretation.</td>
<td>Managing and supervising projects funded by international agencies.</td>
</tr>
<tr>
<td>National</td>
<td>National constitutions and their interpretation as well as the rules used by national legislatures and courts to organize their internal decision-making procedures.</td>
<td>Buying and selling land and forest products, managing public property, building infrastructure, providing services, monitoring and sanctioning.</td>
</tr>
<tr>
<td>Regional</td>
<td>State or provincial constitutions and charters of interstate bodies.</td>
<td>Buying and selling land and forest products, managing public property, building infrastructure, providing services, monitoring and sanctioning.</td>
</tr>
<tr>
<td>Community</td>
<td>County, city, or village charters or organic state legislation.</td>
<td>Buying and selling land and forest products, managing public property, building infrastructure, providing services, monitoring and sanctioning.</td>
</tr>
<tr>
<td>Household</td>
<td>Marriage contract embedded in a shared understanding of who is in a family and what responsibilities and duties of members are.</td>
<td>Buying and selling land and forest products, managing property, building infrastructure, providing services, monitoring and sanctioning.</td>
</tr>
</tbody>
</table>

**The relationship of analytical levels of human choice and geographic domains**

**Conceptual levels of human choice**

- **Constitutional-choice level**
  - International: International treaties and charters and their interpretation.
  - National: National constitutions and their interpretation as well as the rules used by national legislatures and courts to organize their internal decision-making procedures.
  - Regional: State or provincial constitutions and charters of interstate bodies.
  - Community: County, city, or village charters or organic state legislation.
  - Household: Marriage contract embedded in a shared understanding of who is in a family and what responsibilities and duties of members are.

- **Collective-choice level**
  - International: Policy making by international agencies and multinational firms.
  - National: Policy making by national legislatures, executives, courts, commercial firms (who engage in interstate commerce), and NGOs.
  - Regional: Policy making by state or provincial legislatures, courts, executives, and commercial firms and NGOs with a regional focus.
  - Community: Policy making by county, city, village authorities and local private firms and NGOs.
  - Household: Policies made by different members of a family responsible for a sphere of action.

- **Operational-choice level**
  - International: Managing and supervising projects funded by international agencies.
  - National: Buying and selling land and forest products, managing public property, building infrastructure, providing services, monitoring and sanctioning.
  - Regional: Buying and selling land and forest products, managing public property, building infrastructure, providing services, monitoring and sanctioning.
  - Community: Buying and selling land and forest products, managing public property, building infrastructure, providing services, monitoring and sanctioning.
  - Household: Buying and selling land and forest products, managing property, building infrastructure, providing services, monitoring and sanctioning.
The theory of tradeoffs between levels of government (federalism)

<table>
<thead>
<tr>
<th>More centralized</th>
<th>More decentralized</th>
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</thead>
<tbody>
<tr>
<td><strong>public good/public policy</strong></td>
<td><strong>coordination</strong></td>
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<tr>
<td></td>
<td><strong>spillovers</strong></td>
</tr>
<tr>
<td>conflict: inequality/uncertainty</td>
<td><strong>more homogeneous preferences</strong></td>
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<tr>
<td>lack of information</td>
<td><strong>yardstick competition</strong></td>
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<td></td>
<td><strong>experimentation</strong></td>
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<td><strong>local information</strong></td>
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<td><strong>direct participation</strong></td>
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<td></td>
<td><strong>accountability?</strong></td>
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<tr>
<td>accountability?</td>
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<tr>
<td><strong>fiscal</strong></td>
<td><strong>insurance</strong></td>
</tr>
<tr>
<td></td>
<td><strong>fiscal competition: wasteful competition for firms, fiscal discipline</strong></td>
</tr>
<tr>
<td>« over-raiding of fiscal commons »</td>
<td></td>
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<tr>
<td>equity: ability to redistribute</td>
<td>sustained local (dis)advantages</td>
</tr>
<tr>
<td>exploitation of some jurisdictions by others: political instability</td>
<td>inability to redistribute</td>
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</tbody>
</table>
Polycentricity: A more complex and dynamic view

‘Polycentric’ connotes many centers of decision making that are formally independent of each other. Whether they actually function independently, or instead constitute an interdependent system of relations, is an empirical question in particular cases. To the extent that they take each other into account in competitive relationships, enter into various contractual and cooperative undertakings or have recourse to central mechanisms to resolve conflicts, the various political jurisdictions in a metropolitan area may function in a coherent manner with consistent and predictable patterns of interacting behavior. To the extent that this is so, they may be said to function as a ‘system’. (V. Ostrom, Tiebout, and Warren 1961: 831-32)
Multi-scale and multi-level interactions cannot fit in a clean organizational framework

Cash et al. 2006
Multi-scale and multi-level interactions cannot fit in a clean organizational framework

- The multiplicity of cross-scale and cross-level interactions lead to complex dynamics
- There is no single right level at which to characterize the problem (due to plurality of views and complexity)
- Every policy is an experiment with a probability of failure
- Polycentric management is therefore the most robust
Diversification of policy for robust management of complex systems

Brock and Carpenter, 2007, *Panaceas and diversification of environmental policy*

Setting used as example: the Northern Highland Lake District

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**Fig. 1** Temporal scale (measured as return time) vs. spatial scale (measured as extent of spatial patterns) for some key ecological (blue ellipses) and social phenomena (brown ellipses) in the NHLD.
Learning traps

- System changes on two time frames
- Fast timescale: Bayesian learning converges to a reasonable estimate of dynamics
- Slow timescale: socio-ecological system shifts to a new regime gradually. Bayesian learning on the fast timescale stabilizes on the wrong model.
Adaptive management calls for experiments

- Compare a set of institutions and models, and select one institution
- The system is then monitored
- Investment in discoveries and experimentation
- Upon discovery, or indicators of ecosystem change, new cycle initiated

**Fig. 3.** Cycle of adaptive learning and decision. The set of institutions and set of models for the SES change from cycle to cycle. These dynamics depend, in part, on introduction of innovations by people or by emergence of new ecological or social phenomena.
Deciding which level of government is more apt to decide, finance and implement is difficult

Polycentric arrangements may be more robust and adaptive

Effective service delivery in cities is often via polycentric arrangements

Cities are key nodes in more global networks of governance (next lecture)