The growth of cities

Gilles Duranton

University of Toronto

NARSC presidential address

Miami, 10 November 2011

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: $Pop_i = \frac{R_i(0) - \underline{R}}{\tau_i}$
- Assumption: imperfect mobility across cities
  $Pop_{i,t+1} = (Pop^*_{i,t+1})^{\gamma}(Pop_{i,t})^{1-\gamma}$

$\Rightarrow$ Regression: $\Delta_{t,t+1} \log Pop_i = -\alpha \log Pop_{i,t} - \gamma \log \tau_i + \epsilon_{it}$

But I don't know what is τ

- A link between τ and observables must be specified:
  $\tau_i = g(Roads_i)$
- The supply of roads must be spelled out:
  $Roads_{i,t+1} = G(Roads_{i,t}, \Delta_{t,t+1} Pop_i)$

$\Rightarrow$ Roads are endogenous but $Roads_0$ 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 ΔPop_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

$\Rightarrow$ Regression: $\Delta_{t,t+1} \log Pop_i = \alpha Div_i + X_i \beta + \epsilon_{it}$

All is well?

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

- Production: $Y_i = f(L_i) K_i^a L_i^{1-a}$
- Accumulation: $\Delta_{t,t+1} K_i = \theta K_i^b$
- Assumption: $f(L_i) = Div_i$ (again)
- Assumption: imperfect mobility
  $Pop_{i,t+1} = (Pop^*_{i,t+1})^\gamma (Pop_{i,t+1})^{1-\gamma}$

$\Rightarrow$ Regression: $\Delta_{t,t+1} \log Pop_i = \alpha Div_i + X_i \beta + \epsilon_{it}$

(in the extreme case of perfect mobility the regression is $\Delta_{t,t+1} \log Pop_i = \alpha \Delta_{t,t+1} Div_i + X_i \beta + \epsilon_{it}$

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: $\Delta_{t,t+1} \log Pop_i = -\alpha Roads_{it} + X_i\beta + \epsilon_{it}$
- Problem: $Roads_{it}$ and $\Delta_{t,t+1} \log Pop_i$ are simultaneously determined
- Possible solution: instrument $Roads_{it}$ par $Roads_{i0}$ (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: $Cov(Roads_{i0}, Roads_{it}|.) \neq 0$
  Can be tested
- Must satisfy *exclusion restriction*: $Cov(\epsilon_{it}, Roads_{i0}|.) = 0$
  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)
- Agglomeration (Glaeser, Kallal, Scheinkman, and Shleifer JPE 1992, Henderson, Kuncuro, and Turner JPE 1995)
- (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