Graduate Public Finance

Overview of Spatial Public Finance and the Rosen-Roback Model

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Lecture 2

What's special about Spatial PF?

- Mobility of factors (and goods)
- Spillovers
  - Agglomoration
  - Congestion
- Spatial Heterogeneity in Endowments (and Outcomes)
- Hierarchy
  - Federalism
  - Competition with many neighbors

Spatial PF

Academic Motivation:

1. Key policy debates, large spatial disparities, labs of democracy
2. Rich setting for economics and great data
3. Overlap w/ many fields (labor, urban, trade, development, macro)

Goals:

1. Provide context and guidance on open questions
2. Present benchmark models and new research
3. Enhance your applied modeling and empirical skills

Questions

1. Taxation: how should we pay for government services?
   - What should we tax? With what structure? At what rate?
   - Taxation of capital, labor, and goods in a spatial setting
   - Incidence, efficiency, and policy implications
2. Spending: how big should government be and what should it provide?
   - Are local services being under or over provided (level and composition)?
   - How are local services allocated? E.g., How much police spending allocated to rich/poor neighborhoods?
   - Redistribution, safety net, and mobility responses to benefit generosity
3. Hierarchy: How should governments be organized?
   - When is local provision efficient?
   - Fiscal federalism and Tax Competition
4. Dynamics: Growth, Economic Development, and Poverty
   - Big push and Industrial policy? Local vs Aggregate Consequences?
   - Should we have special economic zones? Bail outs? Pension reform?
   - Opportunity and growth across locations: causes, consequences, and policy implications

Motivation: Geographically concentrated economic activity

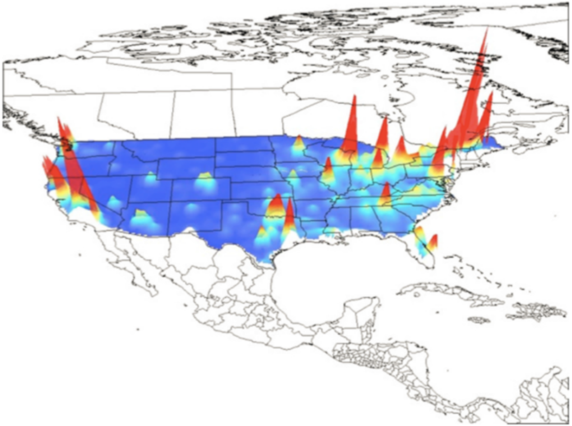
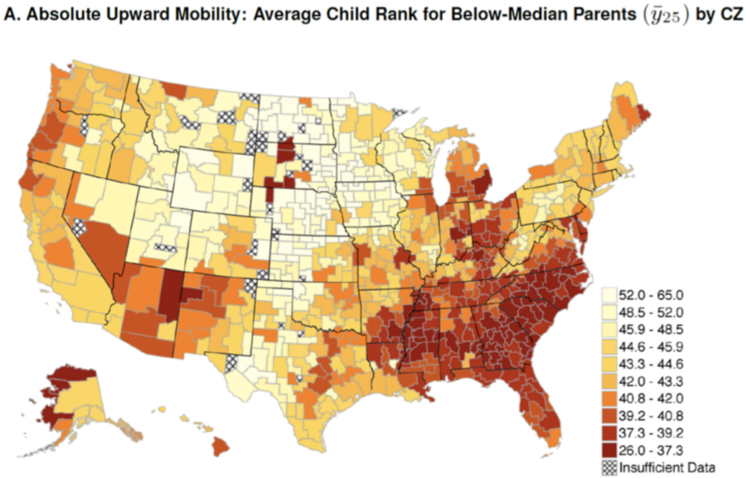


Figure 1 ***Spatial distribution of economic output in the US, by square mile.*** Notes: This figure reports the value of output produced in the US by square mile.

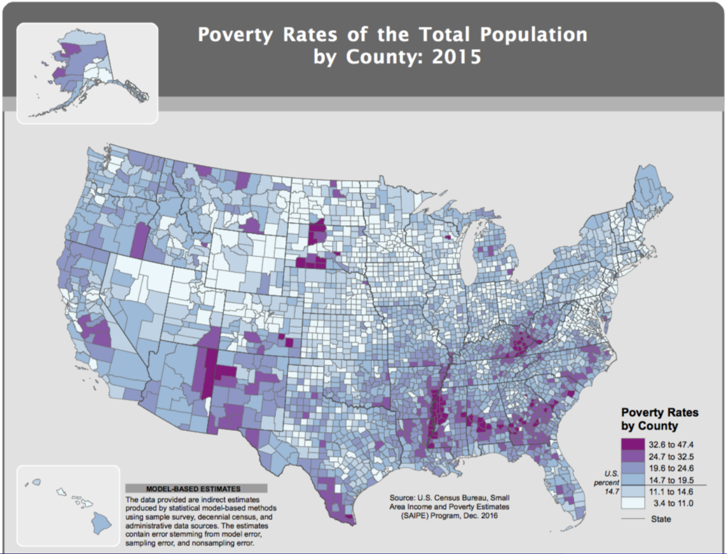
Source: Moretti (2011)

Motivation: Geographically concentrated upward mobility

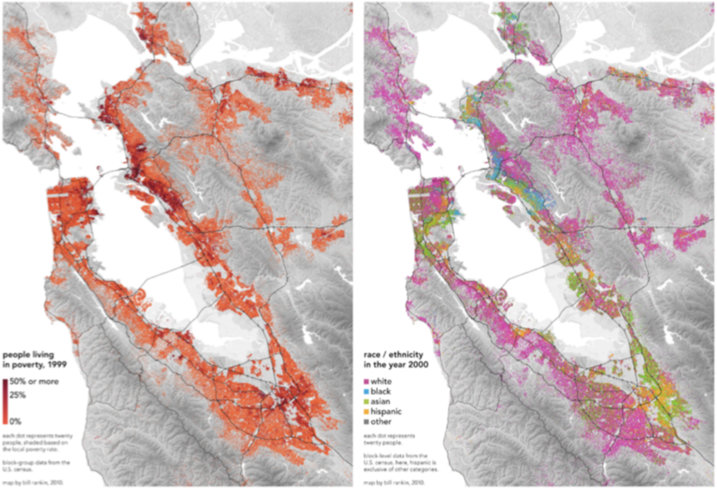


Source: Chetty-Hendren-Kline-Saez (2014)

Motivation: Geographically concentrated poverty

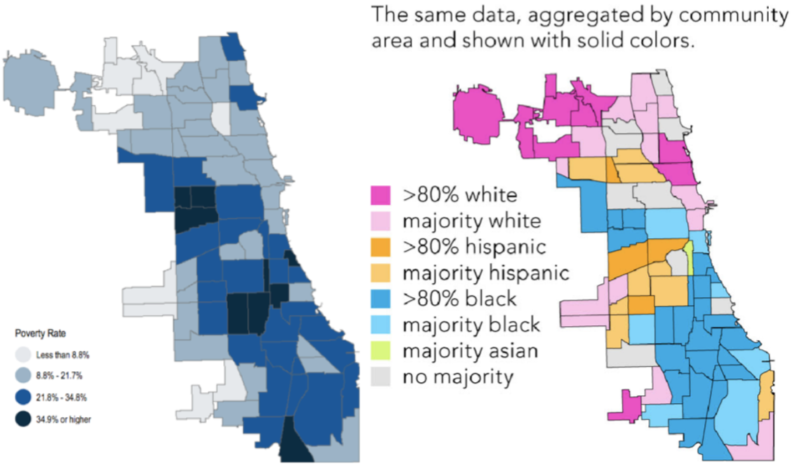


Motivation: Geographically concentrated poverty/race



Source: Rankin (2010) using 2000 Census (http://www.radicalcartography.net/)

Motivation: Geographically concentrated poverty/race



Source: Rankin (2010) and http://capitolfax.com/2013/01/17/todays-maps-illinois-poverty/ using 2010 Census

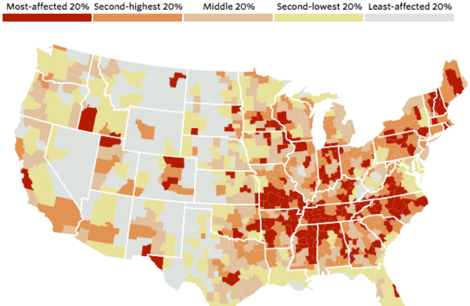
Motivation: Geographically concentrated shocks

The Parts of America Most Vulnerable to China

Some areas of the U.S. were hit especially hard by China's rise, partly because those areas had lots of jobs in industries where imports surged the most.

Most-affected areas of the U.S.

Colors show which areas were most affected by China's rise, based on the increase in Chinese imports per worker in each area from 1990 to 2007. Hovering over each area on the map will show a demographic breakdown of that area, below, and its most-affected industries, at right.

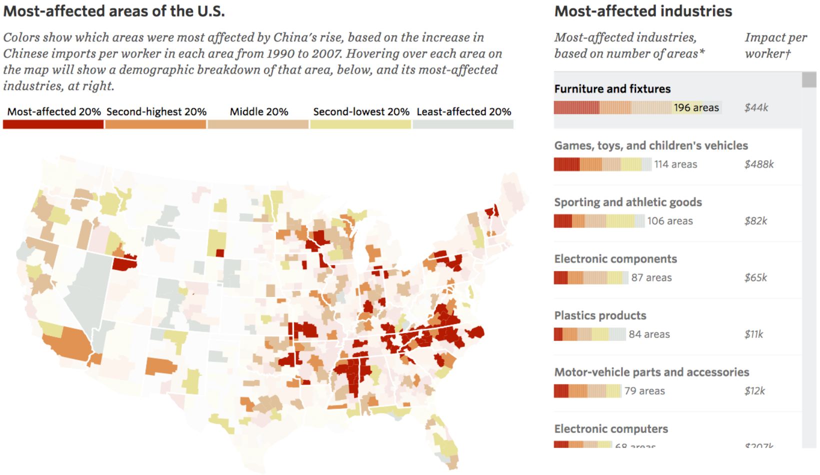


Most-affected industries

*Most-affected industries, based on number of areas**		*Impact per worker†*
Furniture and fixtures	196 areas	$44k
Games, toys, and children's vehicles	114 areas	$488k
Sporting and athletic goods	106 areas	$82k
Electronic components	87 areas	$65k
Plastics products	84 areas	$11k
Motor-vehicle parts and accessories	79 areas	$12k
Electronic computers		

Motivation: Geographically concentrated shocks

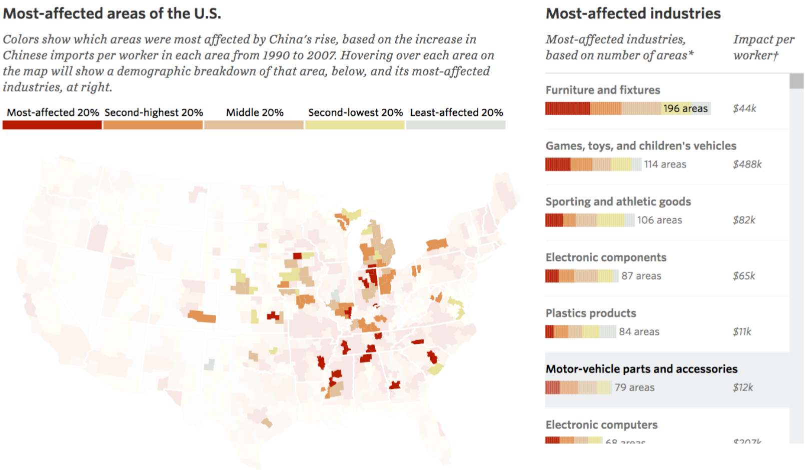
Furniture and fixtures



Source: Autor Dorn Hanson `http://chinashock.info`

Motivation: Geographically concentrated shocks

Motor-vehicle parts and accessories



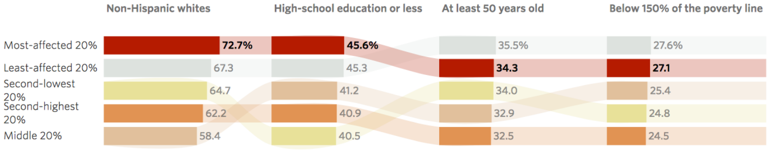
Source: Autor Dorn Hanson `http://chinashock.info`

Motivation: Geographically concentrated shocks

Demographics of the most-affected areas

Demographics of the most-affected areas

They were whiter, less educated, older and poorer than most of the rest of America. The bars below show those demographics by percentage of the population.



*Number of areas is based on the number of commuting zones where each industry was among the five most-affected industries. Commuting zones are groups of counties that share a labor market, similar to a metropolitan area.

†Impact per worker means the value of goods that a U.S. worker would have produced if those goods had been made in America instead of China.

The analysis excludes Alaska and Hawaii. Education level is measured only for those age 25 and over. Poverty-status calculations are for individuals, and exclude those in college dormitories and military housing, as well as institutionalized people and children under age fifteen who aren't related to a householder or other reference person.

Graphic by Andrew Van Dam and Jessia Ma. Additional reporting by Jon Hilsenrath and Bob Davis.

Sources: David Autor and Brendan Price of the Massachusetts Institute of Technology; Gordon Hanson of the University of California, San Diego; David Dorn of the University of Zurich

Source: Autor Dorn Hanson Price `http://chinashock.info`

Motivation: Geographically concentrated unemployment

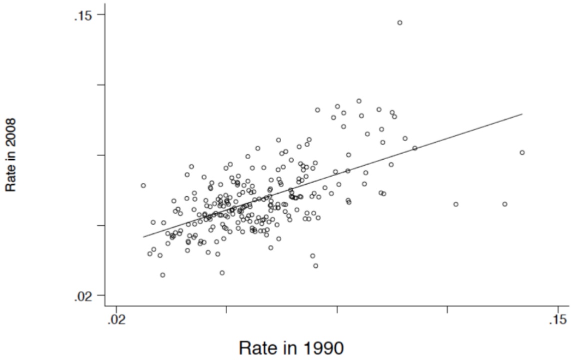
Table 1: Metropolitan Areas with the Highest and Lowest Unemployment Rates in 2008

Rank	Metropolitan Area	Unemployment Rate (1)	Adjusted Unemployment Rate (2)
	Areas with the Highest Rate		
1.	Flint, MI	.1462	.1399
2.	Yuba City, CA	.1099	.1072
3.	Anniston, AL	.1074	.0899
4.	Merced, CA	.1060	.0948
5.	Toledo, OH/MI	.1058	.1064
6.	Yakima, WA	.1047	.0970
7.	Detroit, MI	.1044	.1082
8.	Chico, CA	.1031	.1092
9.	Modesto, CA	.1027	.1021
10.	Waterbury, CT	.1023	.0918
	Areas with the Lowest Rate		
276.	Provo-Orem, UT	.0391	.0369
277.	Madison, WI	.0389	.0511
278.	Odessa, TX	.0383	.0307
279.	Fargo-Morehead, ND/MN	.0362	.0467
280.	Charlottesville, VA	.0348	.0362
281.	Houma-Thibodoux, LA	.0337	.0107

Motivation: Geographically concentrated unemployment

Differences are persistent ($\rho = .59$)

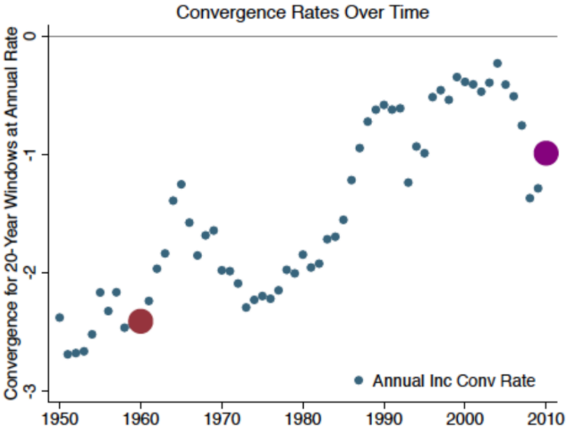
Figure 1: Unemployment Rates in 1990 and 2008, by Metropolitan Area



Notes: Data are from the 1990 Census of Population and the 2008 American Community Survey. The sample includes all individuals in the labor force between the age of 14 and 70.

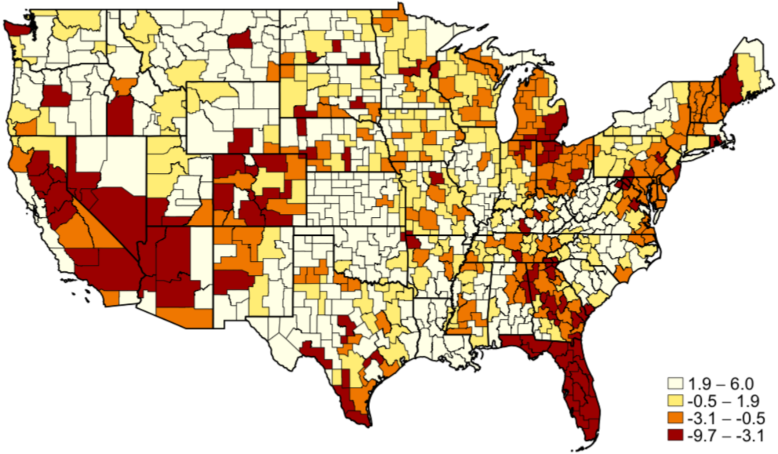
Motivation: Geographically concentrated unemployment

Convergence is slowing



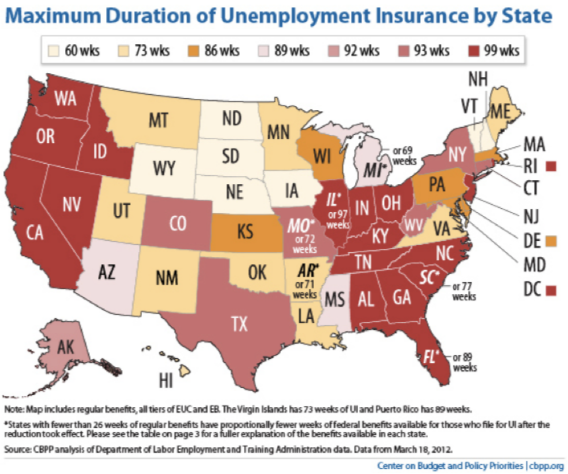
Source: Ganong and Shoag (2014)

Motivation: Geographically concentrated recessions



Source: Yagan (2016)

Motivation: Geographically concentrated policy responses



Source: CBPP (2012)

Effects on political polarization (and many other outcomes)

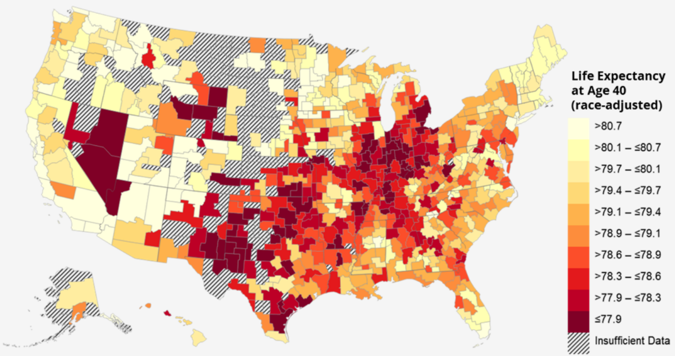
Table 5: Import Exposure and Change in Ideological Position of Election Winner 2002-2010. (Dependent Variables: 100 × Change in Indicators for Election of Politician by Party and Political Position)

	Change in Probability 2002-2010 that Winner has Given Political Orientation					
	Moderate	Liberal Democrat	Moderate Democrat	Moderate Republican	Conserv-ative Republican	Tea Party Member
	(1)	(2)	(3)	(4)	(5)	(6)
Δ CZ Import Penetration	-35.96 **	0.17	-22.91 **	-13.04	35.79 **	24.30 ~
	(13.35)	(7.01)	(8.56)	(9.02)	(13.54)	(12.65)
Mean Outcome	-19.7	2.6	-4.6	-15.0	17.0	11.7
Level in 2002	56.8	19.9	27.0	29.8	23.3	6.1

Notes: N=3,504 County*District cells."Liberal Democrats", "Moderates" and "Conservative Republicans" are defined as politicians whose Nominate scores would respectively put them into the bottom quintile, middle three quintiles, or top quintile of the Nominate score in the 107th (2001-2003) congress that preceeds the outcome period. A Tea Party Member is defined as a representative who was a member of the Tea Party or Liberty Caucus during the 112th (2011-2013) Congress. These two caucuses which are often associated with the Tea Party movement were first established in 2010 and 2011, respectively. All regressions include the full set of control variables from Table 1. Observations are weighted by a cell's share of total district population in 2000, and standard errors are two-way clustered on CZs and Congressional Districts. ~ $p \leq 0.10$, * $p \leq 0.05$, ** $p \leq 0.01$.

Source: Autor Dorn Hanson Majlesi (2017) `http://chinashock.info`. "Congressional districts exposed to larger increases in import penetration disproportionately removed moderate representatives from office in the 2000s. Trade-exposed districts with an initial majority white population or initially in Republican hands became substantially more likely to elect a conservative Republican, while trade-exposed districts with an initial majority-minority population or initially in Democratic hands became more likely to elect a liberal Democrat"

Stakes are high...



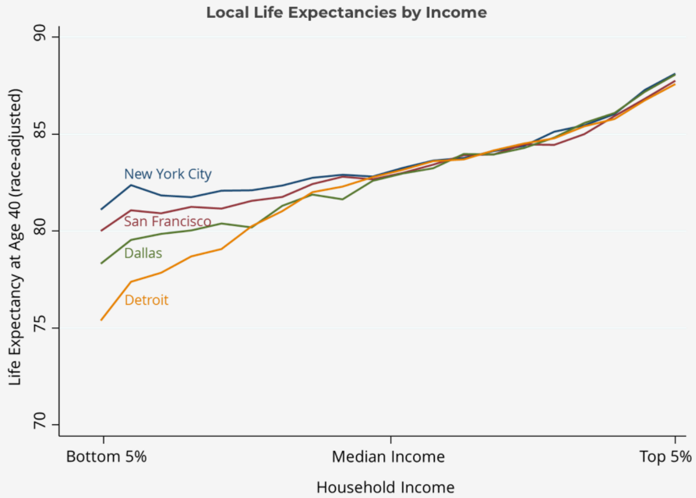
Top 5 Cities: New York City NY, Santa Barbara CA, San Jose CA, Miami FL, Los Angeles CA

Bottom 5 Cities: Tulsa OK, Indianapolis IN, Oklahoma City OK, Las Vegas NV, Gary IN

For low-income people, life expectancy is highest in California, New York, and Vermont. It is lowest in Nevada. The next 8 states with the lowest life expectancies form a belt connecting Michigan, Ohio, Indiana, Kentucky, Tennessee, Arkansas, Oklahoma, and Kansas.

Source: https://healthinequality.org

Stakes are high...



Life expectancy varies substantially across cities, especially for low-income people. For the poorest Americans, life expectancies are 6 years higher in New York than in Detroit. For the

Spatial Public Finance Outline

1. **Baseline Rosen-Roback spatial model**
2. **Place-based Policies: theory**
3. **Place-based Policies: evidence**
4. **Sorting, fiscal federalism**

Graduate Public Finance

The Rosen-Roback Spatial Model[1]

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Lecture 2

Outline

1. Model
   - Overview
   - Workers: Indirect Utility Condition
   - Firms: No Profit Condition
2. Equilibrium
   - Components of Economic Models
   - Exogenous Model Parameters
   - Endogenous Model Outcomes
   - Equilibrium: Indifference Conditions
   - Solving Model
3. Comparative Statics and Value of Amenities
   - Price effects under different assumptions about amenities
   - Inferring Amenity Values
   - Extensions (Albouy JPE, 2009)
4. Recent JMP: Piyapromdee (2018)

Outline

Overview

1. Goals
   - Characterize effect of amenity s change on prices (wages and rents)
   - Infer the value of amenities
2. Markets
   - Labor: price w, quantity N
   - Land: price r, quantity $L = L^w + L^p$ for workers and production
   - Goods: price $p = 1$, quantity X
3. Agents
   - Workers (homogenous, perfectly mobile)
   - Firm (perfectly competitive, CRS)
4. Indifference Conditions
   - Workers have same indirect utility in all locations
   - Firm has zero profit (i.e., unit costs equal 1)

Workers: Preferences and Budget Constraint

Utility is $u(x, l^c, s)$

- x is consumption of private good
- l^c is consumption of land
- s is amenity

Budget constraint is $x + rl^c - w - I = 0$

- I is non-labor income that is independent of location (e.g., share of national land portfolio)
- w is labor income (note: no hours margin).

Workers: Indirect Utility

- Indirect utility is given

$$V(w,r,s) = \max_{x,l^c} u(x,l^c,s) \text{ s.t. } x + rl^c - w - I = 0$$

- Let $\lambda = \lambda(w,r,s)$ be the marginal utility of a dollar of income, then

$$V_w = \lambda > 0$$
$$V_r = -\lambda l^c < 0$$
$$\Rightarrow V_r = -V_w l^c$$

Aside: Example of Indirect Utility

Utility is Cobb Douglas over goods and land with an amenity shifter:

$$u(x, l^c, s) = s^{\theta w} x^{\gamma} (l^c)^{1-\gamma}$$

- Then $x = \gamma \left(\frac{w+I}{1}\right)$ and $l^c = (1-\gamma)\left(\frac{w+I}{r}\right)$
- So indirect utility is:

$$V(w, r, s) = \underbrace{\gamma^{\gamma}(1-\gamma)^{(1-\gamma)}}_{constant} \underbrace{s^{\theta w}}_{Amenities} \underbrace{1^{-\gamma} r^{-(1-\gamma)}}_{Prices} \underbrace{(w+I)}_{Income}$$

- MU of income is $\lambda(w, r, s)$

$$V_w = \lambda = \gamma^{\gamma}(1-\gamma)^{(1-\gamma)} s^{\theta w} 1^{-\gamma} r^{-(1-\gamma)}$$

$$V_r = -\lambda l^c = -\gamma^{\gamma}(1-\gamma)^{(1-\gamma)} s^{\theta w} 1^{-\gamma} r^{-(1-\gamma)} \underbrace{(1-\gamma)\left(\frac{w+I}{r}\right)}_{l^c}$$

$$\Rightarrow V_r = -V_w l^c$$

Firms: Unit Cost Function

CRS production with cost function $C(X, w, r, s)$

- X is output
- Unit cost $c(w, r, s) = \frac{C(X,w,r,s)}{X}$
- L^p is total amount of land used by firms
- N is total employment

From Sheppard's Lemma, we have

$$c_w = N/X > 0$$
$$c_r = L^p/X > 0$$

Aside: Example technology, cost function, factor demand

Suppose $X = f(N, L^p) = s^{\theta_F} N^{\alpha} L^{1-\alpha}$, then cost function is:

$$C(X, w, r, s) = X(s^{\theta_F})^{-1} w^{\alpha} r^{1-\alpha} (\alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}) \Rightarrow$$
$$c(w, r, s) = (s^{\theta_F})^{-1} w^{\alpha} r^{1-\alpha} (\alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)})$$

Then

$$C_w(X, w, r, s) = \alpha \frac{(X(s^{\theta_F})^{-1} w^{\alpha} r^{1-\alpha} (\alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}))}{w} = N$$
$$C_r(X, w, r, s) = (1-\alpha) \frac{(X(s^{\theta_F})^{-1} w^{\alpha} r^{1-\alpha} (\alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}))}{r} = L^p$$

Dividing both sides by X gives:

$$c_w = N/X > 0$$
$$c_r = L^p/X > 0$$

Outline

Aside: Components of Models[2]

Three parts of any model

1. Exogenous parameters: model elements that are taken "as given"
2. Endogenous outcomes: model elements that "move around"
3. Equilibrium conditions: the set of rules that tells you what the endogenous model outcomes should be for a given set of exogenous model parameters.

"Given a [insert set of exogenous model parameters here], equilibrium is defined by the [insert endogenous model outcomes here] such that [list equilibrium conditions here]."

Exogenous parameters

- Workers Parameters: s, θ_W, γ, I
  - s is level of amenities
  - θ_W governs importance of amenities for utility
  - γ governs importance of goods for utility
  - $1 - \gamma$ governs importance of land for utility
  - I is non-labor income
- Firm Parameters: s, θ_F, α
  - s is level of amenities
  - θ_F governs importance of amenities for productivity
  - α is output elasticity of labor
  - $1 - \alpha$ is output elasticity of land

Endogenous Model Outcomes

Recall:

- Labor: price w, quantity N
- Land: price r, quantities L^w, L^p for workers and production
- Goods: price $p = 1$, quantity X

so endogenous outcomes are w, r, N, L^w, L^p, X

Equilibrium Concept: Two key indifference conditions

In equilibrium, workers and firms are indifferent across cities with different levels of s and endogenously varying wages $w(s)$ and rents $r(s)$:

$$c(w(s), r(s), s) = 1 \tag{1}$$

$$V(w(s), r(s), s) = V^0 \tag{2}$$

where V^0 is the initial equilibrium level of indirect utility.

Specifically, in our example:
Given $s, \theta_W, \theta_F, \gamma, I, \alpha$, equilibrium is defined by local prices and quantities $\{w, r, N, L^w, L^p, X\}$ such that 1 and 2 hold and land markets clear.

N.B. We will mainly be focusing on prices: $w(s)$ and $r(s)$.

Solving for effect of amenity changes on prices

- Differentiate 1 and 2 with respect to s and rearrange, we have:

$$\begin{bmatrix} c_w & c_r \\ V_w & V_r \end{bmatrix} \begin{bmatrix} w'(s) \\ r'(s) \end{bmatrix} = \begin{bmatrix} -c_s \\ -V_s \end{bmatrix} \quad (3)$$

- Solving for $w'(s), r'(s)$, we have

$$w'(s) = \frac{V_r c_s - c_r V_s}{c_r Vw - c_w V_r}$$
$$r'(s) = \frac{V_s c_w - c_s V_w}{c_r Vw - c_w V_r}$$

- Note we can rewrite

$$c_r Vw - c_w V_r = \lambda L^p / X + \lambda l^c N / X = \lambda L / X = V_w L / X$$

Aside: example values for matrix elements

$$
\begin{aligned}
c_w &= \alpha \frac{(s^{\theta_F})^{-1} w^{\alpha} r^{1-\alpha} \kappa_0}{w} \\
c_r &= (1-\alpha) \frac{(s^{\theta_F})^{-1} w^{\alpha} r^{1-\alpha} \kappa_0}{r} \\
c_s &= \theta_F \frac{(s^{\theta_F})^{-1} w^{\alpha} r^{1-\alpha} \kappa_0}{s} \\
V_w &= s^{\theta_W} 1^{-\gamma} r^{-(1-\gamma)} \kappa_1 \\
V_r &= -s^{\theta_W} 1^{-\gamma} r^{-(1-\gamma)} \kappa_1 (1-\gamma) \left(\frac{w+I}{r} \right) \\
V_s &= \theta_W \frac{\left(s^{\theta_W} 1^{-\gamma} r^{-(1-\gamma)} \kappa_1 (w+I)\right)}{s}
\end{aligned}
$$

where $\kappa_0 = \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}$ and $\kappa_1 = \gamma^{\gamma}(1-\gamma)^{(1-\gamma)}$ are constants

Effect of amenity changes on prices

- Price changes

$$w'(s) = \frac{(V_r c_s - c_r V_s)X}{\lambda L} \tag{4}$$

$$r'(s) = \frac{(V_s c_w - c_s V_w)X}{\lambda L} \tag{5}$$

- Special cases of interest:

1. Amenity only valued by consumers: $\theta_F = 0 \Rightarrow c_s = 0$
2. Amenity only has productivity effect: $\theta_W = 0 \Rightarrow V_s = 0$
3. Firms use no land $1 - \gamma = 0$ and amenity is non-productive $\theta_F = 0$: $c(w(s)) = 1$, $c_r = c_s = 0$

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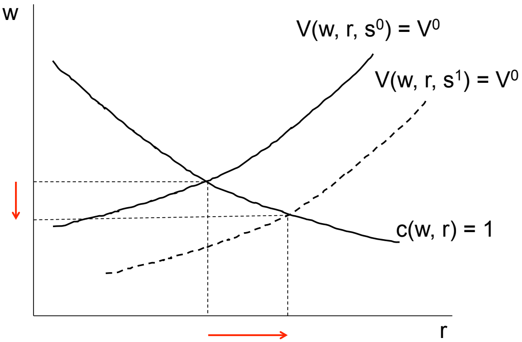
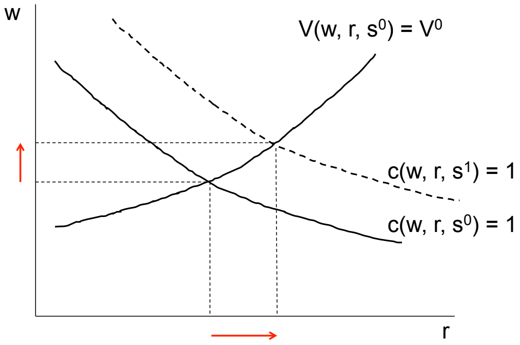
1. Amenity only valued by consumers: $\theta_F = 0 \Rightarrow c_s = 0$

- When $c_s = 0$, higher $s \Rightarrow$ higher r, lower l
- Workers are willing to pay more in land rents and receive less in pay to have access to higher levels of amenities



2. Amenity only has productivity effect: $\theta_W = 0 \Rightarrow V_s = 0$

- When $V_s = 0$, higher $s \Rightarrow$ higher r and higher l
- Firms are willing to pay more in land rents and wages to access higher productivity due to amenities



3. Firms use no land $\gamma = 1$, amenity not productive $\theta_F = 0$

- Only production input is labor and firms are indifferent across locations, so wages must be the same across cities: $c(w(s)) = 1$

- Since $c_r = c_s = 0$,

$$w'(s) = 0$$

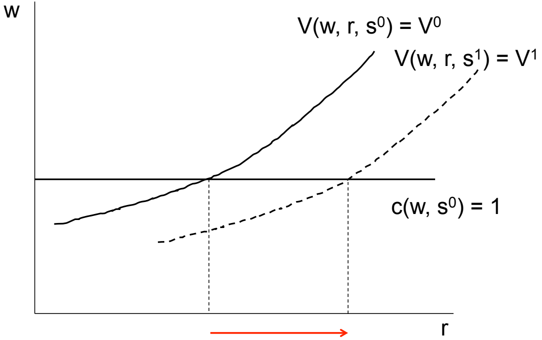
$$r'(s) = \frac{V_s c_w}{-c_w V_r} = \frac{V_s}{l^c V_w}, \text{ since } V_r = -l^c V_w$$

- So the rise in total cost of land for a worker living in a city with higher s is

$$l^c r'(s) = \frac{V_s}{V_w}$$

3. Firms use no land $\gamma = 1$, amenity not productive $\theta_F = 0$

- $\frac{V_s}{V_w}$ = marginal WTP for a change in s so the marginal value of a change in the amenity is "fully capitalized" in rents



$\frac{V_s}{V_w} = \theta_W \frac{(w+I)}{s}$ is increasing in income, decreasing in level of amenities

Inferring the Value of Amenities

How do we infer the value of amenities in the more general case?

- $\Omega(s) = V(w(s), r(s), s)$ represents total utility of living in city s

- If all cities have equal utility, then

$$\begin{aligned}
\Omega'(s) &= V_w w'(s) + V_r r'(s) + V_s = 0 \text{ in equilibrium} \\
V_s &= -V_w w'(s) - V_r r'(s) \\
V_s &= -V_w w'(s) + l^c V_w r'(s) \\
\Rightarrow \frac{V_s}{V_w} &= l^c r'(s) - w'(s) \qquad (6)
\end{aligned}$$

- So WTP for the amenity is extra land cost for consumers less lower wages in a higher-amenity city

Inferring the Value of Amenities

We can get more insight from looking at firms:

- Firms face $c(w(s), r(s), s) = 1$ across cities, so

$$c_w w'(s) + c_r r'(s) + c_s = 0 \tag{7}$$

- Consider 2 cases

1. $c_s = 0$ (no productivity effects of higher amenity levels)
2. $c_s \neq 0$

Inferring the Value of Amenities, $c_s = 0$

- In the case when $c_s = 0$,

$$w'(s) = \frac{-c_r}{c_w} r'(s) = \frac{-L^p}{N} r'(s) \tag{8}$$

- Combine 6 and 7 to get the WTP of the N people in a given city:

$$N \frac{V_s}{V_w} = N l^c r'(s) + L^p r'(s) = L r'(s) \tag{9}$$

  Thus, in this case, aggregate WTP can be derived from looking at how the total value of all land changes as s changes

Inferring the Value of Amenities, $c_s \neq 0$

- Define "social value" SV as the sum of aggregate worker WTP and cost-induced savings. Then the change in SV given changes s is

$$
\begin{aligned}
dSV &= N\frac{V_s}{V_w} - Xc_s \\
&= N(l^c r'(s) - w'(s)) - X(-c_w w'(s) - c_r r'(s)) \\
&= Nl^c r'(s) - Nw'(s)) + X\frac{N}{X}w'(s) + X\frac{L^p}{X}r'(s) \\
&\Rightarrow dSV = Lr'(s) \qquad (10)
\end{aligned}
$$

- So the change in social value is the change in total value of land

Taking it to the data

Estimating equations (of individuals i living in cities c with amenities Z_c):

$$\log w_{ic} = x_i \beta + \gamma_w Z_c + e_{ic}$$

$$\log r_c = \gamma_r Z_c + \epsilon_c$$

(Can you see why Rosen of hedonic regression fame gets credit for this model?)

Bringing it back to theory:

$$\begin{aligned} V_s/V_w &= l^c r'(z) - w'(z) \\ &= w\left[\frac{l^c r}{w}\frac{r'(z)}{r} - \frac{w'(z)}{w}\right] \\ &= w[\theta\gamma_r - \gamma_w] \end{aligned}$$

where $\theta = \frac{l^c r}{w}$ is *land's* share of income.

Aside: Multiplying/dividing to connect to estimable objects is applied theory gold!

Extension: Albouy (JPE, 2009)

- Introduces a non-traded good y sold at city-specific price p
- Worker's Problem: indirect utility is given by

$$V(w, r, s) = \max_{x,y} u(x, y, s) \text{ s.t. } x + py - w - I = 0 \tag{11}$$

- Unit cost function for tradable good:

$$c(w, r, s) = 1 \tag{12}$$

- Unit cost function for non-tradable good:

$$g(w, r, s) = p \tag{13}$$

- Albouy model has 3 endogenous variables, w, r and p, but can follow Rosen-Roback analysis

Extension: Albouy (JPE, 2009)

- Studies the unequal geographic burden of federal taxation
- Progressive fed tax schedule $\Rightarrow$ higher taxes in higher w places
- "Federal taxes act like an arbitrary head tax for living in a city with wage improving attributes, whatever those attributes may be"
- Simulation: a worker moving from a typical low-wage city to a high-wage city would experience a 27% increase in federal taxes, which is equivalent to a $269 billion transfer from workers in high-wage, high-productivity areas to low-wage, low-productivity cities.

N.B. Could use approach to study an amenity s (e.g., inefficiency in the local construction sector) that raises the cost of the local good and has no inherent value for consumers or productivity effects on the traded sector (i.e., $\theta_F = \theta_W = 0$).

Leaving Chicago for Nashville

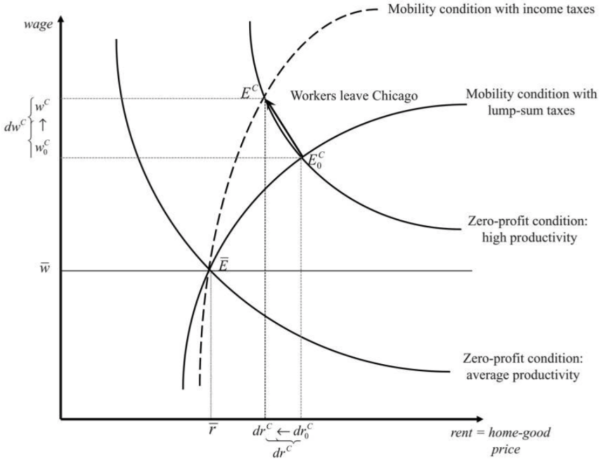


FIG. 1.—Effect of federal taxes on a high trade-productivity city. In a simplified model ($r^j = p^j$, $Q^j = A^j_Y = 1$ for all j), replacing a lump-sum tax, T, with a utility-equivalent federal income tax, τ, raises wages, w, and lowers rents, r, and employment in Chicago, labeled "C," a city with high trade productivity ($A^C_X > 1$), changing the equilibrium from E_0^C to E^C.

Explaining Albouy (JPE, 2009) Figure 1 in words

Initial Equilibrium

- Zero profit condition is higher for Chicago due to higher TFP there
- without taxes, wages w_0^C are higher in Chicago to pay for higher rents (note amenities are set equal in this example)

With progressive income taxes

- Workers in costlier cities like chicago now need to be paid more to be willing to live there
- Relative to initial equilibrium, fewer workers in Chicago which lowers the demand for land in both production and consumption $\Rightarrow$ rents fall by dr^C
- This also raises the labor-to-land ratio, causing wages to rise dw^C
- Firms are no better off since cost savings on land are passed off to workers in higher wages

Moving to Miami: the higher quality of life case

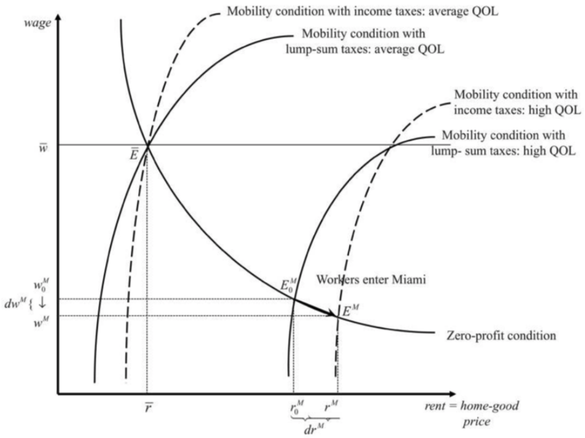


FIG. 2.—Effect of federal taxes on a high-quality-of-life city. In a simplified model ($r^j = p^j$, $A_X^j = A_Y^j = 1$ for all j), replacing a lump-sum tax, T, with a utility-equivalent federal income tax, τ, lowers wages, w, and raises rents, r, and employment in Miami, labeled "M," a city with high quality of life ($Q^M > 1$), changing the equilibrium from E_0^M to E^M.

Explaining Albouy (JPE, 2009) Figure 2 in words

Initial Equilibrium

- Like Chicago, Miami is relatively crowded and has high rents, but as compensation, workers get a nicer environment rather than higher wages
- Labor demand is downward sloping (due to fixed land supply) and a larger supply of workers means a lower equilibrium wage
- Both cities have same TFP so on same zero-profit condition
- The mobility condition is lower and to the right in Miami because of higher quality of life

With progressive income taxes

- A worker is now more willing to bid down wage to live in Miami since a \$1 wage cut implies only a $\$(1-\tau)$ reduction in consumption
- Relative to initial equilibrium, more workers in Miami which raises the demand for land in both production and consumption $\Rightarrow$ rents increase by dr^M
- This also lowers the labor-to-land ratio, causing wages to fall dw^M

Outline

Setup

- Rosen-Roback: one type of worker with homogeneous tastes
  - Moretti (2011) adds idiosyncratic preferences for locations
- Piyapromdee: different worker types and taste heterogeneity
  - Education level: College vs. HS
  - Gender: F vs. M
  - Age: Young vs. Old
  - Immigrant status: Immigrant vs. Native
- Each city has 4-level nested CES function producing common traded good

Housing supply in each city

Housing "rental" rate in city c and year t:

$$R_{ct} = i_t \times CC_{ct} \times \left[\sum_j \gamma_h H_{jct} + \sum_j L_{jct} \right]^{\gamma_c}$$

- i_t = interest rate in t
- CC_{ct} = unobserved construction cost in c at time t
- H_{jct} = number of high education workers in subgroup j, c and t
- L_{jct} = number of low education workers in subgroup j
- $j \in$ [immigrants/natives, young/old, F/M]
- $\gamma_h = 1.68$ is a scale factor
- γ_c = c-specific housing supply elasticity

Preferences across cities

Multinominal Logit Model (MNL) with utility:

$$U_{ict} = \max_{Q,G} \lambda_z \log(Q) + (1 - \lambda_z) \log(G) + u_i(N_{ct}) + \sigma_z \epsilon_{ict}$$

$$\text{s.t. } P_t G + R_{ct} Q = W_{ct}^z$$

- Q = amount of housing with price R_{ct}
- G = amount of numeraire good with price P_t
- $z = z(i)$, where z is immig/natives $\times$ young/old $\times$ F/M $\times$ edu level
- W_{ct}^z = wage earned by a person in group z
- λ_z = housing share parameter
- $\epsilon_{ict} \sim$ EV-I error with scale σ_z
- $u_i(N_{ct})$ = person-specific utility assigned to "network characteristics" N_{ct}, valued differently by each i

Utility maximization problem

Doing the maximization, we get

$$U_{ict} = w_{ct}^z - \lambda_z r_{ct} + \beta_z X_{ict} + \sigma_z \epsilon_{ict}$$

- $w_{ct}^z = \log(W_{ct}^z / P_t)$
- $r_{ct} = \log(R_{ct} / P_t)$
- Assumes we can rewrite $u_i(N_{ct}) = \beta_z X_{ict}$

Indirect utility depends on log real wage (w_{ct}^z), and on the log of real housing prices (r_{ct}), but the weight on the real housing price depends on λ_z

Utility maximization problem

Renormalize the indirect utility by dividing by σ_z:

$$\begin{aligned} U_{ict} &= \lambda_z^w (w_{ct}^z - \lambda_z r_{ct}) + \lambda_z^x X_{ict} + \epsilon_{ict} \\ &= \Gamma_{ct}^z + \lambda_z^x X_{ict} + \epsilon_{ict} \end{aligned}$$

- Γ_{ct}^z is common in city c at time t for all people in z

Note that

- Γ_{ct}^z captures all the endogenous variation in w_{ct}^z and r_{ct}
- X_{ict} captures person-specific network effects
    - E.g., person's country of birth and shares of previous immigrants from the same country in c and $t-10$

Estimation of MNL model

Method: two-step "micro-BLP" approach:

1. Estimate a MNL for location choice for person i including Γ^z_{ct} dummies and person-specific components
2. Calculate determinants of Γ^z_{ct} using $\hat{\Gamma}^z_{ct}$

Estimation

- Estimating equation for $\hat{\Gamma}^z_{ct}$:

$$\begin{aligned}\Delta\hat{\Gamma}^z_{ct} &\equiv \hat{\Gamma}^z_{ct} - \hat{\Gamma}^z_{ct-10} \\ &= \lambda^w_z(\Delta w^z_{ct} - \lambda_z \Delta r_{ct}) + \Delta amenity^z_{ct} + sampling\ error\end{aligned}$$

  - $\Delta amenity^z_{ct}$ = change in the common amenity value of c to people in z
- Instrument $\Delta amenity^z_{ct}$ with "Bartik" shift-share IVs:
  - Based on lagged industry shares in c and national changes in employment in each industry
  - Interacted with the 2 shifters of local housing elasticity

Estimates of $\lambda_z^w = 1/\sigma_z$

Table 5: Parameter Estimates

A. Worker preferences				
	High skill natives	Low skill natives	High skill immigrants	Low skill immigrants
Wage	4.028**	3.725**	1.228**	0.726**
	(0.122)	(0.059)	(0.014)	(0.019)
Implied Rent	-1.208	-1.341	-0.367	-0.247
B. Elasticity of Substitution				
σ_E: skill level	2.576**	σ_{M-H}: high-skill	12.903**	
	(0.577)	nativity	(2.480)	
σ_G: gender	1.924**	σ_{M-L}: low-skill	19.928**	
	(0.591)	nativity	(4.165)	
σ_A: age	8.315**			
	(2.701)			
C. Housing Supply Elasticities		D. Predicted Inverse Housing Supply Elasticities		
Land regulation	3.368**	Mean	0.211	
	(0.079)	SD	0.036	
Geo. constraints	1.223	Minimum	0.153	
	(1.152)	Maximum	0.336	
Base housing supply elasticity	1.605**			
	(0.575)			

Standard errors in parentheses, clustered by MSA. **p<0.05, *p<0.1. Wage parameter estimates represent worker's demand elasticity with respect to local real wage in a small city. Implied rent preferences are the

Estimates of N_{ct} for natives

Table 6: Network Effects for Natives

	Young male high skill natives			Young female high skill natives		
	1990	2000	2007	1990	2000	2007
Birth state	2.947**	2.864**	3.086**	3.063**	3.186**	2.751**
	(5.0E-6)	(5.8E-6)	(8.4E-6)	(5.7E-6)	(8.2E-6)	(3.0E-6)
Distance (1000 miles)	-0.631**	-0.648**	-0.582**	-0.632**	-0.567**	-0.896**
	(3.8E-6)	(4.2E-6)	(4.4E-6)	(4.3E-6)	(4.5E-6)	(4.8E-6)

	Old male high skill natives			Old female high skill natives		
	1990	2000	2007	1990	2000	2007
Birth state	2.598**	2.512**	2.82**	2.437**	2.707**	2.369**
	(1.1E-5)	(7.0E-6)	(7.8E-6)	(1.3E-5)	(9.9E-6)	(3.9E-6)
Distance (1000 miles)	-0.767**	-0.781**	-0.617**	-0.925**	-0.742**	-0.978**
	(9.5E-6)	(6.2E-6)	(5.3E-6)	(1.3E-5)	(7.7E-6)	(6.3E-6)

	Young male low skill natives			Young female low skill natives		
	1990	2000	2007	1990	2000	2007
Birth state	3.808**	3.82**	3.92**	3.482**	3.754**	3.847**
	(7.6E-6)	(9.8E-6)	(1.1E-5)	(6.5E-6)	(1.2E-5)	(1.4E-5)
Distance (1000 miles)	-0.556**	-0.524**	-0.506**	-0.771**	-0.599**	-0.569**
	(7.0E-6)	(6.5E-6)	(7.0E-6)	(8.8E-6)	(8.1E-6)	(9.6E-6)

Estimates of N_{ct} for immigrants

Table 7: Network Effects for Immigrants

	Young male high skill immigrants			Young female high skill immigrants		
	1990	2000	2007	1990	2000	2007
Number of previous immigrants	2.273**	1.402**	0.991**	2.432**	1.644**	1.146**
from same country (in million)	(1.0E-4)	(4.8E-5)	(2.9E-5)	(1.3E-4)	(5.6E-5)	(3.4E-5)

	Old male high skill immigrants			Old female high skill immigrants		
	1990	2000	2007	1990	2000	2007
Number of previous immigrants	2.485**	1.683**	1.205**	2.673**	2.046**	1.391**
from same country (in million)	(2.6E-4)	(1.0E-4)	(4.8E-5)	(3.3E-4)	(1.3E-4)	(5.9E-5)

	Young male low skill immigrants			Young female low skill immigrants		
	1990	2000	2007	1990	2000	2007
Number of previous immigrants	2.445**	1.601**	1.245**	2.602**	1.762**	1.38**
from same country (in million)	(2.9E-5)	(1.4E-5)	(9.4E-6)	(5.1E-5)	(2.4E-5)	(1.8E-5)

	Old male low skill immigrants			Old female low skill immigrants		
	1990	2000	2007	1990	2000	2007
Number of previous immigrants	3.061**	1.809**	1.328**	3.015**	1.885**	1.419**
from same country (in million)	(9.0E-5)	(2.6E-5)	(1.3E-5)	(1.1E-4)	(3.3E-5)	(1.8E-5)