Learning about Cities from Social Interactions Research

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Outline

- Motivation
- Individuals' decisions
- Firm's decisions
- Social interactions and the Alonso-Muth-Mills model
- Urban macro
- Urban emergence
- Urban macro and growth
- Conclusions

Motivation: What are social interactions all about?

Moliére *Le Bourgeois Gentilhomme* 1670. "Act Two. Scene IV"
PHILOSOPHY MASTER: [E]verything that is not prose is verse, and everything that is not verse is prose.
MONSIEUR JOURDAIN : And when one speaks, what is that then?
PM: Prose.
MJ: What! When I say, "Nicole, bring me my slippers, and give me my nightcap," that's prose?
PM: : Yes, Sir.
MJ: By my faith! For more than forty years I have been speaking prose without knowing anything about it, and I am much obliged to you for having taught me that.
Social interactions: Direct, agent-to-agent effects that are not mediated by the market. Not unlike externalities, though not a side show.

Examples

Social interactions: engaging in social interactions "without knowing anything about it."

- Learning new skills and influencing our choices.
- Recycling and composting because others do;
- Spending money to send our kids to schools with smart kids, or avoiding schools with too smart kids;
- Chance encounters in Silicon Valley or Austin, Texas bars lead to ideas for software innovations;
- gaining weight; attending church, synagogue or mosque; joining a gym or a country club; supporting a sports team; keeping up with college friends in person or on Facebook; enforcing, or failing to enforce, building code and zoning violations;

Examples, cont'd

Recent observation: faculty in departments with more widely cited department chairs are more productive.

If yes, what is the mechanism? Chair elicits higher productivity among his/her colleagues? By mentoring?

Chair creates environment conducive to research, by hiring people the right people?

Then, professors with similar characteristics exhibit similar productivity?

"Follow the leader"?

All of the above?

Definitions

- Widely cited department chair and research productive faculty: competing explanations.
  Professors with similar observable or unobservable characteristics have similar productivity? *Correlated effect*
  "Follow the leader"? *endogenous social effect*.
  Chair creates environment conducive to research, by hiring the "right" people? *Contextual effect*
  All of the above? Important to distinguish their relative contributions.
- For individuals in residential neighborhoods, schools, workplace, random encounters, serendipity
- For firms: proximity to suppliers, and to competitors; main ingredient of new economic geography
- For individuals: neighborhood effects, peer effects, role models

Picture of the book

- For *individuals* in residential neighborhoods, schools, workplace, random encounters, serendipity:
  choice of neighborhood implies choice of neighborhood effects, structure of neighborhoods, cities, regions, countries.
- For *firms*: location decision influenced by proximity to workers, suppliers, and competitors; main ingredient of new economic geography
- Chapter 3: location decisions of individuals. Chapter 4: location decisions of firms
- Chapters 3 and 4: *proximity* defined as *group membership*.
- Chapter 5: Economic agents operate in actual physical space, defined as *distance* between each other, to urban centers within cities.
- Chapter 6: Emphasizes the role of social interactions in *human capital spillovers*; links empirical findings, from the more microeconomic treatment of the chapters 3, 4, 5, with the aggregative city-level models that follow in Chapters 7, 8 and 9.
  So: from basic facts about spatial patterns of wages and productivity. moving from states, regions, and counties, down to cities and their neighborhoods.

Social interactions as an overarching theme

- Larger size, greater variety of intermediate goods: agglomeration of activities raises urban productivity;but, congestion is costly.
- Intracity location equilibrium; intercity location equilibrium; intercity trade. Variety of city types: specialized, diversified, satellite; Geography via shipping costs
- Chapters 7, 8, 9: city as unit of analysis — *urban macro*
- Chapter 7: Different city sizes associated with different city functions
- Chapter 8: takes up the single empirical fact about city sizes throughout the world that has generated interest much beyond economics: Zipf's law!
- Chapter 9: takes up economic growth in economies made up of cities: isolated vs. trading cities
- Chapter 10: speculates about the prospect for deeper understanding of social interactions in spatial settings, and second, of their significance for the functioning and future role of cities and regions.

Individuals' location decisions to neighborhood formation

People in choosing where to live try to do their best with their resources in the neighborhoods where they choose to locate

- When my neighbors upgrade their house by remodeling it, or just keeping up its maintenance in ways that shame me, they give me an incentive to maintain my house, too:

  endogenous social effect, originates in deliberate decisions by other members of my milieu.

- Individuals may value the actual characteristics of others in their social and residential milieus: *exogenous,* or *contextual* effects, and are also *social* effects.

  People with kids like to live in neighborhoods where people have kids

  Proxy when you house hunt: look for pamper boxes in their trash!

- Individuals acting similarly because they have similar characteristics (or face similar institutional environments): *correlated* effects.

  People living near others of the same ethnic group.

Neighborhoods, cities, regions: characterized by distributions of attributes and demographic characteristics, resulting from individuals' decisions: *"character!"*

Schelling's Models of Spatial Clustering

- Social interactions in Schelling (1978), p. 147, a location model: "self-forming neighborhood model."

  Individuals choose among locations on a lattice (checkerboard) on the basis of their preferences over the skin color of their neighbors. Schelling's location model is explicitly spatial and aims at explaining spatial equilibrium patterns in residential segregation across neighborhoods.
- Schelling (1978) p. 155, "bounded-neighborhood model", commonly known as Schelling's *neighborhood tipping model*: how neighborhood composition "tips" in favor of particular groups and produces clustering of racial groups.

In Schelling's own words, "[t]hat kind of analysis explores the relationship between the behavior characteristics of the *individuals* who comprise some social aggregate, and the characteristics of the *aggregate*" [*ibid.*, p. 13]. How social outcomes, that may well be unintended, reflect magnification of individual propensities.

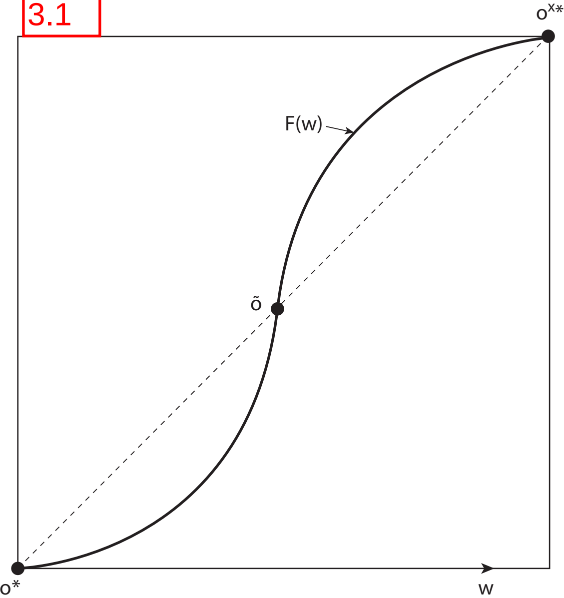
Schelling's neighborhood tipping model

Individual j, white, would live in a neighborhood if percentage of whites among her neighbors, $o \in [0, 1]$, is at least $\tilde{o}_j, o \geq \tilde{o}_j$, where $\tilde{o}_j$ is j's threshold, a preference characteristic. Otherwise, individual j exits. The higher is $\tilde{o}_j$, the less tolerant is individual j. [Easterly (2009)]

Individuals' thresholds $\tilde{o}_j$, distributed in the neighborhood in question according to $F(\tilde{o})$: For any neighborhood with a share of white residents equal to o, the percentage of white individuals who would be willing to live there are those with thresholds exceeding o. Their share is given by the value of the cumulative distribution function at o, $F = F(o)$, whose support is $[0, 1]$.

- See on Figure 3.1

3.1



Schelling's neighborhood tipping model: Empirics

Are stable, economically and racially mixed neighborhoods feasible? Can vigilant policy tools (zoning, and mandates of mixed income housing) counter market forces driving segregation?

- Card, Mas, and Rothstein (2008a; 2008b) first direct evidence in support of Schelling's prediction that segregation is driven by preferences of white families over the (endogenous) racial and ethnic composition of neighborhoods.

  Neighborhood Change Database, panel of Census tracts, 1970 – 2000.
  White population flows exhibit tipping-like behavior in most cities;

  Tipping points range [5%, 20%] minority share.

  US cities vary

  Memphis, Birmingham: strongly held views against racial contact.

  San Diego, Rochester: weakly held views against racial contact.

- Easterly (2009): findings not consistent with instability; agreements and disagreements with Card, Mas, and Rothstein (2008b)

Schelling's neighborhood tipping model: Empirics cont'd

Evidence that micro-neighborhoods are quite mixed, in terms of income

Hardman and Ioannides (2004), Ioannides (2004)

Joint and conditional distributions portray neighbors' characteristics conditional on the kernel's housing tenure, race, and income. See Figure 3.2

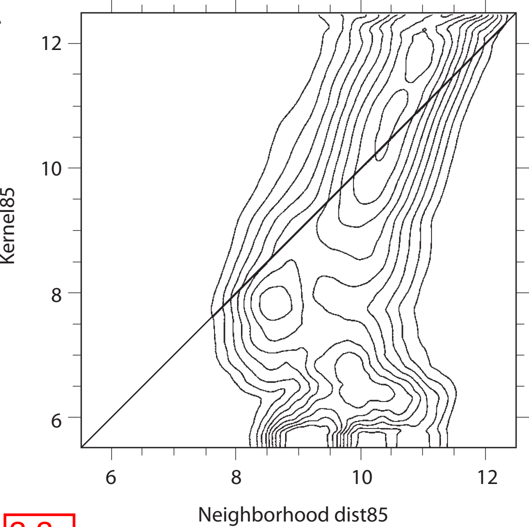
Wheeler and La Jeunesse (2008):

Between 80 and 90 percent of income variance within US urban areas driven by within-neighborhood differences rather than between-neighborhood differences.

Increasing numbers of foreign-born individuals increases income heterogeneity within but not between neighborhoods.

Rising educational attainment seems to influence both measures of inequality, stronger with income variation within neighborhoods.

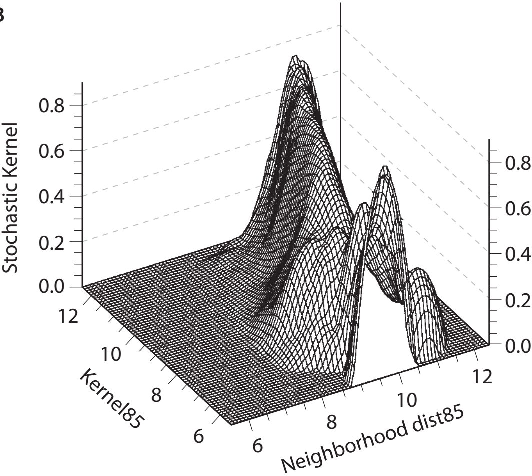
A



12
10
8
6
Kernel85
6
8
10
12
Neighborhood dist85

3.2
A-B

B



Stochastic Kernel
0.8
0.6
0.4
0.2
0.0
12
10
8
6
Kernel85
6
8
10
12
Neighborhood dist85
0.8
0.6
0.4
0.2
0.0

Joint neighborhood choice and housing demand

Data:
tract : $\ell = 1, \ldots, \mathcal{L}$; micro neigh : $k = 1, \ldots, K$; individual : j
Preferences:

$$\text{Utility }_{\ell kj} = \text{specific}_{j,\ell} \times \text{ utility }_{\ell kj} \times \text{random shock}$$

$$\text{utility }_{\ell kj}\left(\text{income}_j, \text{prices}; \text{social effects}_{kj}\right)$$

Micro theory provides *discipline*: $\text{Housing demand}_{\ell kj} =$

$(\text{income}_j, \text{price}; \text{own} z_j, \text{contextual effects } (\mathbf{Z}_k), \text{endog. social effect}_k)$

where $\text{endog. social effect}_k = \text{mean in } k \left\{\text{Housing demand}_{\ell kj}\right\}$.
Choice of neighborhood: $\max_{\ell,k}$: Utility $_{\ell kj}$
Ioannides and Zabel (2008): Tables 3.1, 3.2;
Associated hedonic price [Kiel and Zabel (2008)]: Table 3.3
Epple and Sieg class of models: sorting across communities.
Calabrese et al. also allow for contextual effect: community relative mean income.

Table 3.1.
Multinomial Logit Model for Choice of Census Tract or Residence: Census Tract- and Individual-Level Variables

Variable[a]	Coefficient (1)	Standard Error (2)	Coefficient (3)	Standard Error (4)
Price	0.0009**	0.0004	0.0012***	0.0004
Median tract income	−0.0112**	0.0033		
Median tract income × income in 1st quartile			−0.0447**	0.0052
Median tract income × income in 2nd and 3rd quartiles			−0.0221**	0.0041
Median tract income × income in 4th quartile			−0.0030	0.0046
Median tract rent	−0.0011**	0.0003		
Median tract rent × income in 1st quartile			−0.0008	0.0006
Median tract rent × income in 2nd and 3rd quartiles			−0.0014**	0.0004
Median tract rent × income in 4th quartile			−0.0008	0.0006
Median age of house	0.0048**	0.0016		
Median age of house × income in 1st quartile			0.0124**	0.0029
Median age of house income in 2nd and 3rd quartile			−0.0029	0.0024
Median age of house income in 4th quartile			0.0147**	0.0030
Fraction of vacant units	−2.9517**	0.4040		
Fraction of vacant units × income in 1st quartile			−1.0985	0.6856
Fraction of vacant units × income in 2nd and 3rd quartile			−3.4039**	0.5890
Fraction of vacant units × income in 4th quartile			−7.8333**	1.0788
Fraction owners	1.9387**	0.1543		
Fraction owners × income in 1st quartile			2.6062**	0.2521
Fraction owners × income in 2nd and 3rd quartile			2.0889**	0.1918
Fraction owners × income in 4th quartile			1.2589**	0.2371
Fraction non-white in tract	0.5054**	0.1412		
Fraction non-white in tract × white			−0.6533**	0.1751
Fraction non-white in tract × nonwhite			4.4078**	0.2946
Dominant race	0.2732**	0.0873		
Dominant race × HH head white			−0.1862	0.1182
Dominant race × HH head nonwhite			0.5681**	0.1893
Fraction with HS degree in tract	0.2863	0.2199		
Fraction with HS degree × no HS degree			−3.9459**	0.3479

Fraction with HS degree × HS degree			−0.2363	0.2642
Fraction with HS degree × college degree			4.0347**	0.3570
Median number of bedrooms	0.0772*	0.0371		
Median bedrooms × HH size in 1st quartile			−0.2141**	0.0555
Median bedrooms × HH size in 2nd and 3rd quartiles			0.0507	0.0834
Median bedrooms × HH size in 4th quartile			0.0139	0.0776
Median bedrooms × HH head married			0.2347**	0.0629
Median age of residents	−0.0113**	0.0035		
Median age of residents × age HH head in 1st quartile			−0.0399**	0.0083
Median age of residents × age HH head in 2nd and 3rd quartile			−0.0197**	0.0064
Median age of residents × age HH head in 4th quartile			0.0125*	0.0063
Median age of residents × HH head married			−0.0051	0.0061
FML5Y	−0.0663	0.2035		
FML5Y × age HH head in 1st quartile			0.9450**	0.3216
FML5Y × age HH head in 2nd and 3rd quartiles			−0.0984	0.2619
FML5Y × age HH head in 4th quartile			0.5558	0.3271
Fraction with commute <20 min	1.0514**	0.1533	1.6299**	0.2831
Fraction with commute <20 mins × HH head male			−0.5985	0.3251
Fraction unemployed	−5.8221**	0.7005	−8.3819**	0.7578
Fraction in poverty	−2.3356**	0.3416	−3.4528**	0.3773
Natural log of tract size	−0.0253	0.0300	−0.0146	0.0311
Observations	70,092		70,092	
Log likelihood	−14, 154.6		−12, 791.7	
χ^2 Significance, all variables	0.000		0.000	
Pseudo R^2	0.0736		0.1628	

Source: Ioannides and Zabel (2008)

Robust standard errors are in parentheses. * Significant at 5%; ** significant at 1%.

[a] HH, household; HS, high school; FML5Y, family moved in last 5 years.

Table 3.2.
Estimation Results for Structure Demand Equation

Variable[a]	One Member per Cluster (1)	One Member per Cluster (2)	All Cluster Members Included (3)	All Cluster Members Included (4)	All Cluster Members Included (5)
Year is 1989	0.0275	0.0347	0.0165**	0.0231	0.0369
	(0.0246)	(0.0247)	(0.0064)	(0.0232)	(0.0224)
Year is 1993	−0.0046	0.0004	0.003	0.0007	0.0038
	(0.0226)	(0.0229)	(0.0055)	(0.0142)	(0.0141)
Mean of observed demand by neighbors			0.8395**		
			(0.0141)		
Mean of predicted demand by neighbors				0.8504**	0.7254**
				(0.1748)	(0.1639)
Log of price	−0.1808**	−0.1784**	−0.0644**	−0.0772	−0.1319
	(0.0284)	(0.0292)	(0.0133)	(0.0756)	(0.0714)
Log of neighborhood price	0.2445**	0.2086**	0.0254*	−0.0624*	−0.0443
	(0.0382)	(0.0386)	(0.0111)	(0.0312)	(0.0299)
Log of income	0.2058**	0.2106**	0.0459**	0.0790**	0.0806**
	(0.0278)	(0.0277)	(0.0070)	(0.0073)	(0.0073)
Household size	0.0290**	0.0292**	0.0248**	0.0243**	0.0242**
	(0.0074)	(0.0074)	(0.0017)	(0.0020)	(0.0020)
Completed high school	0.0057	0.008	0.0178*	0.0221**	0.0209**
	(0.0297)	(0.0298)	(0.0072)	(0.0078)	(0.0077)
Changed hands in last 5 years	−0.0365	−0.0356	0.0054	−0.0033	−0.0036
	(0.0202)	(0.0203)	(0.0049)	(0.0055)	(0.0055)
White	−0.0612*	−0.0647*	−0.0115	−0.0227*	−0.0240*
	(0.0283)	(0.0320)	(0.0095)	(0.0099)	(0.0095)
Married	−0.1209**	−0.1200**	−0.0150*	−0.0137	−0.0131
	(0.0295)	(0.0290)	(0.0069)	(0.0077)	(0.0077)

Mean of neighbors' log income			0.0211	0.002	0.0609
			(0.0149)	(0.0796)	(0.0752)
Mean of neighbors' HH size			−0.0212**	−0.0188*	−0.0184
			(0.0042)	(0.0095)	(0.0095)
Percentage of neighbors completed HS			−0.0194	−0.0195	−0.0181
			(0.0173)	(0.0389)	(0.0387)
Percentage of neighbors who moved in last 5 years			−0.0179	−0.0148	−0.0288
			(0.0114)	(0.0301)	(0.0295)
Percentage of neighbors nonwhite			0.0142	−0.0185	0.0048
			(0.0126)	(0.0348)	(0.0334)
Percentage of neighbors married			0.0188	−0.0023	0.0003
			(0.0173)	(0.0399)	(0.0397)
Constant	−4.3003**	−4.3919**	−0.4949**	−0.2659	−0.7045
	(0.3182)	(0.3466)	(0.1044)	(0.6222)	(0.5887)
Observations	764	764	6372	6372	6372
Mean Observations per cluster	1	1	8.3	8.3	8.3
Heckman correction	No	Yes	Yes	Yes	No
P-value, Heckman terms		0.0004	0.4059	0.0409	
P-value, own socioeconomics	0.0000	0.0000	0.0000	0.0000	0.0000
P-value; neighbor socioeconomics			0.0000	0.3163	0.2120
R^2 overall	0.2388	0.2652	0.6155	0.4007	0.3993
Standard error of random effect				0.1355	0.1345
Standard error of regression	0.2434	0.2409	0.0460	0.1584	0.1586
Percent Variance due to random effect				0.4232	0.4197

Source: Ioannides and Zabel (2008).
Robust standard errors are in parantheses. * Significant at 5%; ** significant at 1%.
[a] HH, household; HS, high school.

lowercase [EA]

Table 3.3.
Hedonic Regression with Neighborhood Information: Log of Owner's Valuation

lowercase (2x) [EA]

Variable	(1) Cluster Variables: Yes	(2) Cluster Variables: Yes	(3) Cluster Variables: No
Log of Price	0.677**		1.022**
	(0.083)		(0.064)
Log of Tax	−0.248**		−0.240**
	(0.031)		(0.032)
Central city	0.061		0.0005
	(0.044)		(0.044)
Age of house	0.006		0.007
	(0.004)		(0.004)
Age of house, squared	−0.007		−0.008*
	(0.004)		(0.004)
Garage	0.047		0.072
	(0.047)		(0.050)
Number of bedrooms	0.046		0.047
	(0.024)		(0.025)
Number of full baths	0.100**		0.123**
	(0.023)		(0.023)
Number of rooms	0.021		0.022
	(0.015)		(0.015)
Air conditioning	−0.076		−0.067
	(0.042)		(0.043)
Length of tenure	−0.012**		−0.012**
	(0.004)		(0.004)
Length of tenure, squared	0.026**		0.026**
	(0.009)		(0.009)
Log of lot size	0.053*		0.045*
	(0.022)		(0.022)
Log of unit ft, squared	0.202**		0.233**
	(0.055)		(0.057)
Variable at Cluster, Tract	**Cluster**	**Tract**	**Tract**
Log of Permanent income	0.372**	0.354**	0.520**
	(0.066)	(0.108)	(0.103)
Log of Median age of owner	0.168	0.175	0.172
	(0.161)	(0.150)	(0.151)
Proportion nonwhites	0.029	−0.263	−0.282
	(0.121)	(0.145)	(0.083)
Proportion over 25, completed high school	−0.054	0.302	0.414
	(0.122)	(0.224)	(0.227)
Proportion vacant	0.063	0.221	0.208
	(0.194)	(0.513)	(0.532)
Proportion changed hands last 5 years	0.125	−0.302	−0.276
	(0.097)	(0.278)	(0.284)

lowercase (2x) [EA]

Table 3.3.
Continued.

Variable at Cluster, Tract	Cluster	Tract	Tract
Proportion owned	0.097	−0.471*	−0.486*
	(0.125)	(0.198)	(0.202)
Observations	764		764
Number of houses	392		392
R^2 within	0.469		0.467
R^2 between	0.699		0.681
R^2 overall	0.707		0.687

Source: Kiel and Zabel (2008).
Robust standard errors are in parentheses. * Significant at 5%; ** significant at 1%.

The Kiel and Zabel (2008, 184, table 3) hedonic estimates, reproduced here in table 3.3, are obtained with cluster random effects and robust standard errors. They confirm the notion that cluster, tract, and MSA ("location, location, location," three L's in their words) variables are generally highly significant in the house price hedonic equation (columns 1 and 2, which report a single regression). When the attributes of these different aspects of location are alternatively excluded from the regression, the percentage increases in the standard error are quite similar: 2.2 percent, 2.3 percent, and 2.7 percent, respectively. This indicates that each of the three L's is similarly important in determining house price. Kiel and Zabel also report results when data on clusters are excluded, column 3, which are after all a very special feature of the AHS. Doing so does not affect the estimates for the coefficients of dwelling attributes much (reported in column 3, upper panel), nor those for the census tract attributes (reported in column 3, lower panel). Yet, it is particularly noteworthy that the coefficient of the MSA-specific price index increases from 0.677 to 1.022. This indicates that the cluster variables are important in housing values and relevant for the construction of house price indices.

These results suggest that the concept of neighborhood is multifaceted. Individuals indeed care about the quality of neighborhoods at several levels ("scales"). The information at the levels of cluster, tract, and MSA can be highly correlated, but there is also independent information at those different levels each of which has a significant impact on the willingness to pay for a house in a given location. This accords with the notion that different small neighborhoods have different characters, and that their uniformity and/or diversity confers character on higher-level neighborhoods. These facts are of course very hard to measure directly, but arguably the approaches discussed here constitute a start.

While the use of the hedonic price function here is empirically well grounded, recalling the generalization of the Nesheim model in section 3.3.1 suggests that hedonic estimations are not separable from the estimation of

Social interactions and location decisions of firms

Chapter 4 providing an overarching framework for expressing location decisions of firms:
Can effect of firm's proximity to other firms in the *same* industry is separately identifiable from other factors, such as those of proximity to firms in *other* industries, the size of the total urban economy, availability of a suitable labor force.
Pleasant weather and other physical amenities attract individuals and firms: where might individuals' and firms' evaluations diverge?
Marshall's typology *is* social interactions [MJ: "... I have been speaking prose ..."]

- labor market pooling for workers with specialized skills favors both workers and firms.
- availability and variety of nontraded inputs (including natural amenities) is valuable to all firms in an industry.
- information exchanges, deliberate, inadvertent?

Firms' decisions and social interactions, cont'd

Basic model: Koopmans–Beckmann's choice model of firms among sites, where productivities differ, *add*:

- interdependence of firms' decisions (endogenous interactions), shocks
- logit model of firms' location decisions with direct form interdependence: Prob firm k chooses ℓ :

$$p_{k\ell} = \frac{e^{\varpi\left(a_{k\ell} - \sum_{k'} \sum_j b_{kk'} c_{\ell j} \mathcal{E}\left\{p^k_{k'j}\right\} - \varrho_\ell\right)}}{\sum_{i=1}^L e^{\varpi\left(a_{ki} - \sum_{k'} \sum_j b_{kk'} c_{\ell' j} \mathcal{E}\left\{p^k_{k'j}\right\} - \varrho_i\right)}}, \ k, \ell = 1, \ldots, L.$$

Given site rents, ϱ_ℓ, can solve for $p_{k\ell}$'s, assuming $\mathcal{E}\left[p^k_{k'j}\right] = p_{k'j}$.

All sites are occupied, determines relative rents: $\varrho'_\ell = \varrho_\ell - \varrho_1$.

$$\sum_{k=1}^{L} p_{k\ell}(\varrho_1, \ldots, \varrho_L) = 1, \ \ell = 1, \ldots, L.$$

Agglomeration, localization and urbanization effects

a *localization externality effect*, a.k.a. *Marshall–Arrow–Romer effect*, on firm k's decision: $\hat{p}^{k}_{k'j}$'s;
Measured by shares of employment in locations j by different firms in the same industry, $k' \in \mathcal{K}_j$
urbanization (Jacobs) externality: shares of employment in location j by *all other* industries, $k' \in \mathcal{K}_j$.
gross profit function, firm k industry g, at site ℓ :

$$\pi_{kg\ell} = \theta \mathbf{z}_{g\ell} + \eta_{g\ell} + \epsilon_{kg\ell}, \ell = 1, \ldots, L, \; g = 1, \ldots, G.$$

$\eta_{g\ell}$, depends only on the industry, $\epsilon_{kg\ell}$, random error I.e. wages more important for textiles; small vessel manufacturing need not be near ocean. If $\epsilon_{kg\ell}$, $\sim$ extreme-value, logit:

$$P_{kg\ell}(\eta_{g\ell}) = \frac{e^{\varpi[\theta \mathbf{z}_{g\ell} + \eta_{g\ell}]}}{\sum_{j=1}^{L} e^{\varpi[\theta \mathbf{z}_{gj} + \eta_{gj}]}} = \frac{\lambda_{g\ell} e^{\varpi \eta_{g\ell}}}{\sum_{j=1}^{L} \lambda_{gj} e^{\varpi \eta_{gj}}}.$$

Applications of firms' choice models

- Logit formulation accommodates large class of models, clarifies Ellison-Glaeser (dartboard approach) index.
- Other approaches:
  Dynamics;
  Industry case studies: advertising in NYC;
  Localization via geometric-distance: firm-to-firm distances less for firms in own industry.
- Identifying Agglomeration Spillovers from Quasi-Experimental Settings: "The Million Dollar Plants (MDP)" Unusual data: Greenstone, Hornbeck, and Moretti (2010): million dollar plants identified from industry publication, *Site Selection,* along with site selected and sites rejected.
  Work with TFP, Ξ_{kcjt} : increase in productivity, after accounting for all measured inputs.

Other Approaches to agglomeration

MDP's continued

Regressing TFP, Ξ_{kcjt}, against Win dummy, = if county c wins plant k, simple time trend, α_k, plant specific effect, μ_{jt} industry-specific time varying shock to TFP, λ_c a case-specific effect, and ϵ_{kcjt}, a random shock.

Estimated trends TFP's of incumbent plants in winning and losing counties are statistically equivalent in the 7 years before MDP.

Five years later, MDP opening associated with 12% relative increase in incumbent plants' TFP.

On average, incumbent plants' output in winning counties is $430 million higher 5 years later (relative to incumbents in losing counties), holding constant inputs.

Clear evidence of meaningful productivity spillovers from increased agglomeration.

New economic geography approaches, ala Krugman

Head and Mayer (2004a; 2004b)
Express value to a firm at a location in terms of market potential, an older concept by Harris, modernized by Krugman.

$$\text{market potential}_j = \sum_{\ell=1}^{L} \tau_{\ell j}^{1-\sigma} E_\ell \left(W_\ell\right)^{\sigma-1}.$$

Spending by consumers in other sites is adjusted for distance and local price index.

Head and Mayer find that market potential does matter for location choice of Japanese plants in the EU: a 10% increase in market potential raises the likelihood of a region's being chosen by 3% to 11%, depending on the specification. Krugman's real market potential does not perform as well as the *ad hoc* Harris measure. Additional agglomeration measures, such measures of preexisting Japanese plants, suggest important "path dependence," a form of social interactions. Firms' location decisions are susceptible to jurisdictional boundaries.

Social Interactions and the Alonso-Muth-Mills model

Dispersed amenities alter gradient of land rent, $R'(\ell)$:

$$R'(\ell) = -\frac{\mathcal{T}'(\ell)}{h^*(\ell)} + \frac{\mathcal{O}_3}{h^*(\ell)\mathcal{O}_2} a'(\ell).$$

Individuals value being near other individuals, firms value being near other firms: *sigmoid* distortion of land gradient. Land rents express value of (relative) proximity.

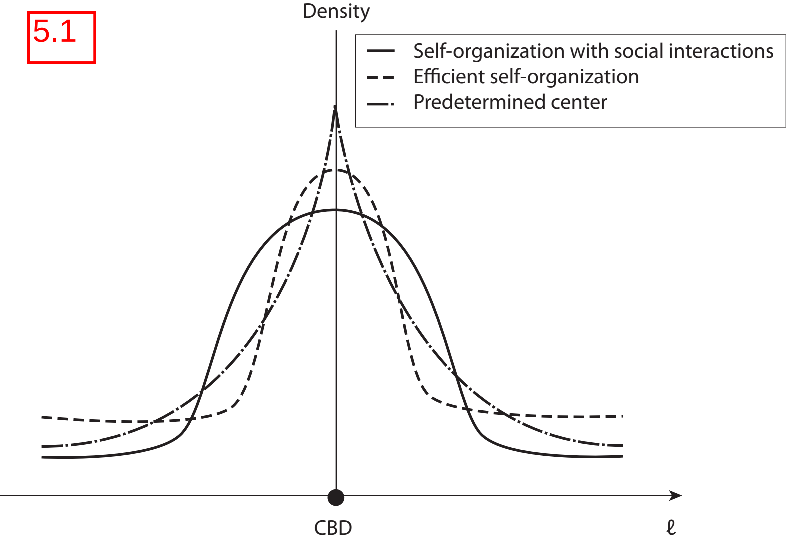
Individuals value the consumption of other individuals, now adjusted by distance [Rossi-Hansberg et al. (2010)]. Model used to evaluate Neighborhoods-in-Bloom, an urban renewal program, Richmond, VA:

$$\tilde{H}(\ell) = \delta \int_{\underline{\ell}}^{\bar{\ell}} e^{-\delta|\ell - s|} H(s) ds + H(\ell),$$

$$R(\ell) = \Upsilon - \tau\ell + \delta \int_{\underline{\ell}}^{\bar{\ell}} e^{-\delta|\ell - s|} H(s) ds - \beta^{-1}\bar{H}, \ \ell \in [-\bar{\ell}, \bar{\ell}].$$

Increases in land values consistent with externalities that fall exponentially with distance, by half per every 990 feet. Land prices in targeted neighborhoods up by 2% to 5%, p.a., above control neighborhood (Bellemeade). Increases translate into land value gains of \$2 – \$6 per dollar invested in the program, over 6 years.

5.1



Density
Self-organization with social interactions
Efficient self-organization
Predetermined center
CBD
ℓ

Urban macro

Chapter 7: Different city sizes associated with different city functions Build on *system-of-cities* [Henderson (1974)] perspective: essential trade off between advantages (based on NEG arguments) and disadvantages (congestion) of city size. Equilibrium vs. optimum city size.

Tackles ancient question — Plato's 7!; Aristotle's bounds — optimum city size.

Sectoral vs. functional specialization of cities; satellite cities; diversified cities. Intercity trade.

Chapter 8: takes up the single empirical fact about city sizes throughout the world that has generated interest much beyond economics: Zipf's law! Synthesis of economic theories and findings about city size distributions.

Chapter 9: takes up economic growth in economies made up of cities: isolated vs. trading cities

Static models of intercity trade and urban structure

Key modeling feature, urban activities benefit from spillovers, external to agents but internal to the economy – earlier idea, more rigorous by NEG. Different equilibrium prices, optimum sizes associated with city functions, urban structure.

Optimum urban structure

- External terms of trade: trading cities, sizes (N_X, N_Y):
  Both city sizes affect terms of trade and welfare at equilibrium.
- internal terms of trade diversified cities, size N:
  Only own city size matters. Greater net labor supply increases the terms of trade in good with the higher raw labor elasticity
- external terms of trade, frictional labor markets, sizes (N_X, N_Y):
  Greater size increases employment rate, congestion costs: net effect in terms of trade and welfare depend on parameter values.

Models provide basis for growth in a system of cities

Static models of intercity trade and urban structure

Different equilibrium prices, sizes associated with city functions

- External terms of trade: trading cities, sizes (N_X, N_Y):

$$\frac{P_X}{P_Y} = \text{parameters}(n_X, n_Y; \text{ship. costs}) \frac{N_Y^{\frac{1-u_Y}{\sigma-1}}}{N_X^{\frac{1-u_X}{\sigma-1}}} \frac{\left[1-\kappa N_Y^{\frac{1}{2}}\right]^{\frac{\sigma-u_Y}{\sigma-1}}}{\left[1-\kappa N_X^{\frac{1}{2}}\right]^{\frac{\sigma-u_X}{\sigma-1}}}.$$

- Internal terms of trade diversified cities, size N:

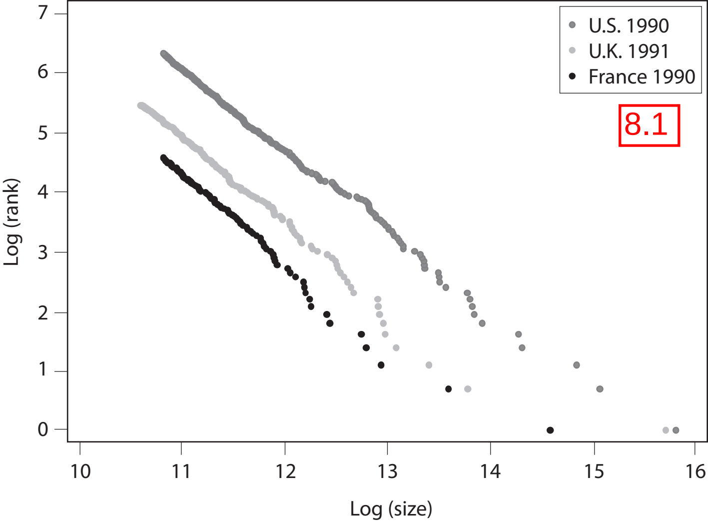
$$\frac{P_X}{P_Y} = \text{parameters} N \left[1-\kappa N^{\frac{1}{2}}\right]^{\frac{u_X-u_Y}{\sigma-1}}.$$

- External terms of trade, frictional labor markets, sizes (N_X, N_Y):

$$\frac{P_X}{P_Y} = \text{parameters}\left(n_X, n_Y; \text{ship. costs}\right) \frac{\left[1-\kappa_e N_Y^{\frac{1}{2}}\right]^{\frac{\sigma-u_Y}{\sigma-1}}}{\left[1-\kappa_e N_X^{\frac{1}{2}}\right]^{\frac{\sigma-u_X}{\sigma-1}}} \frac{\text{employment rate}_Y(N_Y)}{\text{employment rate}_X(N_X)}$$

Empirics of city size distributions; Zipf's law, power laws

- Zipf's law for cities $\ell n[\text{Rank}_\ell] = \bar{s}_o + \zeta \ell n S_\ell + \epsilon_\ell$. Figure 8.1
  Vast literature considers $\zeta = -1$ immutable law; it is *not*! See Ioannides et al. (2008)
- From Gibrat's law (urban growth rates are i.i.d.) : need extra assumptions [Gabaix]
  If unconstrained, limit distribution would be lognormal. Imposing a lower bound creates a mode at the lower tail, and thickens the upper tail, leading to a power law. Also obtained by Rossi-Hansberg and Wright (2007).
- Zipf's Law as a Special Case of Urban Growth Following Reflected Geometric Brownian Motion [Skouras]
- Approximate Zipf's Law as a Limit when Urban Growth Follows General Geometric Brownian Motion [Gabaix]
- Zipf's Law from a "Spatial" Gibrat's Law: mix of activities give rise to aggregation similar to accumulation of geometric shocks.
- Zipf's law from features of the physical landscape (rivers, ground waters)
- Zipf's law is not an immutable law [Dittmar]: study specific patterns of transition in Europe


U.S. 1990
U.K. 1991
France 1990
8.1
Log (rank)
Log (size)
0
1
2
3
4
5
6
7
10
11
12
13
14
15
16

ICT and Urban Structure

Ioannides, Overman, Rossi-Hansberg, and Schmidheiny (2008) find robust evidence that the adoption of the telephone to a more concentrated distribution of city sizes, and consequently more dispersion of economic activity in space. Some suggestive direct evidence that the internet had a similar effect. Further investigation ongoing.
Lisbon presentation
Pg. 18, Table 2, p. 222, Ioannides et al. (2008), Economic Policy.
Prediction: Consider an increase in mean phone lines by 1 S.D. The increase in phone lines per capita concentrates the distribution, by making the Zipf relationship steeper. If ICT improves, cities are not as large.For example, the share of cities with more than a million inhabitants is reduced by 0.6 percentage points. Since the share of cities with populations larger than a million is about 4.3%, this implies about a 14% decrease in the number of these large cities. This is a significant change in urban structure!

Table 2. Phone lines and the city size distribution

Dep. variable:	WLS				IV			
Estimated Zipf coefficient	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
log(phone lines per capita)	−0.146***	−0.109*	−0.054*	−0.100**	−0.124***	0.151	−0.091**	−0.117**
	(0.027)	(0.056)	(0.029)	(0.038)	(0.035)	(0.193)	(0.039)	(0.047)
Inverse road density		−0.335		0.168		−0.023		0.165
		(0.457)		(0.171)		(0.588)		(0.172)
log(country population)		−0.021		−0.111		0.031		−0.131
		(0.031)		(0.092)		(0.052)		(0.098)
log(GDP per capita), PPP		−0.103		−0.044		−0.368		−0.041
		(0.110)		(0.093)		(0.228)		(0.094)
Trade, % GDP		−0.161**		0.083*		−0.166*		0.085*
		(0.076)		(0.045)		(0.091)		(0.045)
Non-agric. sectors, % GDP		−0.408		0.320		−0.982		0.388
		(0.570)		(0.330)		(0.791)		(0.348)
Gov. expend., % GDP		−0.828***				−1.221***		
		(0.280)				(0.433)		
Std. dev. of GDP growth		−1.101				−4.270		
		(3.155)				(4.374)		
log(land area)		0.003				−0.041		
		(0.024)				(0.041)		
Number of cities/1000		−0.171				−0.179		
		(0.301)				(0.359)		
Time	0.002	0.003	−0.002**	0.001	0.001	0.002	−0.001	0.001
	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.003)	(0.001)	(0.002)
Constant	−1.495***	0.683	country fixed effects		−1.473***	3.995	country fixed effects	
	(0.033)	(1.603)			(0.039)	(3.006)		
R^2	0.344	0.675	0.807	0.845	0.336	0.537	0.798	0.844
Obs country-year	63	63	63	63	63	63	63	63
Obs countries	24	24	24	24	24	24	24	24

Notes: Standard errors in brackets. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. Within R^2 is reported for fixed effects models. Instruments are variables for public and private telephony monopoly, EU/EEC-, NAFTA-membership (see Table 3). Weighted least squares (WLS) is weighted by the inverse standard error of the estimated Zipf coefficient.

Intercity Trade and Convergent vs. divergent Urban Growth

- Identical individuals, overlapping generations demographic structure. Individuals work when young, consume in both periods of their lives, may move when old.
- Cities produce either one (specialized) or both (autarkic) of two manufactured tradeable goods, X, Y.

  Goods X, Y combine to produce a non-tradeable composite, used in turn for final consumption and investment.

  Manufactured goods are produced using raw labor, physical capital and intermediates.
- Preview of the law of motion [c.f. Ventura (2005)]:

  combination of weak diminishing returns and strong market size effects can lead to increasing returns to scale in each autarkic city.
- Model extended to allow for government investment to reduce urban transport costs, increase city size.

Preview of main results

- Economic growth in the presence of intercity trade in manufactured goods and free factor mobility.
  Cities specialize and thus an industry with greater economies of scale need not be weighted down and be forced to compete for resource with another industry, which exhibits lower economies of scale.
- Still, result: The law of motion for capital of the integrated economy has the same dynamic properties as its counterpart for an economy with autarkic cities:
  When cities specialize, its advantage is offset by the effect of its superior performance on the terms of trade.
  Different specialized cities grow in parallel, just as autarkic cities can growth in parallel.
  Unceasing growth possible, sustains a divergent pattern in city sizes.

Economic Integration, Urban Specialization, and Growth

- Open city model, free movement of labor: equalize utility
- Return to capital is equalized.
- Intercity trade in X, Y; could also have it in intermediates.
- Cities specialize in X, Y; produce their own intermediates.
- New law of motion: $K_{t+1} =$

$$S\left[n_X(1-\phi_X)\mathcal{N}_{\mathcal{X}} + n_Y(1-\phi_Y)\mathcal{N}_{\mathcal{Y}}\right]\left(\frac{K_t}{\bar{N}}\right)^{\alpha\mu_X\phi_X+(1-\alpha)\mu_Y\phi_Y},$$

where $\mathcal{N}_{\mathcal{X}}, \mathcal{N}_{\mathcal{Y}}$ functions of city populations.

Results

- elasticity of total savings with respect to capital same as in autarkic case:

$$\mu\phi + \upsilon \equiv \alpha\mu_X\phi_X + (1-\alpha)\mu_Y\phi_Y.$$

- Utility maximizing city populations are, again, proportional to: κ^{-2}.
- Real national income of the integrated economy: proportional to

$$(K_t)^{\alpha\mu_X\phi_X+(1-\alpha)\mu_Y\phi_Y}\ \bar{N}^{1-[\alpha\mu_X\phi_X+(1-\alpha)\mu_Y\phi_Y]}$$

  Constant returns to scale property at the national economy [Rossi-Hansberg and Wright (2007)].
- Intuition: industry (national) equilibrium with free entry of firms (cities), each operating with U-shaped average cost curves, may be described as operating with constant returns to scale, at unit cost equal to minimum average cost.

Urban growth empirics

- Random urban growth: i.i.d. shocks to TFP_j; i city specialized in j :

$$\ell n N_{i,T} \approx \ell n N_{i,0} + \frac{1}{\gamma - \sigma} \sum_{t=1}^{T} g_t^j.$$

  Need lower bound to get Pareto.

- Random urban growth with human capital accumulation: i.i.d. shocks to TFP_j; i city specialized in j :

$$\ell n N_{i,T} \approx \ell n N_{i,0} + \frac{\alpha + \sigma}{\gamma - \sigma} [\ell n h_{i,T} - \ell n h_{i,0}] + \frac{1}{\gamma - \sigma} \sum_{t=1}^{T} g_t^j.$$

  No longer Pareto, since: $\ell n h_{i,T} - \ell n h_{i,0} \approx T \text{function}(\bar{h}_{i,0})$.

- Urban growth (Barro-style) regression:

$$\Delta_{t+1,t} \ell n N_{i,t} = \beta_0 + \beta_1 \ell n N_{i,t} + D_{it} \beta_2' + \epsilon i, t.$$

  Estimates show mean reversion: $\beta_1 \in [-0.05, -0.02]$ See Black and Henderson (2003), Ioannides (2013), Table 8.1, p. 390.

Black and Henderson (2003): The Determinants of Relative Urban Growth

Variable	(i)	(ii)	(iii)	(iv)
ℓn[heat^{o}days]	-0.095^{**}	-0.102^{**}	-0.105^{**}	-0.113^{**}
	(0.015)	(0.015)	(0.015)	(0.015)
ℓn[prec/tion]	-0.075^{**}	-0.074^{**}	-0.087^{**}	-0.089^{**}
	(0.016)	(0.015)	(0.017)	(0.017)
Coastal	0.034^{**}	0.049^{**}	0.031^{**}	0.046^{**}
	(0.010)	(0.011)	(0.010)	(0.010)
MP			0.127^{**}	0.141^{**}
			(0.030)	(0.030)
$(\text{MP})^2$			-0.027*	- 0.028**
			(0.0065)	(0.0065)
$\ell n[\text{N}_{it}]$		- 0.023**		- 0.025**
		(0.0033)		(0.0034)
dummies	Yes	Yes	Yes	Yes*
R^2_{adj}	0.373	0.385	0.378	0.392

Standard errors in parentheses. * Significant at 10%. ** Significant at 5%.
Regional differences $<$ 1950, modest; NE consistently, but modestly slower.
1950–1980: all regions slowly than W, differential for S smaller.

Conclusions

So:

"Sets and the City: Urban Growth May Seem Chaotic, but Order Lies beneath." Douglas Clement, Editor, *The Region* Minnessota Fed, September 2004

"A national economy, like a living organism, shapes its internal structure so that the nation as a whole can expand on a stable course" [Clement (2004)].

THANK YOU!

Model

In city i, net labor , due to city geometry:

$$H_{it} = N_{i,t}\left(1 - \kappa_i N_{i,t}^{\frac{1}{2}}\right),$$

The law of motion, for capital:

$$K_{i,t+1} = (1-\phi) S \Xi^*_{i,t}\left(N_{i,t}\left(1 - \kappa_i N_{i,t}^{\frac{1}{2}}\right)\right)^{\mu(1-\phi)-\upsilon} K_{i,t}^{\mu\phi+\upsilon}. \quad (1)$$

The law of motion, for output:

$$Q_{i,t+1} = \hat{\hat{\Xi}}_{i,t} Q_{i,t}^{\mu\phi+\upsilon},$$

where $\Xi^*_{i,t}, \hat{\hat{\Xi}}_{i,t}$, a function of parameters.

Where do parameters come from?

- Preferences: $U_t = S^{-S}(1-S)^{-(1-S)} C_{1t}^{1-S} C_{2t+1}^{S}$
- Law of motion, autarky: $K_{t+1} = SN_t \left(1 - \kappa N_t^{\frac{1}{2}}\right) W_t.$
- Cost of Production of quantity Q_{Jt} of good $J = X, Y$:

$$B_{Jt}(Q_{Jt}) = \left[\frac{1}{\Xi_{Jt}} \left(\frac{W_t}{1-\phi_J}\right)^{1-\phi_J} \left(\frac{R_t}{\phi_J}\right)^{\phi_J}\right]^{u_J}$$

$$\times \left[\sum_m P_{Zt}(m)^{1-\sigma}\right]^{\frac{1-u_J}{1-\sigma}} Q_{Jt}$$

- Production of composite: $Q_t = Q_{Xt}^{\alpha} Q_{Yt}^{1-\alpha}$.
  The numeraire, its price $= 1$.

$$Q_t = C_t + K_{t+1}.$$

Back to the law of motion

The law of motion, for capital:

$$K_{i,t+1} = (1-\phi) S \Xi^*_{i,t} \left(N_{i,t} \left(1 - \kappa_i N_{i,t}^{\frac{1}{2}} \right) \right)^{\mu(1-\phi)-\upsilon} K_{i,t}^{\mu\phi+\upsilon}. \quad (2)$$

μ, ϕ, υ : defined in terms of fundamental parameters.
If "representative" industry strong diminishing returns and weak market-size effects: $\mu\phi + \upsilon < 1$,
then increasing physical capital reduces the output–capital ratio.
If "representative" industry has weak diminishing returns and strong market-size effects: $\mu\phi + \upsilon \geq 1$,
increasing physical capital increases the output-capital ratio.
Properties inherited by law of motion.

Investment in urban transportation

- Setting $N_{i,t}$ to maximize net labor supply:

$$H_{it} = N_{i,t}\left(1 - \kappa_i N_{i,t}^{\frac{1}{2}}\right),$$

yields: $N_{i,t} = \frac{4}{9}\kappa_i^{-2}$.
Other objectives (utility) qualitatively similar result.

- Invest in reducing κ to expand "city capacity."
- $\kappa_{i,t+1} \equiv \tilde{\kappa}_i \left(N_{it} k_{g,i,t+1}\right)^{-\eta},\ \eta, \tilde{\kappa} > 0.$

New law of motion:

$$K_{i,t+1} = S\left[(1-\phi)Q_{i,t} - N_{i,t} k_{g,i,t+1}\right].$$

Optimal investment in unit urban transportation cost

$$N_{it} k_{g,i,t+1} = \tilde{\eta}(1-\phi) Q_{i,t},$$

where:

$$\tilde{\eta} \equiv \frac{2\eta(\mu(1-\phi)-\upsilon)}{2\eta(\mu(1-\phi)-\upsilon)+S(\mu\phi+\upsilon-1)+1}$$

a function of parameters.

Optimal number of young (city size) grows endogenously:

$$\frac{\nu_{i,t+1}}{\nu_{i,t}} = (\mathcal{Z}_{i,t})^{2\eta}\, Q_{i,t-1}^{2\eta(2\eta[\mu(1-\phi)-\upsilon]+\mu\phi+\upsilon-1)}.$$

Divergent versus Convergent Autarkic Cities

If law of motion of city output, exhibits increasing returns to scale, then city sizes will grow.
That is, increasing returns to scale in city output are ensured if $\mu\phi + \upsilon$ exceeds 1, and $\mu(1-\phi) - \upsilon$ always positive.
Whether or not the number of cities grows depends on the rate of growth of population relative to the (endogenous) rate of growth of city size.

Recall Eaton and Eckstein (1997)

- *Parallel* urban growth would be a knife-edge case, where parameter values allow for a steady state, that is constant city output over time. This requires decreasing returns to scale in city output:

$$2\eta(\mu(1-\phi)-\upsilon)+\mu\phi+\upsilon<1,$$

- *Divergent* urban growth, as urban growth rates are larger for large cities, in the case of increasing returns to scale,
- *Convergent* growth is not possible in the long run in this model.