Spatial Equilibrium: Roback 1982 and Glaeser and Gottlieb 2009

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Administration

- I have a homework exercise on monocentric city with Cobb-Douglas preferences. It's good practice if you have time.
- Guanfu will present some of his work today between periods
- Do any grad students want to present work on spatial equilibrium in China?
- Zheng, Fu, Liu, "Demand for Urban Quality of Living in China: Evolution in Compensating Land-Rent and Wage-Rate Differentials." *Journal of Real Estate Finance and Economics*, 2009.

How do we price negative effect of pollution?

Most cost-benefit analyses of “bads”, like pollution, need some measure for negative effect of pollution

In order to evaluate policy we usually calculate a marginal willingness to pay; this can be compared to cost of implementing some pollution reduction policy

So, if you wanted to quantify the negative effect of pollution on Beijing, how would you do it?

What would you try to measure? How would you report your results?

What method would you use to identify this effect? What data would you use?

Spatial Equilibrium Framework

A very useful method for estimating the value (or cost) of location specific factors is to try and infer this value from the decision of mobile agents

In the spatial equilibrium framework workers have utility over tradable goods, non-tradable goods (ex: housing), and the location specific factors (“amenities)

Since utility must be equal across locations, wages and housing prices adjust to make workers indifferent

Therefore we can infer the value of amenities from wages and housing prices

Wages, Rents, and the Quality of Life, JPE 1982

Very famous paper from Roback's 1980 thesis, 2700 citations

Not only important to Urban Economics literature but also quite important to Labor (local labor markets–see references on last slide), Environmental Economics (pricing of environmental amenities), Trade (markets and industry concentration), and Development (migration)

Many theoretical extensions to consider heterogeneous agents, tax policy, agglomeration and congestion

Recent work uses framework in quite rigorous empirical estimation of quality of life and city wage differentials (see Albouy, "Are Big Cities Bad Places to Live? Estimating Quality of Life across Metropolitan Areas.")

Workers

Identical workers with cost-less migration, each supplies one unit of labor

Different cities have different *exogenous* amenities (ex: warm climate, natural beauty, clean air), denoted s

Worker utility is function of s, consumption of composite commodity X (numeraire, paid with wage w), and consumption of land l^c (rented at r)

$$\max_{x,l^c} U(x, l^c; s) \text{ s.t. } x + r * l^c = w + I \tag{1}$$

Free migration ensures spatial equilibrium condition of equal utility:

$$V(w, r; s) = k \tag{2}$$

Assume amenity increases utility: $V_s = \partial V / \partial s > 0$

Firms

Firms produce X with CRS production function $X = f(L^p, N; s)$, where N is number of workers and L^p is land used in production

In equilibrium the unit cost (CRS) must equal price of X (assumed to be 1); if not firms could relocate to more profitable cities, which would increase factor prices (land, labor) in those cities until equilibrium is reached

$$C(w, r; s) = 1 \tag{3}$$

Let $C_w = N/X$ and $C_r = L^p/X$; the amenity may be unproductive $C_s < 0$ or productive $C_s > 0$

An amenity that is positive for consumers (clean air) may be unproductive for firms (clean air regulation may require expensive non-polluting technology)

Equilibrium

In equilibrium wages and rents adjust so that workers are indifferent across locations:

$$V(w, r; s) = k \tag{2}$$

$$C(w, r; s) = 1 \tag{3}$$

$$L^p + N * l^c = L \qquad \text{(Land Constraint)}$$

Can use equations 2) and 3) to determine wages w and rent r

Easiest way is to graph isocost curves ($C = 1$) and indifference curves ($V = k$) in wage w and rent r space

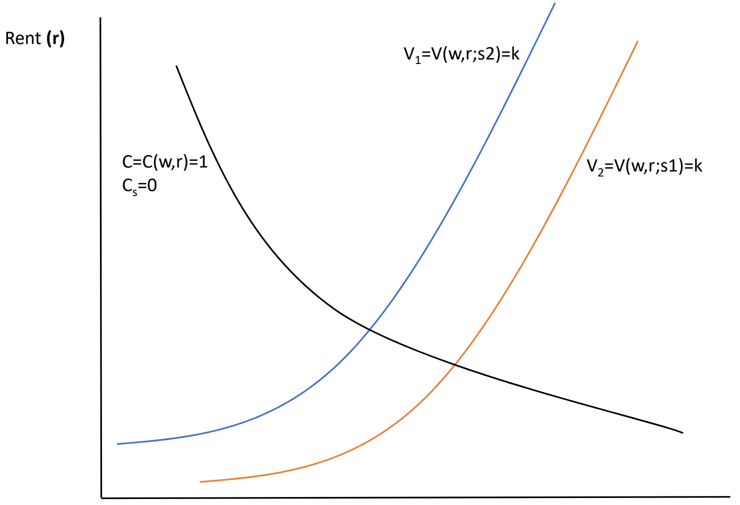
Can vary amount of amenity s to see effect on curves and solve for equilibrium levels of w and r

Benchmark Cases

In David Card's lecture notes he considers some simple cases to build up the intuition before considering Roback's Figure 1

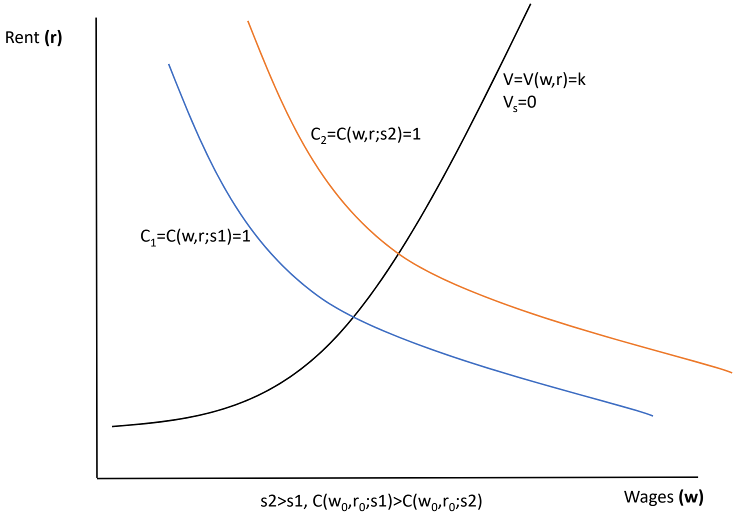
- Say that the amenity has no effect on production ($C_s = 0$) and one city has nicer weather than another, $s_2 > s_1$, $V_s > 0$. How will wages and rent compare across the two cities? Will both wages and rent adjust or is one enough?
- What if the amenity has no effect on utility but does lower the cost of production: $s_2 > s_1$, $C_s < 0$, $V_s = 0$? For example, one city has access to cheap hydroelectricity (from an ugly river).
- Consider again a consumer amenity but for the case where not only does the amenity have no effect on production, but *also* land is not even used in production.

Consumer Amenity Only



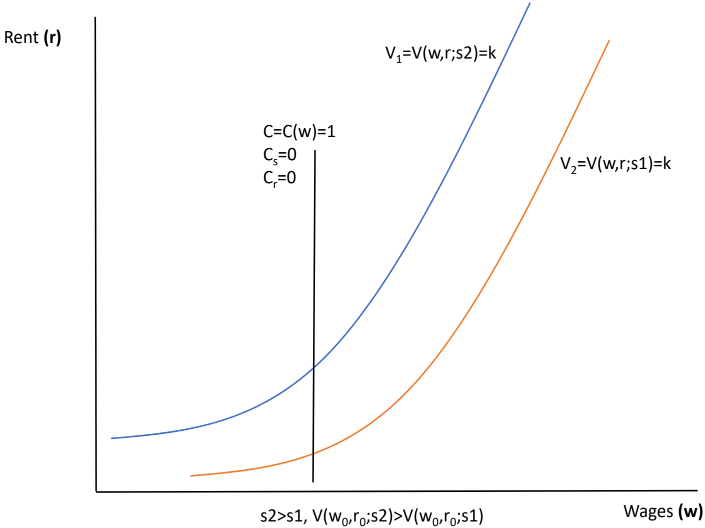
s2>s1, $V(w_0,r_0;s2)>V(w_0,r_0;s1)$

Producer Amenity Only



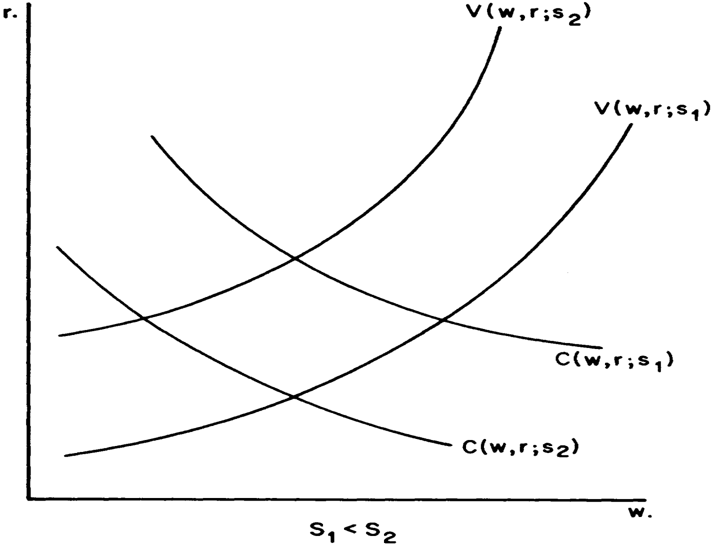
s2>s1, $C(w_0,r_0;s1)>C(w_0,r_0;s2)$

Consumer Amenity, No Land in Production



Consumer Amenity, Producer Disamenity

What if s is valued by consumer but increases cost of producer?



Equilibrium Wage and Rent

If s is valued by consumers but a disamenity for producers then wages are lower in s_2 city but rent may be higher or lower

Similarly, if s is valued by producers but a disamenity for consumers (ex: low pollution standards) then rent will be higher in low s city but wages are uncertain

Differentiate both equilibrium conditions, $V(w,r;s) = k$ and $C(w,r;s) = 1$ w.r.t. s:

$$\frac{dw}{ds} = \frac{-V_s * C_r + C_s * V_r}{V_w * C_r - V_r * C_w} \quad (4)$$
$$\frac{dr}{ds} = \frac{-V_w * C_s + V_s * C_w}{V_w * C_r - V_r * C_w}$$

Denominator is always positive (next slide) so if $V_s > 0$ and $C_s > 0$ then $dw/ds < 0$ but $dr/ds <> 0$

Using Roy's Identity for Consumer Land Demand

$$V(r, w; s) = \max_{x, l^c} U(x, l^c; s) \text{ s.t. } x + r * l^c = w + I \qquad (1)$$

Let λ be marginal utility of additional unit of income, then:

$$\frac{\partial V}{\partial w} = V_w = \lambda$$
$$\frac{\partial V}{\partial r} = V_r = -\lambda * l^c$$

This gives us $V_r = -V_w * l^c$, which we also know from Roy's identity (ratio of derivative of indirect utility w.r.t. price and w.r.t. wealth is equal to Marshallian demand)

Then since $C_r = L^p$ and $C_w = N/X$, we know that $V_w * C_r - V_r * C_w = V_w * l^p - (-V_w * l^c) * (N/X) = V_w * L/X > 0$

Quality of Life Derivation

Using the equilibrium condition we can infer the value of the amenity from changes in wages and rents

$$\Omega(s) = V(w(s), r(s), s) = k$$
$$\frac{d\Omega(s)}{ds} = \frac{\partial V}{\partial w}\frac{dw}{ds} + \frac{\partial V}{\partial r}\frac{dr}{ds} + \frac{\partial V}{\partial s} = 0$$

Using Roy's identity we get:

$$Vs = -V_w * \frac{dw}{ds} + V_w * l^c * \frac{dr}{ds}$$
$$p_s^* \equiv \frac{V_s}{V_w} = l^c * \frac{dr}{ds} - \frac{dw}{ds} \quad (5)$$

This p_s^* is the marginal willingess to pay for an additional unit of the amenity s

Quality of Life and Valuing Amenities

$$p_s^* \equiv \frac{V_s}{V_w} = I^c * \frac{dr}{ds} - \frac{dw}{ds} \tag{5}$$

Albouy (2012) takes the total differential of the spatial equilibrium equation and log-linearizes around national averages of wages and prices; this gives him an index of quality of life that does not require choosing amenities (basically a residual from wages and prices for traded and non-traded goods)

The application of Roback (and Glaeser Gottlieb) is to value specific amenities (denote with z) by estimating dr/dz and dw/dz using regressions of rents on z and wages on z across cities with different amounts of z

Roback then multiplies the calculated weight p_z^* times the amount of the attribute z in a city, for all attributes $z \in Z$, to get a measure of quality of life

Example Valuation

Say z is a bad amenity, such as crime or pollution; we want to know how people value a reduction in this bad

Roback re-writes eq5 as budget shares (easier estimation)

$$p_z^* \equiv \frac{V_z}{V_w} = l^c * \frac{dr}{dz} - \frac{dw}{dz} = w\left[\frac{l^c * r}{w} * \frac{dr}{dz} * \frac{1}{r} - \frac{dw}{dz} * \frac{1}{w}\right]$$

$$\frac{p_z^*}{w} = k_l \frac{d \log r}{dz} - \frac{d \log w}{dz} = k_l * \gamma_r - \gamma_w$$

In the above eq. k_l is the share of budget spent on land

Then we take an estimate of k_l, run regressions for γ's, and plug back into eq 5:

$$\log w_{ic} = x_i\beta + \gamma_w * z_c + \epsilon_{ic}$$

$$\log r_c = \gamma_r * z_c + \mu_c$$

Roback's Extensions

Roback then extends the basic model by introducing a non-tradable goods (housing) sector

This sector also competes for land use; incorporating this sector allows author to derive effect of change in s on utility as function of house price changes *and* wages

Glaeser and Gottlieb extend this set-up even further and look more deeply at empirical implications

Glaeser Gottlieb 2009: Introduction

Paper starts out by noting that while research on economic growth tends to focus on cross-country differences, differences *within* countries are also quite large

In US, productivity in most productive cities is more than three times productivity in lowest cities

Further, population is very concentrated: 68% of Americans live in 1.8% of land (we've seen this stat before)

Authors use classic spatial equilibrium model (Rosen-Roback) to explain how to empirically study these issues

Three key equilibrium conditions: 1) workers indifferent between locations 2) firms indifferent about hiring more workers 3) builders indifferent about building more housing supply

After describing model they show several empirical applications

Productivity and City Size

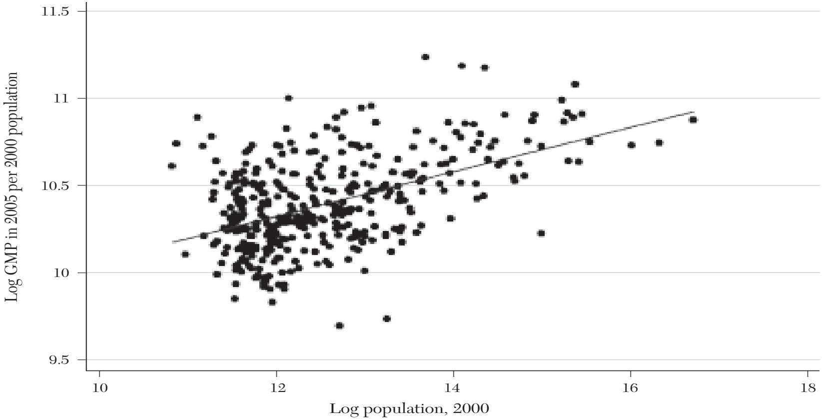


Figure 1. Productivity and City Size

Notes: Units of observation are Metropolitan Statistical Areas under the 2006 definitions. Population is from the Census, as described in the Data Appendix. Gross Metropolitan Product is from the Bureau of Economic Analysis.

The regression line is $\log GMP\ per\ capita = 0.13\ [0.01] \times \log population + 8.8\ [0.1]$. $R^2 = 0.25$ and $N = 363$.

Persistence of Productivity

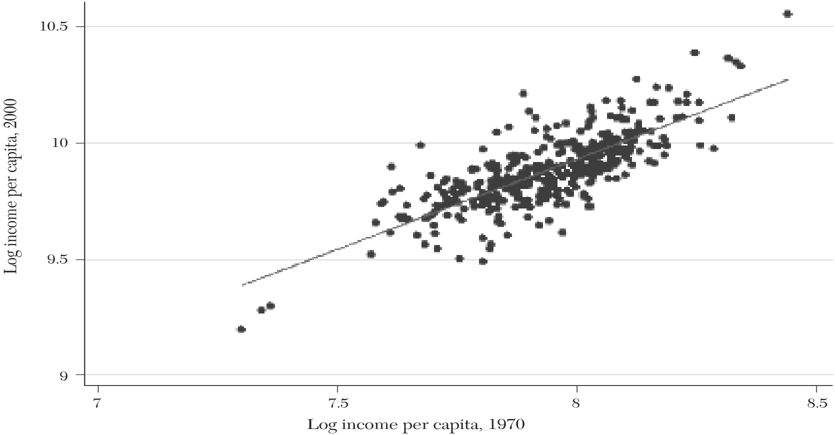


Figure 2. Income Over Time

Notes: Units of observation are Metropolitan Statistical Areas under the 2006 definitions, using Metropolitan Divisions where applicable. Data are from the Census, as described in the Data Appendix.

The regression line is $\textit{Income 2000} = 0.77\ [0.03] \times \textit{Income 1970} + 3.75\ [0.26]$.
$R^2 = 0.60$ and $N = 363$.

City Production of Tradable Good

City-level production function with two types of capital: 1) tradable K_T with national exogenous price γ_t and 2) non-tradable K_N (ex: land) with local endogenous price γ_N

Assume that amount of non-traded capital is fixed at stock $\bar{K_N}$, then:

$$G_T = A_t^i \bar{K_N}^{\alpha\gamma} K_T^{\alpha(1-\gamma)} L^{1-\alpha} \qquad \text{(GG1)}$$

Taking FOC w.r.t. L and K_T (assume some price of output) gives (inverse) demand for labor:

$$\phi A_t^i \bar{K_N}^{\alpha\gamma} L^{-\alpha\gamma} = W^{1-\alpha(1-\gamma)} \qquad \text{(GG2)}$$

The term ϕ includes price of output, price of traded capital, and other constants

Worker Utility 1

Workers get utility from 1) traded goods G_T 2) non-traded goods G_N and 3) amenities θ_t^i

Can write this as indirect utility function like $V(w, r; s)$, with Y_t^i as income (wage), P_t^i as price of non-traded good (housing), and amenities:

$$V(Y_t^i, P_t^i, \theta_t^i) \tag{GG3}$$

Authors note that spatial equilibrium condition implies constant utility: $V(Y_t^i, P_t^i, \theta_t^i) = U_t$

Then holding θ fixed and taking the total differential we have $dV = V_y dY + V_p dP = 0$, or

$$\frac{dY}{dP} = -\frac{V_P}{V_Y} \tag{1}$$

An increase in housing prices is associated with higher income, or higher incomes are offset by higher housing prices

Worker Utility 2

Authors assume Cobb-Douglas utility with amenity multiplier: $U = \theta_t^i G_T^{\beta} G_N^{1-\beta}$

Then, optimizing and plugging demand equations back into utility function gives indirect utility (ω is constant):

$$V = \omega \theta_t^i W_t^i (P_t^i)^{\beta - 1} \qquad \text{(GG4)}$$

Setting this equal to country utility U_t we can solve for wage and take logs:

$$log(W_t^i) = log(U_t) + (1-\beta) log(P_t^i) - log(\theta_t^i) \qquad \text{(GG5)}$$

Housing Prices vs Income

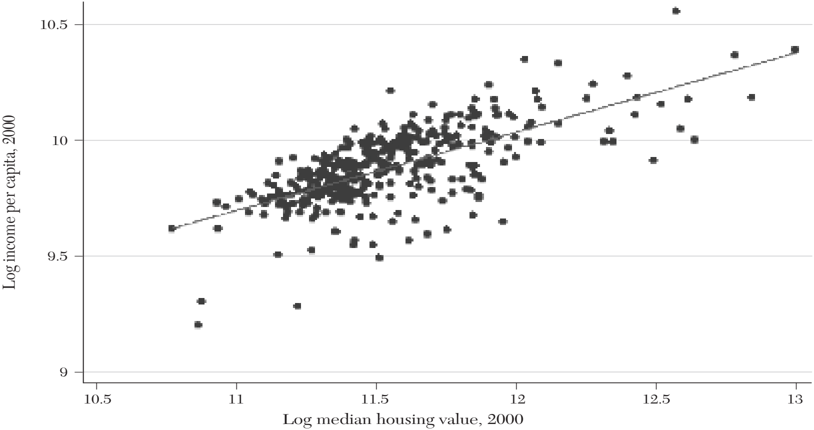


Figure 3. Housing Prices and Income

Notes: Units of observation are Metropolitan Statistical Areas under the 2006 definitions. Data are from the Census, as described in the Data Appendix.

The regression line is $\log income = 0.34\ [0.02] \times \log value + 5.97\ [0.22]$. $R^2 = 0.46$ and $N = 363$.

Production of Non-Tradable Sector

Again, assume there is labor L and tradable and non-tradable capital in production of H

Tradable capital is same as in city production of tradable good, K_T

Non-tradable capital (land) is different: Z_N, fixed at $\bar{Z}_N$

$$G_N = H_t^i {\bar{Z}_N}^{\mu\eta} K_T^{\mu(1-\eta)} L^{1-\mu} \tag{GG6}$$

Note: I think equation at top of p993 has typo (should be K_T, not K_N)

Term H_t^i is non-tradable productivity multiplier

Output of Non-Tradable Sector (Housing)

Then with price P_t^i profit maximization gives output as:

$$\left((P_t^i)^{1-\mu\eta} H_t^i W^{(\mu-1)}\right)^{1/\mu\eta} \bar{Z}_N \quad \text{(GG7)}$$

Can also solve for labor demand from this non-tradable sector, which authors note is $(1-\mu)(1-\beta) * N_t^i$, where N_t^i is city population

This part is generally unclear but population can be determined by labor demand for two sectors

Equilibrium

Authors do not clearly write equilibrium equations; however, given text we can write this as:

$$L^i_{Tt}(W^i_t) + L^i_{Nt}(W^i_t, P^i_t) = N^i_t \quad (1)$$

$$\left((P^i_t)^{1-\mu\eta} H^i_t W^{(\mu-1)}\right)^{1/\mu\eta} \bar{Z}_N = (1-\beta) W^i_t / P^i_t \quad (2)$$

$$V(W^i_t, P^i_t, \theta^i_t) = \omega \theta^i_t W^i_t (P^i_t)^{\beta-1} = U_t, \forall i \quad (3)$$

$$\sum_i N^i_t = N_t \quad (4)$$

Eq 1 sums workers in two sectors, Eq 2 equates output of non-tradable good with expenditure from local consumers, Eq 3 is spatial equilibrium, Eq 4 distributes labor over all markets (labor market clearing)

Note: slides from Joaquin Blaum (MIT presentation) were very useful in corroborating above equations and I mostly use his notation

Equilibrium Solution

$$log(N_t^i) = \kappa_N + \lambda_A^N log(A_t^i \bar{K_N}^{\alpha\gamma}) + \lambda_H^N log(H_t^i \bar{Z_N}^{\mu\eta}) + \lambda_\theta^N log(\theta_t^i)$$
$$log(W_t^i) = \kappa_W + \lambda_A^W log(A_t^i \bar{K_N}^{\alpha\gamma}) + \lambda_H^W log(H_t^i \bar{Z_N}^{\mu\eta}) + \lambda_\theta^W log(\theta_t^i)$$
$$log(P_t^i) = \kappa_P + \lambda_A^P log(A_t^i \bar{K_N}^{\alpha\gamma}) + \lambda_H^P log(H_t^i \bar{Z_N}^{\mu\eta} + \lambda_\theta^P log(\theta_t^i)$$

Following table shows how parameters from model feed into λ's and can be used for comparative statics

- Increase in tradable good productivity increases population, wages, house prices
- Increase in housing construction productivity increases population, decreases wages and house prices
- Increase in amenities increases population but decreases wages and house prices

Parameter Table

TABLE 2
ESTIMATING PARAMETERS

Equation parameters	Value of parameters in the baseline model	Value of parameters with agglomeration economies
λ_A^N	$\frac{\beta + \mu(1-\beta)(1-\eta)}{((1-\alpha)\eta + \alpha\gamma)\mu(1-\beta) + \alpha\beta\gamma}$.	$\frac{\beta + \mu(1-\beta)(1-\lambda)}{(1-\alpha+\omega)(1-\beta)\eta\mu + (\mu+\beta-\mu\beta)(\alpha\gamma-\omega)}$
λ_H^N	$\frac{(1-\alpha+\alpha\gamma)(1-\beta)}{((1-\alpha)\eta + \alpha\gamma)\mu(1-\beta) + \alpha\beta\gamma}$.	$\frac{(1-\alpha+\alpha\gamma)(1-\beta)}{(1-\alpha+\omega)(1-\beta)\eta\mu + (\mu+\beta-\mu\beta)(\alpha\gamma-\omega)}$
λ_θ^N	$\frac{1-\alpha+\alpha\gamma}{((1-\alpha)\eta + \alpha\gamma)\mu(1-\beta) + \alpha\beta\gamma}$.	$\frac{1-\alpha+\alpha\gamma}{(1-\alpha+\omega)(1-\beta)\eta\mu + (\mu+\beta-\mu\beta)(\alpha\gamma-\omega)}$
λ_A^W	$\frac{\mu\eta(1-\beta)}{((1-\alpha)\eta + \alpha\gamma)\mu(1-\beta) + \alpha\beta\gamma}$.	$\frac{\mu\eta(1-\beta)}{(1-\alpha+\omega)(1-\beta)\eta\mu + (\mu+\beta-\mu\beta)(\alpha\gamma-\omega)}$
λ_H^W	$\frac{-\alpha\gamma(1-\beta)}{((1-\alpha)\eta + \alpha\gamma)\mu(1-\beta) + \alpha\beta\gamma}$.	$\frac{-(1-\beta)(\alpha\gamma-\omega)}{(1-\alpha+\omega)(1-\beta)\eta\mu + (\mu+\beta-\mu\beta)(\alpha\gamma-\omega)}$
λ_θ^W	$\frac{-\alpha\gamma}{((1-\alpha)\eta + \alpha\gamma)\mu(1-\beta) + \alpha\beta\gamma}$.	$\frac{-(\alpha\gamma-\omega)}{(1-\alpha+\omega)(1-\beta)\eta\mu + (\mu+\beta-\mu\beta)(\alpha\gamma-\omega)}$
λ_A^P	$\frac{\mu\eta}{((1-\alpha)\eta + \alpha\gamma)\mu(1-\beta) + \alpha\beta\gamma}$.	$\frac{\mu\eta}{(1-\alpha+\omega)(1-\beta)\eta\mu + (\mu+\beta-\mu\beta)(\alpha\gamma-\omega)}$
λ_H^P	$\frac{-\alpha\gamma}{((1-\alpha)\eta + \alpha\gamma)\mu(1-\beta) + \alpha\beta\gamma}$.	$\frac{-(\alpha\gamma-\omega)}{(1-\alpha+\omega)(1-\beta)\eta\mu + (\mu+\beta-\mu\beta)(\alpha\gamma-\omega)}$
λ_θ^P	$\frac{(1-\alpha)\mu\eta - (1-\mu)\alpha\gamma}{((1-\alpha)\eta + \alpha\gamma)\mu(1-\beta) + \alpha\beta\gamma}$.	$\frac{(1-\alpha+\omega)\eta\mu - (1-\mu)(\alpha\gamma-\omega)}{(1-\alpha+\omega)(1-\beta)\eta\mu + (\mu+\beta-\mu\beta)(\alpha\gamma-\omega)}$

How to use this in estimation

Researchers often try to estimate effect of some variable (X_t^i) on productivity in traded sector, non-traded sector, or amenities

$$\frac{\partial log(A_t^i \bar{K_N}^{\alpha\gamma})}{\partial X_t^i} = \delta_A \tag{2}$$

$$\frac{\partial log(H_t^i \bar{Z_N}^{\mu\eta})}{\partial X_t^i} = \delta_H \tag{3}$$

$$\frac{\partial log(\theta_t^i)}{\partial X_t^i} = \delta_\theta \tag{4}$$

This effect can be inferred by running regressions of population, wages, and prices on variable X_t^i

Inferring Effects

$$\hat{b}_N = E[N_t^i | X_t^i] = \lambda_A^N \delta_A + \lambda_H^N \delta_H + \lambda_\theta^N \delta_\theta \quad (5)$$

$$\hat{b}_W = E[W_t^i | X_t^i] = \lambda_A^W \delta_A + \lambda_H^W \delta_H + \lambda_\theta^W \delta_\theta \quad (6)$$

$$\hat{b}_P = E[P_t^i | X_t^i] = \lambda_A^P \delta_A + \lambda_H^P \delta_H + \lambda_\theta^P \delta_\theta \quad (7)$$

Or:

$$\delta_\theta = (1 - \beta)\hat{b}_P - \hat{b}_W \quad (8)$$

$$\delta_A = \alpha\gamma\hat{b}_N + (1 - \alpha(1 - \gamma))\hat{b}_W \quad (9)$$

$$\delta_H = \mu\eta\hat{b}_N + (1 - \mu_\mu\eta)\hat{b}_W - \hat{b}_P \quad (10)$$

Ex: to understand effect of crime on utility $\partial log(\theta_t^i)/\partial X_t^i = \delta_\theta$ we use estimates of house prices and wages on (exogenous) crime, plus need estimate of share of household expenditure on housing $(1 - \beta)$ from literature

Important: notice that this cannot be inferred solely from change in house prices, must also look at change in wages

Rise of the "Sunbelt"

In US, fastest growing areas have warm climates

These areas, in the south and west of US, are known as the "sunbelt"

Why has population growth shifted to sunbelt?

1. Has productivity increased in South?
2. Have political institutions become more efficient (and less corrupt)?
3. Has advent of air conditioning made South more comfortable (amenities)?
4. Are people attracted to cheap housing, made possible by pro-building policies?

Population Growth and Climate

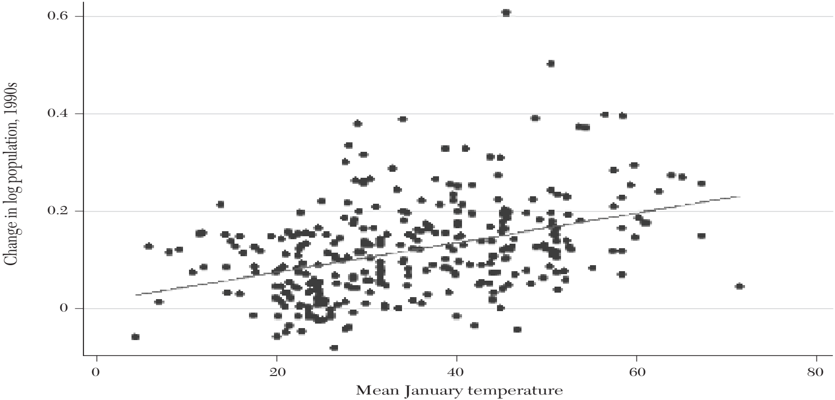


Figure 4. Population Growth and Temperature

Notes: Units of observation are Metropolitan Statistical Areas under the 1999 definitions, using Primary Metropolitan Statistical Areas rather than Consolidated Metropolitan Statistical Areas where applicable and New England County Metropolitan Areas where applicable. Population data are from the Census, as described in the Data Appendix. Mean January temperature is from the City and County Data Book, 1994.

The regression line is $\textit{Population growth} = 0.0030\ [0.0004] \times \textit{Temperature} + 0.02\ [0.01]$.
$R^2 = 0.16$ and $N = 316$.

Explaining the sunbelt 1

Authors run regressions of population, wages, and house values on temperature with controls

Combine coefficients using model to look at effect of temperature on amenities, productivity, housing construction productivity

Find

- Effect of temperature on productivity: -0.14
- Effect of temperature on amenities: $+0.59$–people are willing to give up 0.59% of real wages for an additional degree F.
- Effect of temperature on wages: -0.52

Sunbelt Regressions

TABLE 3
SPATIAL EQUILIBRIUM

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Log wage	Log house value	Log real wage	Log wage	Log house value	Log real wage
Year:	2000	2000	2000	1990, 2000	1990, 2000	1990, 2000
Mean January temperature	−0.19	0.60	−0.33			
	[0.06]	[0.31]	[0.10]			
Mean January temperature × year 2000				−0.001	−0.43	0.19
				[0.05]	[0.11]	[0.03]
Year 2000 dummy				0.25	0.62	0.06
				[0.02]	[0.06]	[0.02]
Individual controls	Yes	—	Yes	Yes	—	Yes
Housing controls	—	Yes	—	—	Yes	—
MSA fixed effects	—	—	—	Yes	Yes	Yes
N	1,590,467	2,341,976	1,590,467	2,950,850	4,245,315	2,950,850
R^2	0.29	0.36	0.21	0.27	0.60	0.26

Notes: Individual-level data are from the Census Public Use Microdata Sample, as described in the Data Appendix. Metropolitan-area population is from the Census, as also described in the Data Appendix. Mean January temperature is from the City and County Data Book, 1994, and is measured in hundreds of degrees Fahrenheit. Real wage is controlled for with median house value, also from the Census as described in the Data Appendix. Individual controls include age and education. Location characteristics follow Metropolitan Statistical Areas under the 1999 definitions, using Primary Metropolitan Statistical Areas rather than Consolidated Metropolitan Statistical Areas where applicable and New England County Metropolitan Areas where applicable. Standard errors are clustered by metropolitan area.

Explaining the sunbelt 2

Repeat exercise but look at growth instead of levels

Find that in 1990's temperature not correlated with *increases* in productivity or amenities but is correlated with increasing housing supply

Conclude that over longer period, rise of Sunbelt due to both increases in productivity and housing supply but *not* amenities

Emphasize that most expensive US cities had large housing price increases with very little population growth

Authors argue that more attention should be paid to housing supply as a driver of population growth

House Values and City Growth

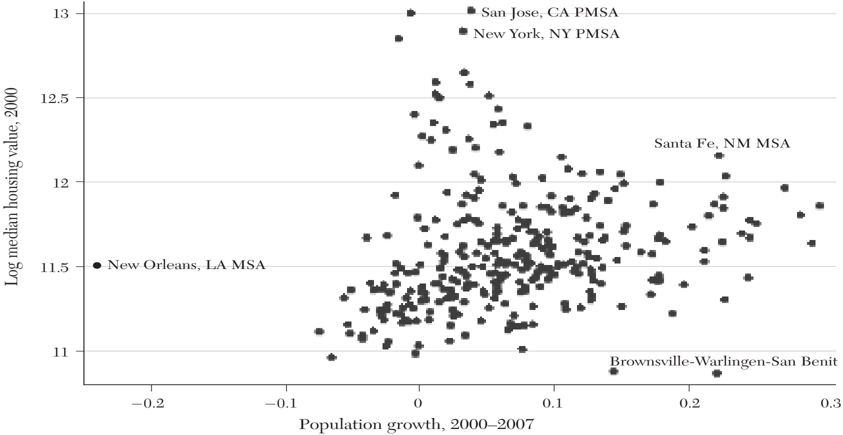


Figure 5. House Values and City Growth

Notes: Units of observation are Metropolitan Statistical Areas under the 1999 definitions, using Primary Metropolitan Statistical Areas rather than Consolidated Metropolitan Statistical Areas where applicable and New England County Metropolitan Areas where applicable. Data are from the Census, as described in the Data Appendix.

Agglomeration

Authors extend model by allowing productivity to be a function of population, similar to earlier papers in our class

This can strengthen some effects but also reverse others, depending on parameters

Example: increase in amenities increases population but that may now increase productivity, possibly increasing wages

Final Note: Estimation of Agglomeration

Typically we estimate agglomeration economies by regressing log income on log population or log density

Spatial equilibrium model shows that population is an outcome and thus must be endogenous: some omitted variable increasing productivity must increase population

Most papers try to instrument for population with a historical variable which may be exogenous to current unobservable productivity shocks

In context of GG model, this means either correlated with H_t^i or θ_t^i

Problem is that neither gives true treatment effect of population on productivity because will depend on other parameters (share of production associated with nontraded capital, or share of production associated with labor plus nontraded capital)

References

1. David Card's lecture notes on local labor markets: http://eml.berkeley.edu/ webfac/card/e250a_f16/lecture8-2016.pdf
2. Albouy, David, "Are Big Cities Bad Places to Live? Estimating Quality of Life across Metropolitan Areas.", Working Paper (under revision at JPE, see davidalbouy.net to download)
3. Zheng, Siqi, Fu, Yuming, Liu Hongyu, "Demand for Urban Quality of Living in China: Evolution in Compensating Land-Rent and Wage-Rate Differentials." *Journal of Real Estate Finance and Economics*, 2009.
4. Glenn C. Blomquist, Mark C. Berger and John P. Hoehn, "New Estimates of Quality of Life in Urban Areas." *The American Economic Review*,1988