Urban Networks: Connecting Markets, People, and Ideas

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World Bank Conference
The Rise of the South at a Crossroads
A View from East Asia and Latin America

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Network Formation and Urban Growth

- Do megacities outperform smaller but tightly connected cities?
- What are they key determinants of their differential performance?
- A pressing question for Europe
  - We love our historical cities and are invested in their preservation
  - Are we paying for our love of history?
- A pressing question for Asia and Latin America
  - How big a megacity is too big, especially in a developing country?
  - Renewed interest in dispersion and high-speed transit
Conceptual Distinction

City: Absence of space between people

1. Perfect mobility of workers across firms
2. Integrated single pool of entrepreneurial ideas
3. Commuting to work and to man-made amenities

Network: Distinct but connected cities

1. Mobility of skilled but not unskilled workers
2. More diverse but less free-flowing ideas
3. Separate markets for housing and amenities
City Growth

Network Expansion: Add cities to the urban network
  - Greater firm creation, higher income, higher welfare
  - But we don’t model the cost of network infrastructure

Consolidation: Tighten network links to create a megacity
  - Loss of diversity: innovation may decline
  - But consumption opportunities improve

Densification: Concentrate people but lose land
  - Consolidation with scarcity
  - The elasticity of housing supply is key
Entrepreneurship

- Firm creation through recombinant growth
  - Jacobs (1969) and Weitzman (1998)
- Skilled workers \((H_{c,t}, H_r)\) and old firms \(N_{c,t-1}\) create new firms \(N_{c,t}\)
  \[
  N_{c,t} = \alpha_{c,t} N_{c,t-1}^\mu H_{c,t}^\eta H_r^\nu
  \]
  - City-specific productivity \(\alpha_{c,t}\)
  - Elasticities \(\mu, \eta\) and \(\nu\) with \(\mu + \eta + \nu > 1\)
- Localized entrepreneurial knowledge spillovers
  1. Within city \(c\) only: \(H_{c,t}^\eta\)
  2. Within the whole urban network \(r\): \(H_r^\nu\)
Endogenous Consumption Amenities

- A resident $i$ of city $c$ has utility

$$u_{i,c,t} = h_{i,c,t}^{\tau} q_{i,c,t}^{1-\gamma_i-\tau} (g_{i,c,t} G_{c,t})^{\gamma_i}$$

  - Consumption of housing $h_{i,c,t}^i$, numeraire $q_{i,c,t}^i$, amenities $g_{i,c,t}^i$
  - Positive spillovers in consumption: $G_{c,t}$

- Amenities are localized in space and persistent over time

$$G_{c,t} = \Gamma_{c,t} G_{c,t-1}^{1-\phi} (\bar{\gamma} Y_{c,t})^\phi$$

- Endogenous amenities are skill-biased
  - High-skill share $\gamma_H >$ low-skill share $\gamma_L$
Land Scarcity

- The source of congestion in our model
- Fixed endowment of land $T_c$ in each city
- Endogenous investment in building up
- Equilibrium housing supply

$$h_{c,t} = \Psi_{c,t} T_c^\zeta (\tau Y_{c,t})^{1-\zeta}$$

- Productivity $\Psi_{c,t}$, income $Y_{c,t}$
- Congestion $\zeta \in (0, 1)$ ⇒ housing supply elasticity $1/\zeta - 1$
Spatial Structure

- A continuum of cities partitioned into regions $r = 1, 2, \ldots, R$
  - Region $r$ includes measure $C_r$ of cities
- Unskilled workers $L_c$ are immobile
- Skilled agents $H_r$ are mobile within each region, not across regions
- Skilled agents create firms, employ unskilled workers, produce output
  \[ Y_{c,t} = \left[ Y_t \left( A_{c,t} L_c \right)^{\sigma-1} N_{c,t} \right]^\frac{1}{\sigma} \]
  - Gains from specialization $\sigma > 1$ (Ethier 1982)
  - Productivity $A_{c,t}$, endogenous aggregate output $Y_t$
Sorting

- Skilled agents sort given \( \{ L_c, T_c; N_{c,t-1}, G_{c,t-1}; \alpha_c, t, A_c, t, \Gamma_c, t, \Psi_c, t \} \)

- Stability condition

\[
\sigma > \eta \left( 1 + \phi \gamma_H - \zeta \tau \right)
\]

  - High housing share \( \tau \) and low supply elasticity \( 1/\zeta - 1 \)
  - Limited spillovers in amenities \( \phi \gamma_H \) and firm creation \( \eta/\sigma \)

- Distribution within region \( r \) such that

\[
H_{c,t}^{1-\eta} \frac{1-\zeta \tau + \phi \gamma_H}{\sigma} \propto \left[ \alpha_c, t N_{c,t-1}^\mu (A_c, t L_c)^{\sigma-1} \right]^{1-\zeta \tau + \phi \gamma_H} \left( \Psi_c, t T_c^\zeta \right)^\tau \left( \Gamma_c, t G_{c,t-1}^{1-\phi} \right)^{\gamma_H}
\]
Cost and Benefits of Fragmentation

- $R$ identical regions, each comprising $C_r$ identical cities
- Fragmentation into separate idea networks ($R \uparrow$) is harmful
  - Reduced entrepreneurship spillovers $\Rightarrow$ slower firm creation
  - Lower incomes across the board, less (and cheaper) housing
  - Everyone’s utility falls
- Fragmentation of idea networks into separate commuting zones ($C_r \uparrow$)
  1. Reduces pecuniary variables iff $\mu + \eta > 1$
      - If $\nu > 1 - \mu - \eta > 0$ local diversity helps entrepreneurship
  2. Reduces individual $i$’s utility iff

\[
\gamma_i + (1 - \zeta \tau + \phi \gamma_i) \frac{\mu + \eta - 1}{\sigma - 1} > 0
\]

- Unambiguous loss of access to amenities
Cost and Benefits of Density

- Empirically, all fragmentation is probably harmful
- But technology can only go so far in eliminating distance
- Concentrating population so that $\partial \ln T = \partial \ln C_r < 0$
  1. Increases firm creation and incomes iff $\mu + \eta > 1$
  2. Increases individual $i$’s utility iff

$$\gamma_i - \zeta \tau + (1 - \zeta \tau + \phi \gamma_i) \frac{\mu + \eta - 1}{\sigma - 1} > 0$$

- Similar results for concentrating into networks
- Housing supply may increase if it is sufficiently elastic
Long-Run Preference Reversals

- Log-linear first-order VAR: stationary if $\mu < 1 \Rightarrow$ steady state
- If $\eta > 1 - \mu > 0$ fragmentation is more harmful in the long run
- Consolidation has larger long- than short-run income effects
- If $\gamma_i < \zeta \tau$ and $\sigma \in (\sigma^i_{d+}, \bar{\sigma}^i_{d+})$ there is a preference reversal

\[
\frac{\partial \ln u_t^i}{\partial \ln C_r} + \frac{\partial \ln u_t^i}{\partial \ln T} > 0 > \frac{\partial \ln \bar{u}^i}{\partial \ln C_r} + \frac{\partial \ln \bar{u}^i}{\partial \ln T}
\]

- Drivers of preference reversal
  1. Large local spillovers: $\partial (\bar{\sigma}^i_{d+} - \sigma^i_{d+}) / \partial \mu > \partial (\bar{\sigma}^i_{d+} - \sigma^i_{d+}) / \partial \eta > 0$
     - Accumulating income gains
  2. Highly persistent amenities: $\partial (\bar{\sigma}^i_{d-} - \sigma^i_{d-}) / \partial \phi < 0$
     - Amenities converge more slowly to their steady-state level
Distributive Conflict and Preference Reversal

- Concentration is always relatively regressive (in welfare terms)
  - The skilled care more about greater access to amenities
  - The unskilled care more about cheap housing

- Preference reversal by the unskilled increases consensus
  - In the short run, they dislike concentration because prices rise
  - But in the long run, income rises and so does housing supply
  - They come to agree with the skilled that density is good

- Preference reversal by the skilled decreases consensus
Regional Heterogeneity and Coordination Failure

- Heterogeneous regions, composed of identical cities
  - Region-specific productivities and initial endowments
- Interregional benefits of firm creation
  \[
  \frac{\partial \ln Y_{r,t}}{\partial \ln N_{s,t}} = \frac{1}{\sigma (\sigma - 1)} \frac{Y_{s,t}}{Y_t} > 0 \text{ for all } s \neq r
  \]
- Coordination failure for $\mu + \eta > 1$ and $\gamma_i < \zeta \tau$: insufficient density
- Free-riding is a temptation for small regions: $Y_{r,t} / Y_t < \hat{y}_d^i$
  - Exacerbated by a large, inelastic housing sector: $\partial \hat{y}_d^i / \partial (\zeta \tau) > 0$
  - Alleviated by large, transient amenities: $\partial \hat{y}_d^i / \partial \gamma_i < 0$, $\partial \hat{y}_d^i / \partial \phi < 0$
  - And by large local spillovers: $\partial \hat{y}_d^i / \partial \eta = \partial \hat{y}_d^i / \partial \mu < 0 < \partial \hat{y}_d^i / \partial \sigma$
- Opposite temptation if $\gamma_i > \zeta \tau$ (or $\mu + \eta < 1$): excess density
Urban Heterogeneity and Skill Poaching

- Let a finite set of identical cities collapse into one with its original land
- Feedback from land and amenities to firm creation
- The number of skilled entrepreneurs rises iff
  \[
  \gamma_H - \zeta \tau + \frac{\eta + \mu - 1}{\sigma} (1 - \zeta \tau + \phi \gamma_H) > 0
  \]
- Firm creation, output and wages rise iff
  \[
  \mu + \eta (1 - \zeta \tau + \gamma_H) > 1
  \]
  - More stringent than before iff \( \zeta \tau > \gamma_H \)
- Unskilled workers’ welfare rises iff
  \[
  \gamma_L - \zeta \tau + (1 - \zeta \tau + \phi \gamma_L) \frac{\mu + \eta (1 - \zeta \tau + \gamma_H) - 1}{\sigma - \eta (1 - \zeta \tau + \phi \gamma_H)} > 0
  \]
  - Triple cost of rising house prices
Gains from Reducing Heterogeneity

- Finite set of $m$ cities with identical land endowments
- Heterogeneous endowment of factors $(L_c, N_{c,t-1}, G_{c,t-1})$

1. Size heterogeneity: empirical distribution of shares

$$s_k = \theta \hat{s}_k + \frac{1 - \theta}{m}$$

- Combination of a non-degenerate distribution and equal shares

2. Heterogeneous factor proportions

- Fraction $\omega$ have i.i.d. shares of each factor
- Fraction $1 - \omega$ have perfectly correlated shares of all factors

- If consolidation is attractive for $(\theta, \omega)$, it is for all $\theta' \geq \theta$ and $\omega' \geq \omega$
Thinking about Urban Networks

- Key differences from a megacity
  1. More diverse but less connected entrepreneurs
  2. Less access to amenities
  3. Probably less congestion

- Focus on firm creation
  - Lower in the network if there are local increasing returns
  - Most important in the long run, undervalued in the short run

- Key role for housing supply elasticity
  - If you cannot build up you’ll hate density
  - Insufficient density from coordination failure
  - Insufficient density to attract the skilled

- Density exacerbates distributive tensions

- Hopefully a useful framing for future empirical work