The growth of cities

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Introduction/Motivation

Cities keep growing but what makes them grow?

Rather than a variable-by-variable examination of results, I will insist on key methodological points

• Role of theory

• Empirical identification of engines of urban growth
Theory: what is it for?

- Clarifies the postulated chains of action
- Generates specifications
- Highlights identification problems (and sometimes proposes solutions)
- Generates side predictions
- Imposes consistency constraints
Generating specifications and raising identification issues

Example: The monocentric urban model (AMM)

- Assume linear commuting costs, flexible land consumption, and construction sector.

- Key result: \( \text{Pop}_i = \frac{R_i(0) - R}{\tau_i} \)

- Assumption: imperfect mobility across cities
  \( \text{Pop}_{i,t+1} = (\text{Pop}_{i,t+1}^*)^\gamma (\text{Pop}_{i,t})^{1-\gamma} \)

\[ \Rightarrow \text{Regression: } \Delta_{t,t+1} \log \text{Pop}_i = -\alpha \log \text{Pop}_{i,t} - \gamma \log \tau_i + \epsilon_{it} \]
But I don’t know what is $\tau$

- A link between $\tau$ and observables must be specified:
  $\tau_i = g(\text{Roads}_i)$

- The supply of roads must be spelled out:
  $\text{Roads}_{i,t+1} = G(\text{Roads}_{i,t}, \Delta_{t,t+1} \text{Pop}_i)$

$\Rightarrow$ Roads are endogenous but $\text{Roads}_0$ is potentially a valid instrument
Clarifying and making side predictions

Example: urban growth and amenities

- Typical regression: $\Delta_{t,t+1} \log Pop_i = \alpha A_i + X_i \beta + \epsilon_{it}$

- $A_i$ is an amenity (e.g., temperature); $\hat{\alpha} >> 0$

- Vague call to Roback (1982) to justify this regression

- But Roback (1982) is a static model predicting a relation between $Pop_i$ and $A_i$ not between $\Delta Pop_i$ and $A_i$

- Possible channel: income growth effect

- But requires a supplementary assumption $\partial^2 U / \partial A \partial v > 0$

- In turn generates further implications: higher coefficients in times of stronger growth, effects of inequality, etc
Imposing consistency constraints and guiding research

Example: random urban growth models

- ‘Deterministic’ urban growth models can explain population differences over time but not levels (Zipf’s law)
- Key idea: i.i.d. shocks can generate observed distributions of city sizes
- Simplest model with urban decreasing returns generates a log normal distribution (Eeckout AER 2004). Adding a reflective lower bound leads to a strict Zipf (Gabaix QJE 1999, Rossi-Hansberg and Wright RES 2007)
- These shocks can receive microfoundations in terms of innovation (Duranton RSUE 2006 and AER 2007)

A nice complement to deterministic urban growth models?
No

Random growth models are incompatible with systematic determinants of urban growth

- The determinants of urban growth remain the same but their effects change over time (Glaeser, Ponzetto, Tobio, 2011)

- Determinants change over time in a random manner (Duranton Puga JUE 2005, Rossi-Hansberg Desmet JET 2009)

- Zipf’s law can be explained by static models (Hsu, 2009, Lee and Li, 2010, Behrens, Duranton, and Robert-Nicoud, 2010)

We will be forced to make choices and will need to look at these three conjectures more in-depth
More on raising identification issues

Example: dynamic externalities

Implicit model of dynamic externalities:

- **Production:** \( Y_i = BK_i^a L_i^{1-a} \)
- **Accumulation:** \( \Delta_{t,t+1} K_i = f(L_i)K_i^b \)
- **Assumption:** \( f(L_i) = Div_i \) (microfoundations?)
- **Assumption:** free labour mobility

\[ \Rightarrow \text{Regression: } \Delta_{t,t+1} \log \text{Pop}_i = aDiv_i + X_i\beta + \epsilon_{it} \]

All is well?
Alternative model of static externalities with dynamic effects (Black and Henderson JPE 1999):

- Production: \( Y_i = f(L_i)K_i^aL_i^{1-a} \)

- Accumulation: \( \Delta_{t,t+1}K_i = \theta K_i^b \)

- Assumption: imperfect mobility
  \( Pop_{i,t+1} = (Pop_{i,t+1}^*)^\gamma (Pop_{i,t+1})^{1-\gamma} \)

\[ \Rightarrow \text{Regression: } \Delta_{t,t+1} \log Pop_i = \alpha \text{Div}_i + X_i \beta + \epsilon_{it} \]

(in the extreme case of perfect mobility the regression is
\[ \Delta_{t,t+1} \log Pop_i = \alpha \Delta_{t,t+1} \text{Div}_i + X_i \beta + \epsilon_{it} \]

We don’t know what we test! (and writing one model is not enough)
To conclude on theory

Theory is fundamental:

• It tells us what we are assuming and will be estimating
• It forces us to be consistent (internally but also externally)
• It tells us which regression(s) we should implement
• It highlights identification problems (and sometimes proposes solutions)
• It generates side predictions
Empirical identification: Instrumental variables

Example: Duranton and Turner (2011)

• Regression: $\Delta_{t,t+1} \log Pop_i = -\alpha Road_{it} + X_i \beta + \epsilon_{it}$

• Problem: $Road_{it}$ and $\Delta_{t,t+1} \log Pop_i$ are simultaneously determined

• Possible solution: instrument $Road_{it}$ par $Road_{i0}$ (i.e., 1947 highway map, 1898 railroads, Exploration routes since 1535)

• Results: $\alpha_{OLS} \approx 0.05$ et $\alpha_{IV} \approx 0.15$
However

- Must satisfy relevance condition: \( \text{Cov}(\text{Roads}_{i0}, \text{Roads}_{it} | .) \neq 0 \)
  Can be tested

- Must satisfy exclusion restriction: \( \text{Cov}(\epsilon_{it}, \text{Roads}_{i0} | .) = 0 \)
  Cannot be tested. Instead:
  - Argue the logic of the IV
  - Think about possible violations of the exclusion restriction
  - Use further controls to preclude undesired correlations with the error
  - Use different instruments
  - Perform overidentification tests (when meaningful)
  - Produce out of sample evidence to explain any OLS-IV difference
**Identification: alternative approaches**

- Controlled experiments are mostly ruled out on that topic.
- But natural experiments like the bombing of Japan or the iron curtain (Davis and Weinstein AER 2002 or Redding and Sturm AER 2008).
- Discontinuities (Holmes JPE 1998, Greenstone Hornbeck and Moretti JPE 2010).
The growth of cities: a summary of results

Four main engines of growth

- Amenities (Rappaport RSUE 2007, Glaeser and co-authors, Carlino and Saiz 2010)
- Human capital (Glaeser, Scheinkman, and Shleifer JME 1995, Glaeser and other co-authors, Moretti bc 2004)
- Roads and transportation (Duranton and Turner 2011)
- (Chance)
Three secondary engines of growth

- Zoning and regulations (Glaeser, Gyourko, and Saks JoEG 2006, Glaeser and co-authors, Saiz QJE 2010)
- Housing durability (Glaeser and Gyourko JPE 2005)
- Relative location and market potential (Redding and Sturm AER 2008)
Possible engines we know little about:

- Local policies and local governments
- Innovation
- ICT revolution
- Other supply shocks?
Conclusions

• Robust factors of urban growth start being isolated but much remains to be confirmed

• Others factors to be explored

• Empirical work on random urban growth remains superficial

• Lots remains to be learnt outside the us and a few European countries

• Gradually better models and better empirical methods