Evolution of the System of Cities under Globalization

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Stylized facts

Continuing urbanization is a world trand

Share of people in urban areas	1950	2009	2050 (forecast)
The world	28,8%	50,1%	68,7%
Developed countries	52,6%	74,9%	86,2%
Developing countries	17,6%	44,6%	65,9%

Importance as economic units

- about 80% of GDP created in cities
- creating and development of human and social capital
- source of economies of scale and scope

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⇒ declining significance of national governments

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Challenges for theory

- How and why did some distribution of cities emerge in the economy?
- What are the forces driving this process and what is the relationship between them?
- What can we expect from this distribution in the future?
- Is this process (constrained) efficient?

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Some references

- Henderson (1974): increasing returns lead to specialized cities
- Tabuchi (1998), Alonso-Villar (2008): bell-shaped curve of agglomeration
- Tabuchi & Thisse (2008): hierarchical structure
- Anas(2004): optimal deurbanization

Anas (2004)

Setup

World is **endogenous** number of cities.
Agglomeration forces:
increasing returns in production
love for varieties + transportation costs
Dispersion force:
increasing with a city size congestion
What is the social optimum (second best)?

Result

The only optimal trend is deurbanization (decreasing city size).

Anas (2004)

Possible artefact

Constant elasticity of substitution (CES) utility

Hypothesis

The result driven by CES function

Research aim

Extend the model on more general utility function
Examine robustness of Anas (2004) result

Model description

Main asumptions

- Endogenous number of cities
- Symmetric position of cities in terms of trade
  - symmetric position in space: located on a big circle trading through center
  - transportation costs do not depend on distance

Timing

Social planner chooses number of cities to maximize agents utility
Firms produce and price varieties of consumption good
Consumers buy consumption good

System of cities

Consumer's problem

Maximize additive separable utility function subject to budget constraint:

$$max \left\{ \iint\limits_{l \in L, j \in J} u(x_{lj})\, dldj \right\} s.t. \iint\limits_{l \in L, j \in J} p_{lj} x_{lj}\, dldj \leq (1 - \theta(N))w$$

They supply inelastically unit of labor for working for wage w and commuting two the work

$\theta(N)$ — congestion costs due to commuting depend on city size

System of cities

Consumer's FOC

Assuming interior solution (consumption of all goods) demand function:

$$p_{lj} = \frac{u'(x_{lj})}{\lambda}$$

where λ — Lagrange multiplier of budget constraint,
i.e. marginal utility of income
i.e. measure of the competition level in the market
Sufficient condition: $\lim\limits_{x \to 0} u'(x) = \infty$

System of cities

Producers

- Monopolistic competition a-la Dixit-Stiglitz(1977)
  Cost function : $c(y) = (cy + F)w$
- Sell product in all the cities
- Shipping of good to any city but the one of origin requires transportation costs:
  Iceberg type — shipping to the city i 1 unit of good requires sending from city j τ units
- Producers maximize total profit knowing demand functions
- There are no entrance barriers

System of cities

Producer's problem

Individual producer's problem:

$$max \left\{ \pi_{li} = (p_{li}^{i} - cw)Nx_{li}^{i} + \int\limits_{j \neq i} (p_{li}^{j} - wc\tau)Nx_{li}^{j}\, dj - Fw \right\}$$

Producer's FOC

$$\frac{\partial \pi_{li}}{\partial x_{li}^{i}} = N\left(\frac{u'(x_{li}^{i})}{\lambda} + \frac{u''(x_{li}^{i})x_{li}^{i}}{\lambda} - cw\right) = 0$$

$$\frac{\partial \pi_{li}}{\partial x_{li}^{j}} = N\left(\frac{u'(x_{li}^{j})}{\lambda} + \frac{u''(x_{li}^{j})x_{li}^{j}}{\lambda} - \tau cw\right) = 0$$

System of cities

Equilibrium

Focus only on the symmetric equilibria:

$$x_{li}^{i} = x^{h} \quad and \quad x_{li}^{j} = x^{f} \quad \forall l, i, j \neq i$$

Producer's FOC

Can rewrite as pricing rules:

$$p^{h} = \frac{cw}{1 - r(x^{h})} \quad p^{f} = \frac{\tau cw}{1 - r(x^{f})}$$

here $r(x) \equiv -\frac{u''(x)x}{u'(x)}$

System of cities

Free entry

Free entry condition brings firms to zero profit level:

$$\frac{Nr(x^h)x^h}{1-r(x^h)} + \frac{(P-N)\tau r(x^f)x^f}{1-r(x^f)} = \frac{F}{c}$$

Labor market clearance

Since congestion (commuting) costs are in time:

$$m(cNx^h + c\tau(P-N)x^f + F) = N(1-\theta(N))$$

here m — mass of firms in a city (equivalently, mass of varieties)

System of cities

Definition of Equilibrium

(Symmetric) trade **equilibrium** in a system with given number of cities

- consumption bundles (x^h, x^f) solving consumer's problem given prices (p^h, p^f, w)
- corresponding production bundles $(Nx^h, (P - N)x^f)$ solving producer's problem given λ and granting zero profit
- mass m of varieties producing in every city granting labor market clearing

Social optimum (second best)

Social planner maximizes equilibrium utility of representative agent as a function of N and P:

$$V(P,N) = m(P,N)(u(x^h(P,N)) + (P/N - 1)u(x^f(P,N))) \to \max_N$$

Solving this problem she gets optimal city size and number of cities given population of the system:

$$N^* = N^*(P) \quad and \quad n^*(P) = \frac{P}{N^*(P)}$$

Achievable with help of competitive developers

Internal structure of a city

City

Monocentric circle

Dwellers

- rent unit of land for renting
- divide unit of time between working and commuting to CBD

Rent

is collected by municipal officials and divided equally between dwellers

Stability

No costs of relocation within city $\Rightarrow$
Income and utility is the same in any point of a city

Internal structure of a city

Formally

- individual labor supply $H(r) = 1 - sr$
  with s — commuting time costs per unit of distance
- city size $\bar{r} = \sqrt{N/\pi}$
- aggregate labor supply $H = \int_0^{\bar{r}} 2\pi r H(r)\, dr = N(1 - kN^{1/2})$
- normalization $k \equiv 2s/3\sqrt{\pi}$
- individual income $I = (1 - kN^{1/2})w$ or $\theta(N) = kN^{1/2}$

Comparative statics

Increasing city size

Variable	$r'(x) < 0$	$r'(x) = 0$ (CES)	$r'(x) > 0$
x^h, x^f	$\downarrow$	$\downarrow$	$\downarrow$
p^h, p^f	$\uparrow$	0	$\downarrow$
m	$\uparrow$	$\uparrow$	$\uparrow$

Here $r(x) \equiv -\frac{\partial p}{\partial x}\frac{x}{p} \equiv -\frac{u''(x)x}{u'(x)}$, and $r_{u'}(x) \equiv -\frac{u'''(x)x}{u''(x)}$

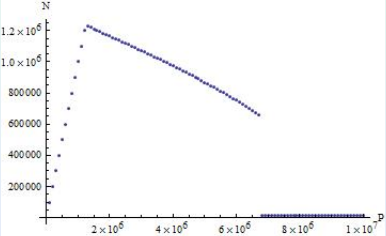
Comparative statics

Decreasing transportation costs

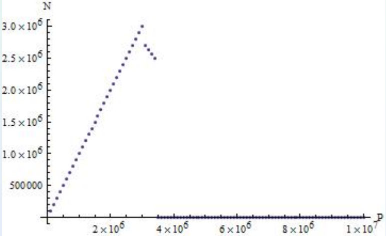
Variable	$r'(x) < 0$	$r'(x) = 0$ (CES)	$r'(x) > 0$
x^h	$\downarrow$	$\downarrow$	$\downarrow$
x^f	$\uparrow$	$\uparrow$	$\uparrow$
p^h	$\uparrow$	0	$\downarrow$
p^f	$\downarrow$	$\downarrow$	$\downarrow$

Social optimum

Start from example $u(x) = x^{\rho} + bx$
$b < 0 \Rightarrow r'(x) > 0$ — pro-competitive effect
$b > 0 \Rightarrow r'(x) < 0$ — anti-competitive effect



$\rho = 0.9,\ b = -1$



$\rho = 0.9,\ b = 0.5$

Limiting social optimum

Theorem: conditions

Let $u(x)$ satisfy following condition:

(i) $r_{u'}(x) \leq a_1 < 2$, i.e. $r_{u'}(x)$ separated from two;

(ii) $r(x) \leq a_2 < 1$, i.e. $r(x)$ separated from one;

(iii) For any city trade is beneficial, i.e. utility in the best autarchy equilibrium is lower than in trade equilibrium for any $N_{min} \leq N \leq N_{max}$.

Theorem: corollary

$\forall \overline{N}$ $N_{min} \leq \overline{N} \leq N_{max}$ there exist $\overline{P}$ such that $\frac{\partial V}{\partial N}(\overline{N}, P) < 0$ $\forall P > \overline{P}$.

In other words, with sufficiently high population of the system dispersion equilibrium is stable

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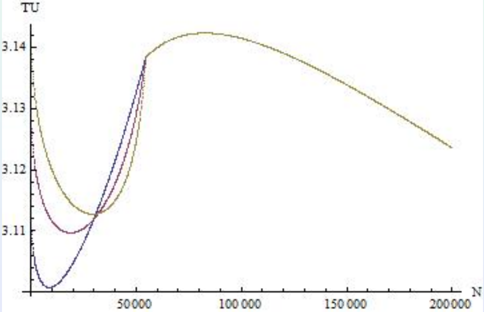
Corner solution (necessity of condition (iii))

Another example $u(x) = \ln(1 + x)$
Finite derivative in zero $\Rightarrow$ possible cut off from the "foreign"markets



Utility of representative dweller depending on the city size

What is Missing?

Model structure suggested by Anas does not allow for developing agglomerations

Our results call for changes

Possible directions of extension:

- addition of the spacial structure with immobile second sector
- addition of the economies of scale on city (not firm) level

Thank You for Your Attention!