Monte, Redding, Rossi-Hansberg (2018) "Commuting, Migration, and Local Employment Elasticities"

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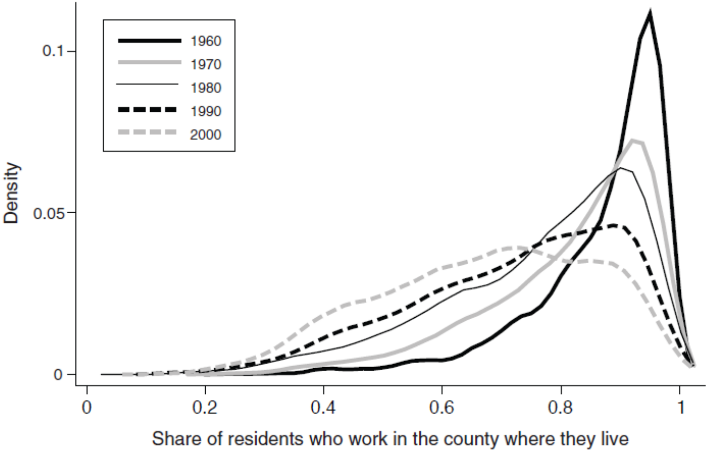
Introduction (1)

- So far we have argued about people's location choices.
- There we implicitly assumed that people work in a location they choose to live in.
- But, sometimes people commute from one location to another.
  - One lives in Ikeda city and commutes to Toyonaka city.
  - One commutes from Omiya, Saitama to Shinjuku, Tokyo.
  - One commutes from New Jersey to Manhattan, New York.
- That is, one's residential place and workplace are sometimes different.
- Monte, Redding, Rossi-Hansberg (2018) integrate both location choices and commutes into a unified framework.

Introduction (2)

- People spend 8 percent of their workday commuting to and from work.
- Migration and commuting determine the response of local employment to a local labor demand shock.
  - Local employment elasticity.
- The authors develop a quantitative general equilibrium model that incorporates spatial linkages between locations in both
  - goods markets (trade),
  - factor markets (commuting and migration).
- The local employment elasticity differs across locations depending on their linkages to one another in goods and factor markets.

Shares of non-commuters across counties



Model: setup

- The economy consists of a set of locations $n, i \in N$.
  - The authors abuse notations to denote the number of locations by N, too.
- Each location is endowed with a supply of land (H_n).
- The economy as a whole is populated by a measure $\bar{L}$ of workers.
- Each worker is endowed with one unit of labor that is supplied inelastically.

Preferences and endowments (1)

- Each worker chooses a pair of residence and workplace locations to maximize her utility taking as given the choices of other firms and workers.
- The preferences of a worker ω who lives and consumes in location n and works in i depend
  - final goods consumption $(C_{n\omega})$,
  - residential land use $(H_{n\omega})$,
  - an idiosyncratic amenities shock $(b_{ni\omega})$,
  - iceberg commuting costs in utility units $(\kappa_{ni}) \in [1, \infty)$,

$$U_{ni\omega} = \frac{b_{ni\omega}}{\kappa_{ni}} \left(\frac{C_{n\omega}}{\alpha} \right)^{\alpha} \left(\frac{H_{n\omega}}{1-\alpha} \right)^{1-\alpha}.$$

Preferences and endowments (2)

- For each worker living in n and working in i, idiosyncratic amenities ($b_{ni\omega}$) are drawn from an independent Fréchet distribution

$$G_{ni}(b) = e^{-B_{ni} b^{-\varepsilon}}, \; B_{ni} > 0, \; \varepsilon > 1.$$

- The scale parameter B_{ni} determines the average amenities from living in n and working in i.
- The shape parameter $\varepsilon > 1$ controls the dispersion of amenities.
- All workers ω residing in n and working in i receive the same wage and make the same consumption and residential land choices.
- So sometimes we suppress index ω.

Preferences and endowments (3)

- The goods consumption index in location n is

$$C_n = \left[\sum_{i \in N} \int_0^{M_i} c_{ni}(j)^\rho \, dj \right]^{\frac{1}{\rho}}, \; \sigma = \frac{1}{1-\rho} > 1, \qquad (1)$$

  where
  - M_i is the mass of varieties that location i serves,
  - $c_{ni}(j)$ is the consumption of variety j shipped from i to n,
  - ρ is a parameter governing the elasticirty of substitution across varieties.
- The equilibrium consumption of each variety is

$$c_{ni}(j) = \alpha X_n P_n^{\sigma-1} p_{ni}(j)^{-\sigma},$$

  where
  - X_n is aggregate expenditure in n,
  - P_n is the price index dual to (1),
  - $p_{ni}(j)$ is the "cost inclusive of freight" price of a variety j produced in i and consumed in n.

Landlords and land markets

- A fraction $(1-\alpha)$ of worker income is spent on residential land.
- Assume that this land is owned by immobile landlords.
- They receive worker expenditure on residential land as income, and consume only goods where they live.
  - This means that they do not consume residential land.
- Thanks to this assumption, we can avoid introducing a mechanical externality into workers' location decisions from the local distribution of land rents.
  - Redding (2016) had this mechanical externality.
- And yet, we can discuss general equilibrium effects from changes in the value of land.

Goods and land markets

- Let $\bar{v}_n$ be the average labor income of residents across employment locations.
- Let R_n be the measure of residents in n.
- Then we have

$$P_n C_n = \underbrace{\alpha \bar{v}_n R_n}_{\text{workers' expenditure on goods}} + \underbrace{(1-\alpha)\bar{v}_n R_n}_{\text{landlords' expenditure on goods}} = \bar{v}_n R_n.$$

- Land market clearing is

$$Q_n = (1-\alpha)\frac{\bar{v}_n R_n}{H_n},$$

where Q_n is the land price in n.

Production: Krugman

- Tradable varieties are produced using labor under monopolistic competition and increasing returns to scale.
- Firms in a location have the same productivity and fixed costs but produce different varieties.
- To produce a variety, a firm must incure a fixed cost of F and a constant variable cost depending on a location's productivity A_i.
- The total amount of labor ($l_i(j)$) required to produce $x_i(j)$ amount of a variety j in location i is

$$l_i(j) = F + \frac{x_i(j)}{A_i}.$$

Optimal prices

- Profit maximization implies that equilibrium prices are a constant mark-up over marginal cost

$$p_{ni}(j) = \frac{\sigma}{\sigma - 1} \frac{d_{ni} w_i}{A_i}, \tag{2}$$

where w_i is the wage in location i.

- Combining profit maximization and zero profits, equlibrium output of each variety is

$$x_i(j) = A_i F(\sigma - 1).$$

- This constant output and labor market clearing imply

$$M_i = \frac{L_i}{\sigma F}. \tag{3}$$

- See my hand-written notes for derivations of these three equations.

Goods trade

- The share of location n's expenditure on goods from location i is
$$\pi_{ni} = \frac{M_i p_{ni}^{1-\sigma}}{\sum_{k\in N} M_k p_{nk}^{1-\sigma}} = \frac{L_i (d_{ni} w_i / A_i)^{1-\sigma}}{\sum_{k\in N} L_k (d_{nk} w_k / A_k)^{1-\sigma}},$$
where the last equality follows from (2) and (3).
- Workplace income in each location equals total expenditure on goods produces in that location
$$w_i L_i = \sum_{n\in N} \pi_{ni} \bar{v}_n R_n.$$
- Using the equilibrium pricing rule and labor market clearing, the price index is expressed as
$$P_n = \frac{\sigma}{\sigma-1}\left(\frac{1}{\sigma F}\right)^{\frac{1}{1-\sigma}} \left[\sum_{i\in N} L_i (d_{ni} w_i / A_i)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$
$$= \frac{\sigma}{\sigma-1}\left(\frac{L_n}{\sigma F \pi_{nn}}\right)^{\frac{1}{1-\sigma}} \frac{d_{nn} w_n}{A_n}.$$

Labor mobility and commuting (1)

- The indirect utility for a worker ω residing in location n and working in location i is

$$U_{ni\omega} = \frac{b_{ni\omega} w_i}{\kappa_{ni} P_n^{\alpha} Q_n^{1-\alpha}}.$$

- Only the random part of $U_{ni\omega}$ is $b_{ni\omega}$.
- $U_{ni\omega}$ is a linear function of $b_{ni\omega}$.
- Therefore, $U_{ni\omega}$ also follow a Fréchet distribution whose distribution function is

$$G_{ni}(U) = e^{-\Psi_{ni} U^{-\varepsilon}},$$

where $\Psi_{ni} = B_{ni}(\kappa_{ni} P_n^{\alpha} Q_n^{1-\alpha})^{-\varepsilon} w_i^{\varepsilon}$.

Labor mobility and commuting (2)

- Each worker chooses a pair of a residential location (N) and a work location (i).
- The probability that a worker chooses to live in n and work in i is

$$\lambda_{ni} = \frac{B_{ni}(\kappa_{ni} P_n^{\alpha} Q_n^{1-\alpha})^{-\varepsilon} w_i^{\varepsilon}}{\sum_{r \in N} \sum_{s \in N} B_{rs}(\kappa_{rs} P_r^{\alpha} Q_r^{1-\alpha})^{-\varepsilon} w_s^{\varepsilon}} \equiv \frac{\Phi_{ni}}{\Phi}.$$

- The authors call a pair of a residential location and a work location as a "bilrateal commute."
- The probability that a worker resides in location n (but may work somewhere else) is

$$\lambda_n^R = \frac{R_n}{\bar{L}} = \sum_{i \in N} \lambda_{ni} = \sum_{i \in N} \frac{\Phi_{ni}}{\Phi}.$$

- The probability that a worker works in location i (but may live somewhere else) is

$$\lambda_i^L = \frac{L_n}{\bar{L}} = \sum_{n \in N} \lambda_{ni} = \sum_{n \in N} \frac{\Phi_{ni}}{\Phi}.$$

Toward average income $\bar{v}_n$ (1)

- We introduced $\bar{v}_n$, the average labor income of *residents* in location n.
- To compute $\bar{v}_n$, we derive relevant variables.
- The probability that a worker commutes to location i conditional on living in location n is

$$\lambda^R_{ni|n} \equiv \frac{\lambda_{ni}}{\lambda^R_n} = \frac{B_{ni}(w_i/\kappa_{ni})^{\varepsilon}}{\sum_{s\in N} B_{ns}(w_s/\kappa_{ns})^{\varepsilon}}.$$

  - This is a commuting gravity equation.
  - The elasticity of commuting flows with respect to commuting costs (κ_{ni}) is $-\varepsilon$.
- Then we get the following expression connecting the number of workers employed in i and the number of residents living in ns:

$$L_i = \sum_{n\in N} \lambda^R_{ni|n} R_n.$$

Toward average income $\bar{v}_n$ (2)

- Expected worker income conditional on living in location n is

$$\bar{v}_n = \sum_{i \in N} \lambda^R_{ni|n} w_i .$$

- Expected worker income ($\bar{v}_n$) is high in locations that have low commuting costs (low κ_{ni}) to high-wage employment locations.

Expected utility

- Expected utility is

$$\bar{U} = E[U_{ni\omega}] = \Gamma\left(\frac{\varepsilon - 1}{\varepsilon}\right)\left[\sum_{r\in N}\sum_{s\in N} B_{rs}(\kappa_{rs}P_r^{\alpha}Q_r^{1-\alpha})^{-\varepsilon} w_s^{\varepsilon}\right]^{\frac{1}{\varepsilon}}$$

for all $n, i \in N$, where

  - E is the expectation operator and the expectation is taken over the distribution for the idiosyncratic component of utility,
  - $\Gamma(\cdot)$ is the Gamma function.

General equilibrium (1)

- An equilibrium is a tuple of $\{w_n, \bar{v}_n, Q_n, L_n, R_n, P_n\}_{n=1}^N$ such that

$$w_n L_n = \sum_n \underbrace{\frac{L_i (d_{ni} w_i / A_i)^{1-\sigma}}{\sum_{k \in N} L_k (d_{nk} w_k / A_k)^{1-\sigma}}}_{\pi_{ni}} \bar{v}_n R_n,$$

$$\bar{v}_n = \sum_i \underbrace{\frac{B_{ni} (w_i / \kappa_{ni})^{\varepsilon}}{\sum_s B_{ns} (w_s / \kappa_{ns})^{\varepsilon}}}_{\lambda^R_{ni|n}} w_i,$$

$$Q_n = (1-\alpha) \frac{\bar{v}_n R_n}{H_n},$$

$$\frac{R_n}{\bar{L}} = \frac{\overbrace{\sum_i B_{ni} (\kappa_{ni} P_n^{\alpha} Q_n^{1-\alpha})^{-\varepsilon} w_i^{\varepsilon}}^{\sum_i \Phi_{ni}}}{\underbrace{\sum_r \sum_s B_{rs} (\kappa_{rs} P_r^{\alpha} Q_r^{1-\alpha})^{-\varepsilon} w_s^{\varepsilon}}_{\Phi}},$$

General equilibrium (2)

$$\frac{L_i}{\bar{L}} = \frac{\overbrace{\sum_n B_{ni}(\kappa_{ni} P_n^{\alpha} Q_n^{1-\alpha})^{-\varepsilon} w_i^{\varepsilon}}^{\sum_n \Phi_{ni}}}{\underbrace{\sum_r \sum_s B_{rs}(\kappa_{rs} P_r^{\alpha} Q_r^{1-\alpha})^{-\varepsilon} w_s^{\varepsilon}}_{\Phi}},$$

$$P_n = \frac{\sigma}{\sigma - 1}\left(\frac{1}{\sigma F}\right)^{\frac{1}{1-\sigma}} \left[\sum_i L_i \left(\frac{d_{ni} w_i}{A_i}\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}},$$

- These are $6N$ equations for $6N$ unknowns.

Exact hat algebra (1)

- A major motivation for developing this quantitative model is to compute counterfactual equilibria.
- A standard approach is to calibrate or estimate parameter values one by one.
- Another popular approach is the *exact hat algebra*.
- In short, this method collapses all parameter values except elasticities by taking ratios of endogenous variables between the counterfactual and the baseline.

Exact hat algebra (2)

- Denote the value of a variable or parameter x in the baseline by x and the one in the counterfactual by x'.
- Then let $\hat{x}$ be the relative change of the variable

$$\hat{x} = \frac{x'}{x}.$$

    - This is the "hat" in the exact hat algebra.

Exact hat algebra (3)

- Given
  - the parameters $\{\alpha, \sigma, \varepsilon\}$,[1]
  - counterfactual changes in the exogenous variables $\{\hat{A}_n, \hat{B}_n, \hat{\kappa}_{ni}, \hat{d}_{ni}\}$,

  we can solve the following eight equations for the counterfactual changes in the endogenous variables $\{\hat{w}_n, \hat{\bar{v}}_n, \hat{Q}_n, \hat{\pi}_{ni}, \hat{\lambda}_{ni}, \hat{P}_n, \hat{R}_n, \hat{L}_n\}$:

$$\hat{w}_i \hat{L}_i w_i L_i = \sum_n \pi_{ni} \hat{\pi}_{ni} \hat{\bar{v}}_n \hat{R}_n \bar{v}_n R_n,$$

$$\hat{\bar{v}}_n \bar{v}_n = \sum_n \frac{\lambda_{ni} \hat{B}_{ni} (\hat{w}_i / \hat{\kappa}_{ni})^{\varepsilon}}{\sum_s \lambda_{ns} \hat{B}_{ns} (\hat{w}_s / \hat{\kappa}_{ns})^{\varepsilon}} \hat{w}_i w_i,$$

[1] The appendix of the original paper lists more parameters: $\{\delta, \kappa\}$. But I do not know why we need κ, and I do not know what δ is.

Exact hat algebra (4)

$$\hat{Q}_n = \hat{\bar{v}}_n \hat{R}_n,$$

$$\hat{\pi}_{ni}\pi_{ni} = \frac{\pi_{ni}\hat{L}_i(\hat{d}_{ni}\hat{w}_i/\hat{A}_i)^{1-\sigma}}{\sum_k \pi_{nk}\hat{L}_k(\hat{d}_{nk}\hat{w}_k/\hat{A}_k)^{1-\sigma}},$$

$$\hat{\lambda}_{ni}\lambda_{ni} = \frac{\lambda_{ni}\hat{B}_{ni}(\hat{P}_n^{\alpha}\hat{Q}_n^{1-\alpha})^{-\varepsilon}(\hat{w}_i/\hat{\kappa}_{ni})^{\varepsilon}}{\sum_r\sum_s \lambda_{rs}\hat{B}_{rs}(\hat{P}_r^{\alpha}\hat{Q}_r^{1-\alpha})^{-\varepsilon}(\hat{w}_s/\hat{\kappa}_{rs})^{\varepsilon}},$$

$$\hat{P}_n = \left(\frac{\hat{L}_n}{\hat{\pi}_{nn}}\right)^{\frac{1}{1-\sigma}} \frac{\hat{d}_{nn}\hat{w}_n}{\hat{A}_n},$$

$$\hat{R}_n = \frac{\bar{L}}{R_n}\sum_i \lambda_{ni}\hat{\lambda}_{ni},$$

$$\hat{L}_i = \frac{\bar{L}}{L_i}\sum_n \lambda_{ni}\hat{\lambda}_{ni}.$$

Exact hat algebra: comments

- An advantage of the exact hat algebra approach is that we don't have to calibrate productivity, amenities, and trade costs.
- We only need the elasticities (usually from the literature), the highly available variables.
  - "The highly available variables" are the residential and work location shares λ_{ni} and trade shares π_{ni}, the number of residents R_n, the number of workers L_n, the wage w_n.
- Actually we can apply this method to Redding (2016), the paper we looked at in our previous lecture.
- Compare this with the model inversion method.

Data

- From the Commodity Flow Survey (CFS), the authors use data on bilateral trade and distances shipped for 123 CFS regions.
  - From my experiences, the CFS data is not as good as standard international trade data if you use it for multiple periods.
  - Many zeros. And when I estimated distance elasticities year be year, the values get bigger over time.
  - CFS regions are coarser than counties and often finer than states.
  - Unfortunately, CFS is not included in IPUMS.
- Data on bilateral commuting between counties come from the American Community Survey (ACS) from 2006-2010 and US Census 1960-2000.
- From the Bureau of Economic Analysis (BEA), the authors use data on employment and wages by workplace.

Data issue on goods trade (1)

- Geographic units in this paper are counties.
- But, goods trade is measured across CFS regions, which are coarser than counties.
- Then how do the authors recover trade costs across counties d_{ni}?
- They assume that trade costs are an exponential of bilateral distances

$$d_{ni} = \text{dist}_{ni}^{\psi} \tilde{e}_{ni},$$

where $\tilde{e}_{ni}$ is a stochastic error.

Data issue on goods trade (2)

- Then log of bilateral trade from i to n is

$$\log X_{ni} = \zeta_n + \chi_i - (\sigma - 1)\psi \log \text{dist}_{ni} + \log e_{ni},$$

  where
  - the source fixed effect (χ_i) controls for employment, wage, and productivity (L_i, w_i, A_i);
  - the destination fixed effect (ζ_n) controls for average income, $\bar{v}_n$, residents, R_n, and multilateral resistance,
  - $\log e_{ni} = (1 - \sigma) \log \tilde{e}_{ni}$.
- The authors estimate $(\sigma - 1)\psi$ using observations across CFS regions.
- Using a standard value 4 of σ, they recover $\psi = 0.42$.
- Using this value of ψ and distances across countries, they recover trade costs across counties.
- Why don't they use CFS regions as geographic units from the beginning? I don't know.
  - A possible reason: CFS regions are used only in CFS. So people don't have a sense of them.

Parameter values (1)

- We've alreaedy got trade costs. How about other parameters?
- The authors consider a commposite of commuting costs and amenities $\mathscr{B}_{ni} \equiv B_{ni}\kappa_{ni}^{-\varepsilon}$.
- Basically, almost all other parameters (elasticities) come from the following "commuting gravity equation"

$$\lambda_{ni} = \frac{\mathscr{B}_{ni}\left(\frac{L_n}{\pi_{nn}}\right)^{-\frac{\alpha\varepsilon}{\sigma-1}} A_n^{\alpha\varepsilon} w_n^{-\alpha\varepsilon} \bar{v}_n^{-\varepsilon(1-\alpha)} \left(\frac{R_n}{H_n}\right)^{-\varepsilon(1-\alpha)} w_i^{\varepsilon}}{\sum_r \sum_s \mathscr{B}_{rs}\left(\frac{L_r}{\pi_{rr}}\right)^{-\frac{\alpha\varepsilon}{\sigma-1}} A_r^{\alpha\varepsilon} w_r^{-\alpha\varepsilon} \bar{v}_r^{-\varepsilon(1-\alpha)} \left(\frac{R_r}{H_r}\right)^{-\varepsilon(1-\alpha)} w_s^{\varepsilon}}$$

- The authors parameterize $\mathscr{B}_{ni}$ as

$$\mathscr{B}_{ni} = \mathscr{B}_n \mathscr{B}_i \text{dist}_{ni}^{-\phi} \mathscr{B}_{ni},$$

where

  - $\mathscr{B}_n$ is a residence component,
  - $\mathscr{B}_i$ is a workplace component,
  - $\text{dist}_{ni}^{-\phi}$ is a component related to distance,
  - $\mathscr{B}_{ni}$ is an orthogonal component (error term).

Parameter values (2): two-step estimation

1. The authors estimate ϕ with

$$\log \lambda_{ni} = g_0 + \eta_n + \mu_i - \phi \log \text{dist}_{ni} + \log \mathscr{B}_{ni}$$

   and get $\phi = 4.43$. The last term is the error term.

2. They estimate ε with

$$\log \lambda_{ni} = g_0 + \eta_n + \varepsilon \log w_i - \phi \log \text{dist}_{ni} + \log u_{ni},$$

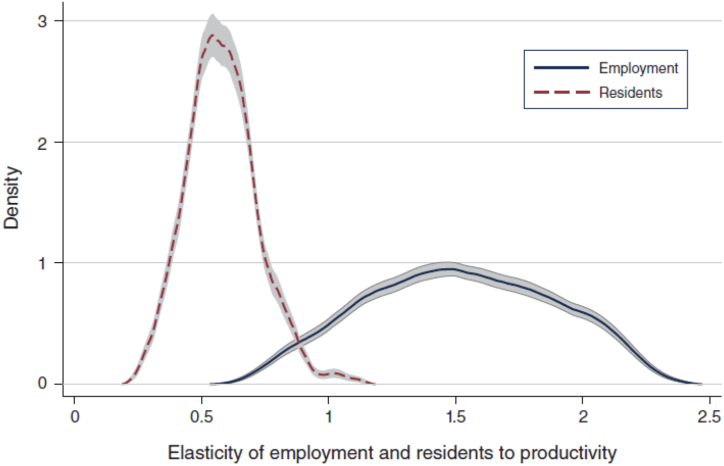
   where the error term is given by $\log u_{ni} \equiv \log \mathscr{B}_i + \log \mathscr{B}_{ni}$.
   - They impose $\phi = 4.43$ in this regression. (So I guess they shift $\phi \log \text{dist}_{ni}$ to the left-hand side.)
   - They get $\varepsilon = 3.30$.

- They instrument w_i with recovered productivities. But we don't get into details here.

(So many) Counterfactuals: local employment elasticities

- The authors compute 3,111 counterfactual exercises where they shock each county with a 5 percent productivity shock.
  - In so doing, they hold productivity in all other counties and all other parameters constant.
- They they observe how the numbers of workers and residents respond to such a shock in each county.

Employment and residents elasticities



Employment and Residents Elasticities: Comment (1)

- The figure on the previous page shows the kernel density estimates of employment and resident elasticities across counties.
- Employment elasticities are much larger than residents elasticities.
- Suppose a county's productivity rises.
- The marginal product of labor increases there.
- More people want to work in that county.
- Some of them also choose to live there.
  - As a result, housing rents increase, which these residents must bear.
- Others commute from neighboring counties to benefit from higher wages while enjoying lower housing rents where they live.
  - However, they incur commuting costs.

Employment and Residents Elasticities: Comment (2)

- The distribution of employment elasticities is much flatter than the distribution of residents elasticities.
- The residents elasticity is all about the county that received a productivity shock.
- But commuting networks matter for the employment elasticity.
- And some counties are connected to many and or big counties (the right tail of the distribution).
- And other counties are isolated from other counties (the left tail of the distribution).