Optimal Spatial Taxation
Are Big Cities Too Small?

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Motivaton

- Local labor markets (cities):
  1. Urban wage premium
  2. Location choice (size) determines prices (wages, housing)
- Ex ante identical agents $\rightarrow$ ex post heterogeneous

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- Local labor markets (cities):
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  2. Location choice (size) determines prices (wages, housing)
- Ex ante identical agents $\rightarrow$ ex post heterogeneous
- Government needs to raise revenue G:
  - Location choice responds to tax rate in local labor market
  - Tax cities differentially? Flat (proportional)? Lump sum?

$\rightarrow$ Propose GE model and estimate optimal income tax schedule

Motivation

Existing Federal Income Taxes

- Federal Taxes affect workers of same skill differentially
  1. Urban Wage Premium
  2. Progressive Taxation
- Average tax rate: 5% points difference *at median* income:

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	Labor Force	Wage level	Avg. Tax Rate
New York	9 million	1.5	19.0%
Asheville, NC	130,000	1	14.0%

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- Due to mobility: no redistribution $\Rightarrow$ same skills, same utility

$\therefore$ Focus on taxing ex ante identical agents

Motivation

- Taxes affect identical agents differently across cities
  - ⇒ In equilibrium: affects location decision
- Policy Question: Optimal Taxation across local labor markets
  - Are big cites *too small/too big*?

Findings

Representative Agent Economy

- Optimal Ramsey Tax rates in big cities:
  - relatively decreasing in Gvt spending G
  - relatively increasing in concentration of housing wealth
- For the US, benchmark economy:
  - Optimal tax higher in big cities (but lower than current)
  - Would lead to big relocation and output gain (6.9%)
  - Moderate welfare gain

Related Work

- Literature:
    - Impact of income taxation: Wildasin (1980), Glaeser (1998), Kaplow (1995), Knoll-Griffith (2003)
    - Quantitative: Albouy (2009), Albouy-Seegert (2010)
- Main difference: general equilibrium
- Prices, quantities (housing, consumption, population) are endogenous

Model

Model

- J cities, size l_j with $\mathcal{L} = \sum_j l_j$
- Preferences:
$$u(c, h) = a_j l_j^{\delta} \; c^{1-\alpha} h^{\alpha}$$
a_j: amenities; l_j^{δ} are congestion costs
- Mobility $\Rightarrow$ utility equalization:
$$u(c_j, h_j) = u(c_{j'}, h_{j'}), \quad \forall j, j'$$
- Production:
$$y_j = A_j l_j^{\gamma} \quad \Rightarrow \quad w_j = A_j l_j^{\gamma - 1}$$
- Market clearing: $\sum_j l_j = \mathcal{L}$ and $h_j l_j = H_j$

Model

Tax Schedule

- Pre tax income w; after tax income $\tilde{w}$
- To estimate US tax schedule (Heathcote-Storesletten-Violante 2012, and Bénabou 2002):

$$\tilde{w}_j = \lambda w_j^{1-\tau}$$

  - $\tau = 0$: proportional; $\tau > 0$: progressive; $\tau < 0$: regressive
  - US, estimated $\tau \approx 0.12$
- Taxes are used to finance government spending G
- $T^G = \phi \frac{G}{\mathcal{L}}$: fraction ϕ is transferred to households

Model

Housing Production

- On average: land value 30%, construction 70% of housing
  - → land from 25% (small) to 50% (big cities)
- Housing supply in city j (with K_j capital, L_j land)

$$H_j = B\left[(1-\beta)K_j^{\rho} + \beta L_j^{\rho}\right]^{1/\rho},$$

- Representative competitive firm in each city maximizes profits

Model

Ownership of Housing

- Housing value: 24% of output
  - Construction cost (17%): foregone consumption
  - Land value (7%): transfer
- Ownership distribution of housing is key to results
- Income from land is redistributed to the households:

$$T_j = (1 - \psi) \frac{\sum_j r_j L_j}{\sum_j l_j}$$

ψ captures concentration of land wealth

- $\psi = 0$: households hold perfectly diversified housing portfolio
- $\psi = 1$: all housing is held by zero measure landlords

Model

Ownership of Housing

- Model housing as an asset traded after policy impact
- But only at extreme cases
- Complication for more general setup: heterogeneity
  1. Initial distribution matters
  2. Trading assets $\Rightarrow$ ex post heterogeneity

Equilibrium Allocation

Equilibrium Allocation

The Household Problem

- Households solve:

$$\max_{\{c_j, h_j\}} u(c_j, h_j) = a_j l_j^{\delta} c_j^{1-\alpha} h_j^{\alpha}$$
$$\text{s.t. } c_j + p_j h_j \leq \tilde{w}_j + T_j + T^G$$

$\Rightarrow$ $p_j h_j = \alpha(\tilde{w}_j + T_j + T^G)$

- the indirect utility is:

$$u_j = a_j[(1-\alpha)^{1-\alpha}](\tilde{w}_j + T_j + T^G)^{1-\alpha} l_j^{\delta-\alpha} H_j^{\alpha}.$$

Equilibrium Allocation

Housing Production

- The firm maximizes its profits by choosing K_j and L_j

$$\max_{K_j, L_j} p_j \; B[(1-\beta)K_j^{\rho} + \beta L_j^{\rho}]^{1/\rho} - r_j L_j - r^K K_j$$

  (p_j housing price, r_j land rental price, r^K capital rental price)

- Set $r^K = 1$. Free entry + FOC's
  - $\Rightarrow$ the equilibrium housing supply is

$$h_j = B\left[(1-\beta)\left(\frac{1-\beta}{\beta} r_j\right)^{\frac{\rho}{1-\rho}} + \beta\right]^{1/\rho} L_j$$

Equilibrium Allocation

Worker Mobility

- Workers must be indifferent between locations j and j'

$$u_j = u_{j'}$$

- Normalize $a_1 = 1$, so

$$a_j = \frac{(\widetilde{w}_1 + T_1 + T^G)^{1-\alpha} l_j^{\alpha-\delta} \left[(1-\beta)\left(\frac{1-\beta}{\beta} r_1\right)^{\frac{\rho}{1-\rho}} + \beta\right]^{\alpha/\rho} L_1^{\alpha}}{(\widetilde{w}_j + T_j + T^G)^{1-\alpha} l_1^{\alpha-\delta} \left[(1-\beta)\left(\frac{1-\beta}{\beta} r_j\right)^{\frac{\rho}{1-\rho}} + \beta\right]^{\alpha/\rho} L_j^{\alpha}}$$

after using indirect utility and equilibrium housing supply.

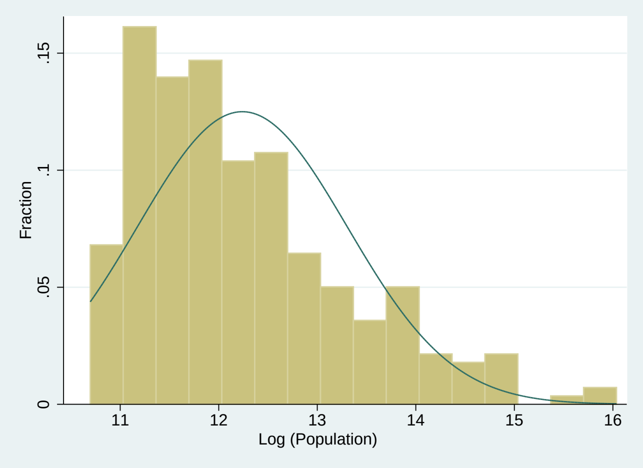
Quantitative Exercise

Quantitative Exercise

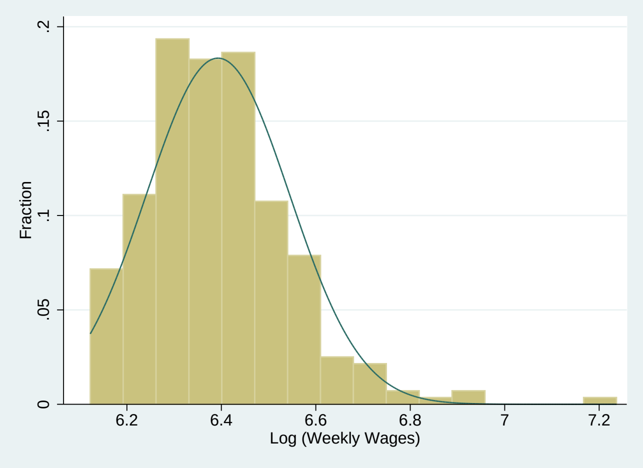
Benchmark Economy – Data

- Take w_j and l_j from the data. Set $\gamma = 1$, so $A_j = w_j$
- 2013 CPS. 264 MSAs. Age 16+ in labor force
- The average labor force is 484,373
  max: NY, 9.3 million; min: Bowling Green, KY, 37,000
- Average weekly wages is $645
  max: 70% above mean (Sante Fe, NM); half (Amarillo, TX)

Size distribution (Labor Force)



Wage Distribution



Quantitative Exercise

Benchmark Economy – Taxes

- The relation between after and before taxes

$$\tilde{w}_j = \lambda w_j^{1-\tau}$$

- Use the OECD tax-benefit calculator: $\lambda = 0.85, \tau = 0.12$
  - λ: Personal + Soc. Sec.: Robustness, $\lambda = 0.9$ and 0.815
  - τ: Robustness, $\tau = 0.053$ and 0.2

w	0.5	1	2	5
average tax rate	11.4%	15%	25%	32.8%

- We set $\phi = 0.5$ (half of tax revenue are transfers)

Quantitative Exercise

Benchmark Economy - Preference Parameters

- Housing Exp. 24% (Davis,Ortalo-Magné) $\Rightarrow \alpha = \frac{0.24}{\lambda} = 0.282$
- Commuting cost elasticity $\delta = -0.1$
  - $\rightarrow$ Kahn (2010): the joint effect of commuting time (opportunity wage cost) and direct commuting cost (transportation)
- Asset distribution: $\psi = 0.5$

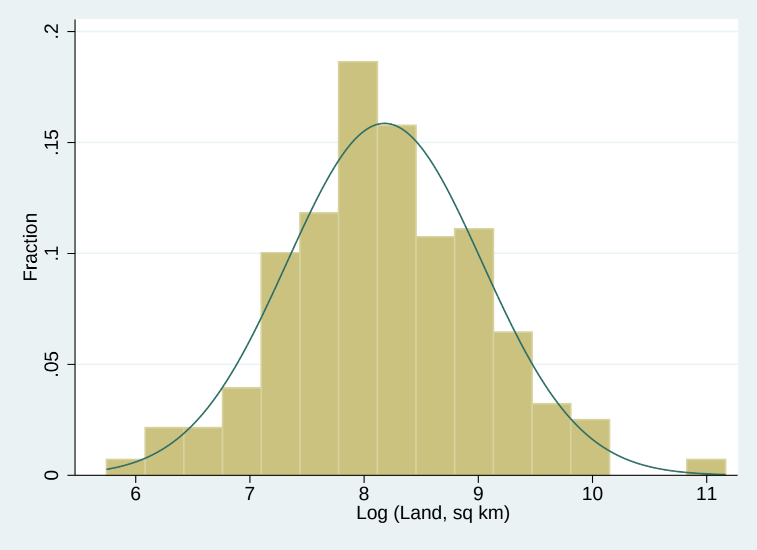
Quantitative Exercise

Benchmark Economy – Calibration

- Need to determine $\{\beta, \rho, B, L_j, a_j\}$.
- Select β and ρ such that:
  1. average share of land in housing cost is 0.3
  2. land share $\in [0.15, 0.5]$ across MSA
     (Davis-Palumbo (2007), Albouy-Ehrlich (2012))
- B such that $h = 200$ m^2 (average across MSAs)
- Use observed land area L_j (average across MSAs 5000 km^2)

Quantitative Exercise

Land Areas



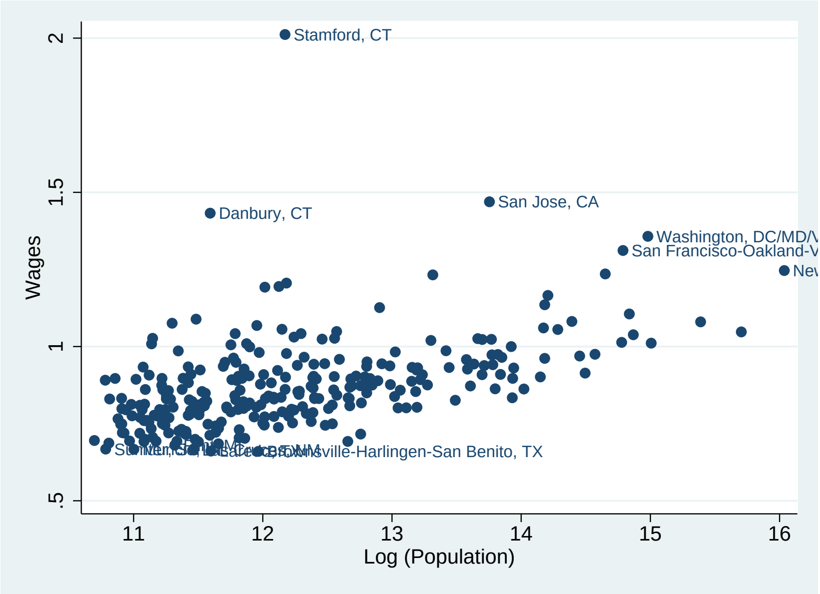
Quantitative Exercise

Benchmark Economy – Calibration

- Find a_j from utility equalization
- Benchmark Economy. Procedure:
  1. $A_j = w_j$ (FOC) and l_j from data
  2. given λ and τ, find $\{p_j, r_j, H_j, a_j, c_j, h_j, T_j\}$ such that l_j's are equilibrium allocations

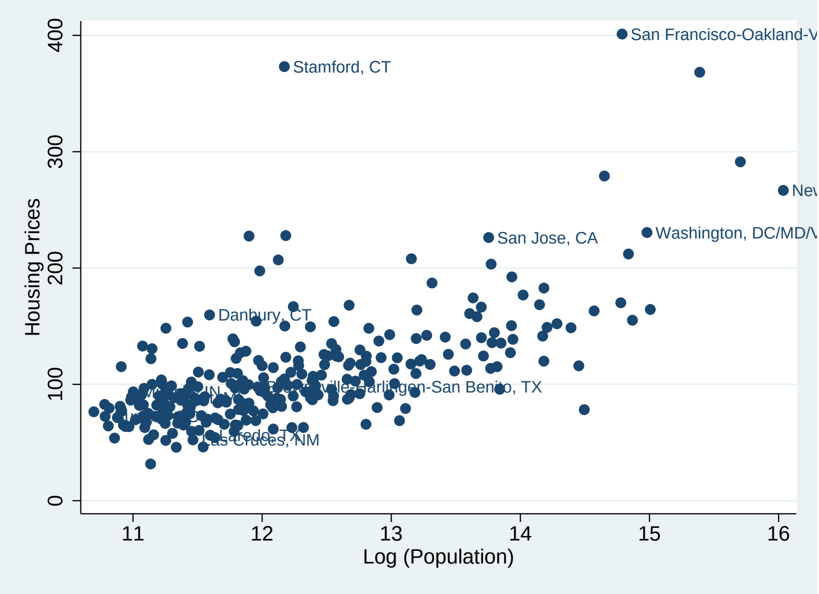
Quantitative Exercise

Benchmark Economy – Wages (observed)



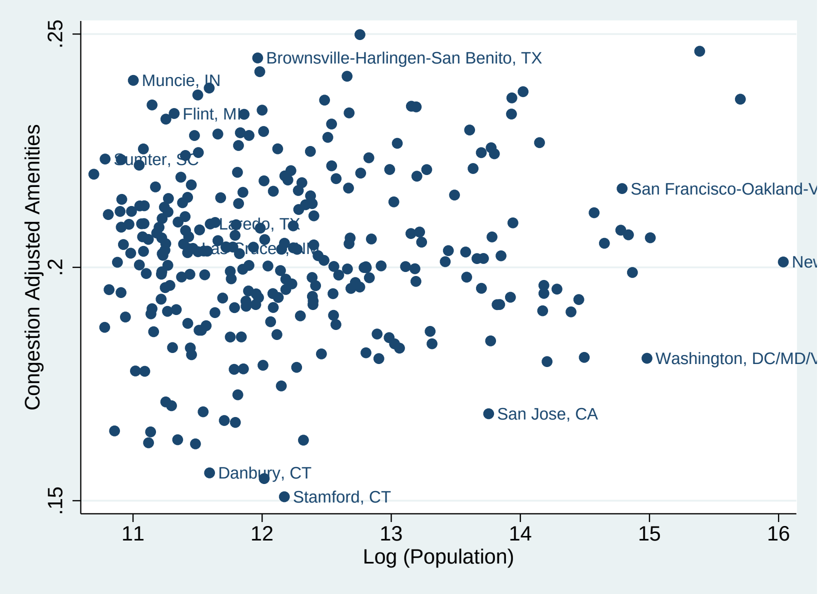
Quantitative Exercise

Benchmark Economy – Housing Prices



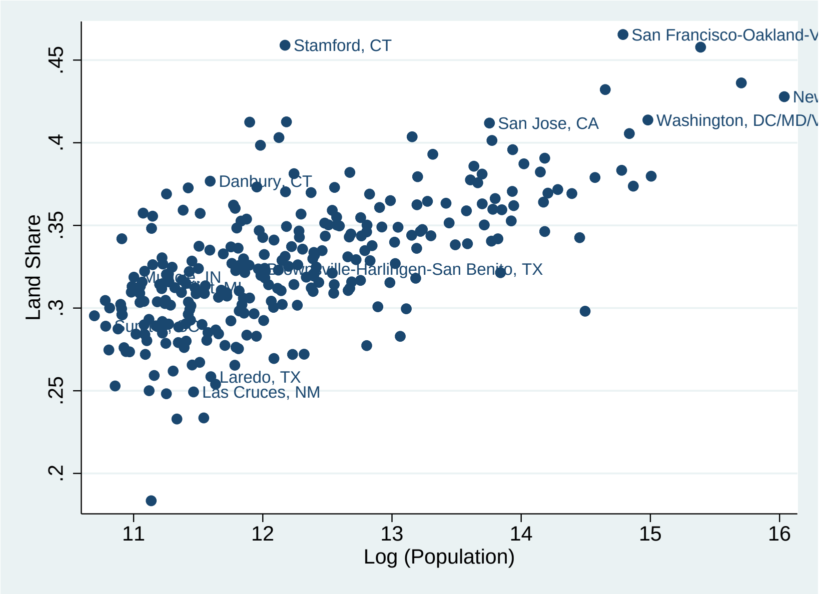
Quantitative Exercise

Benchmark Economy – Amenities



Quantitative Exercise

Benchmark Economy – Land Share in the Value of Housing



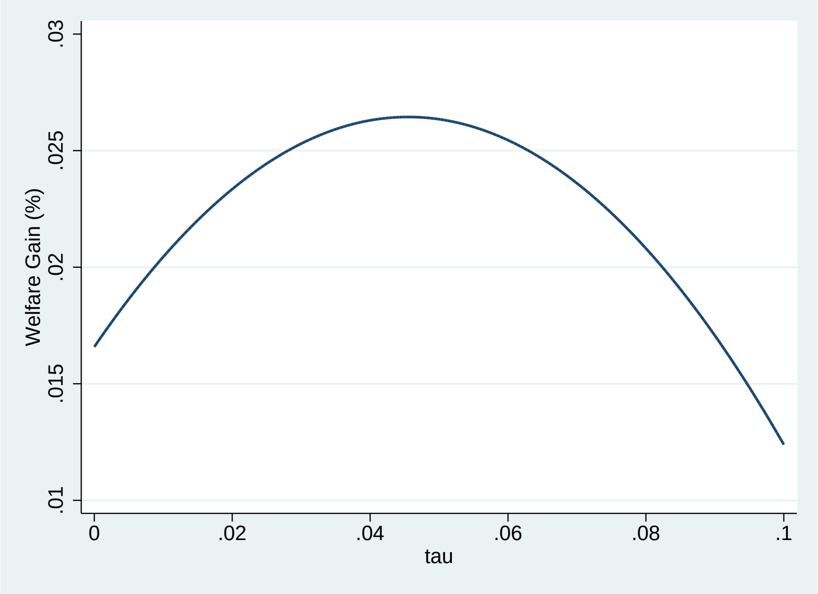
Quantitative Exercise

Optimal Taxation

- Given A_j and a_j from the benchmark economy, calculate:
  1. new equilibrium allocation $\{l_j, c_j, h_j, T_j, H_j\}$
  2. prices $\{p_j, r_j\}$

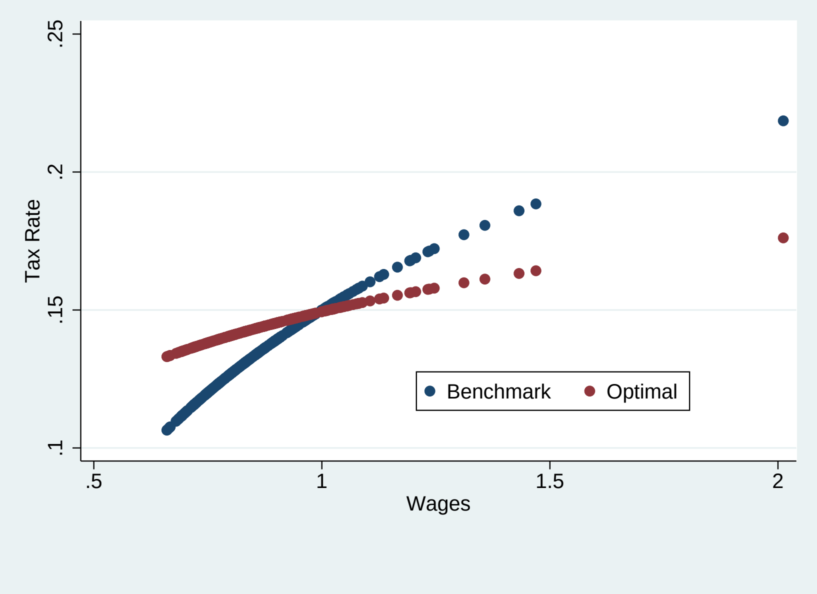
  for different λ, τ (λ such that revenue neutral)
- Select $\tau^\star$ that maximizes utility

Optimal Tax Schedule τ



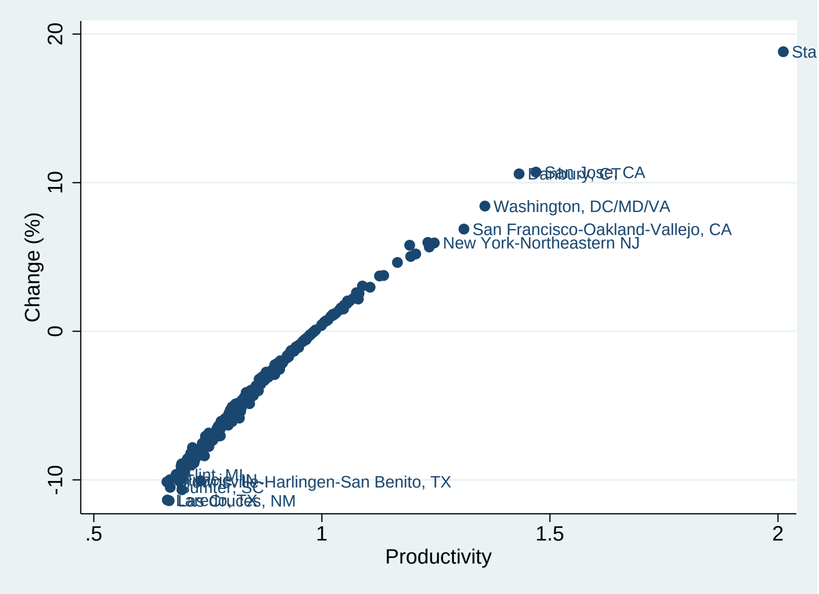
Tax Schedules

Actual vs. Optimal



Simulation: $\tau^{\star} = 0.046$

Change in Labor Force – Productivity



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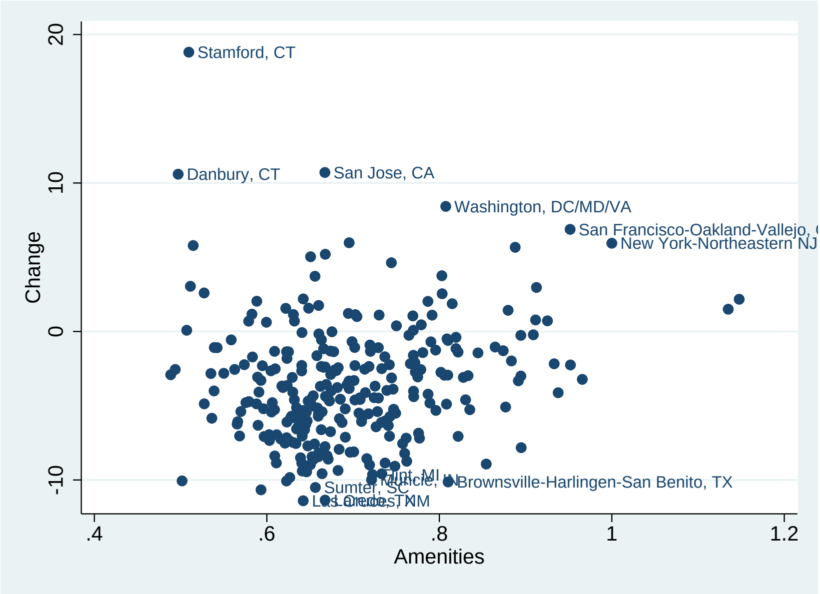

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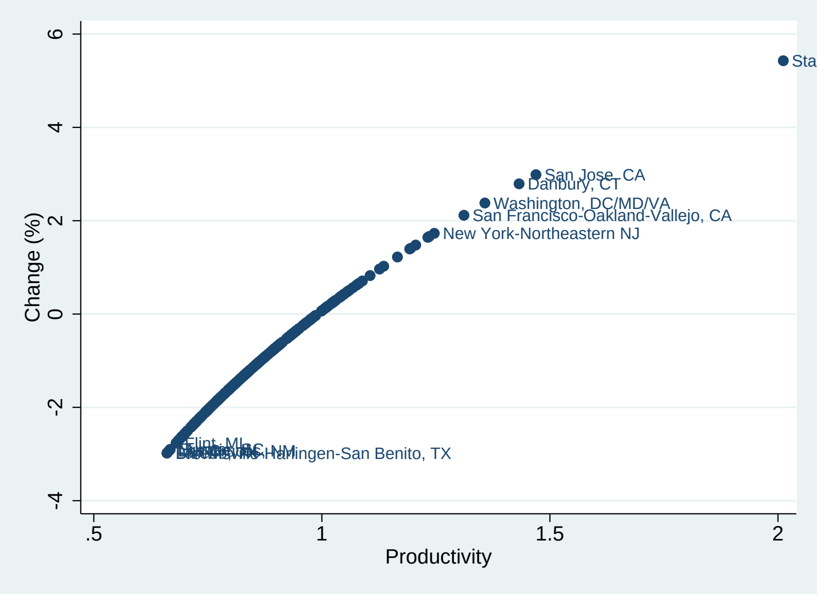
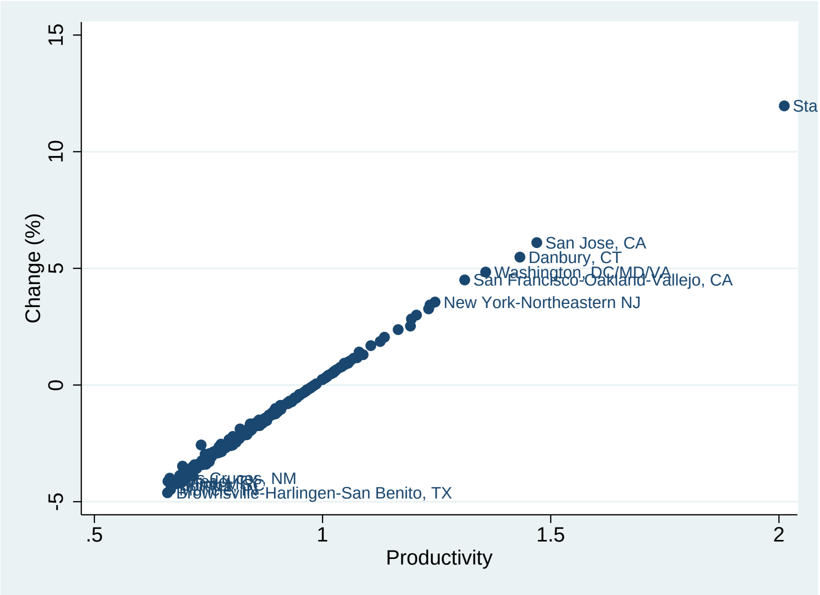
Change in After-tax Wages



Simulation: $\tau^{\star} = 0.046$

Change in Housing Prices

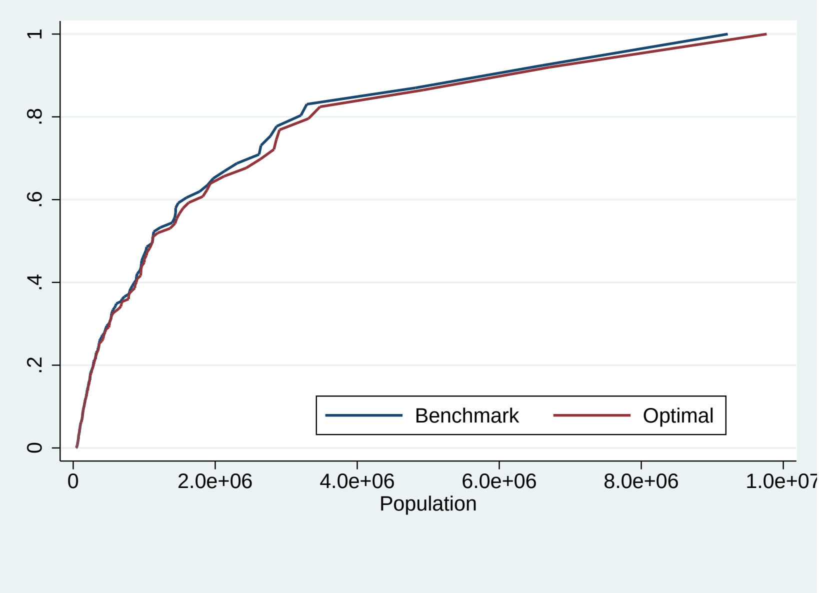


Outcomes for Selected Cities

MSA	A	a	$\%\Delta l$	$\%\Delta p$	$\%\Delta c$	$\%\Delta h$
Highest A						
Stamford, CT	2.01	0.51	18.8	12.0	5.1	-6.2
San Jose, CA	1.47	0.67	10.7	6.1	2.8	-3.2
Danbury, CT	1.43	0.50	10.6	5.5	2.6	-2.8
Lowest A						
Las Cruces, NM	0.67	0.64	-11.4	-4.0	-2.3	1.8
Laredo, TX	0.66	0.67	-11.4	-4.1	-2.3	1.9
Brownsville, TX	0.66	0.81	-10.1	-4.6	-2.3	2.4
Highest a						
Chicago, IL	1.08	1.15	2.2	1.4	0.6	-0.8
Los Angeles-Long Beach, CA	1.05	1.13	1.5	0.9	0.4	-0.5
New York-Northeast NJ	1.25	1.00	5.9	3.6	1.6	-1.9
Lowest a						
Danbury, CT	1.43	0.50	10.6	5.5	2.6	-2.8
Grand Junction, CO	0.91	0.49	-2.6	-0.9	-0.5	0.4
Houma-Thibodoux, LA	0.9	0.49	-2.9	-1.0	-0.6	0.5

Simulation: $\tau^{\star} = 0.046$

City Size Distribution



Aggregate Outcomes

Optimal $\tau^\star = 0.046$

Outcomes	Benchmark
Optimal τ	0.046
Output gain (%)	6.92
Population top 5 cities (%)	3.85
Fraction population that moves (%)	1.67
Change in average prices (%)	2.55
Welfare gain (%)	0.026

Optimal Spatial Tax

Optimal Spatial Tax

Constrained Optimal: Ramsey Taxes

- 2 cities, no gvt. transfers, congestion, amenities, housing prod.
- The Ramsey planner's problem is:

$$\max_{\{t_j\}} \sum_j u_j l_j$$

$$\text{s.t.} \quad \sum_j A_j t_j l_j^{\gamma} = G, \quad u_j = u_{j'}, \quad \sum_j l_j = \mathcal{L}$$

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- For any ψ, the optimal taxes $\exists G^{\star}$ such that:
  - for $G < G^{\star}$: optimal Ramsey tax higher in big city;
  - for $G > G^{\star}$: optimal Ramsey tax lower in big city

Constrained Optimal: Ramsey Taxes

Role of G

- G is source of inefficiency (disappears from the economy)
- $G \uparrow \Rightarrow$ tax more productive city less
- Productive resources to pay G: efficient from work in big city

  $\rightarrow \quad G \uparrow \; \Rightarrow \;$ optimal urbanization $\uparrow$

Constrained Optimal: Ramsey Taxes

Equal housing bond: $\psi = 0$

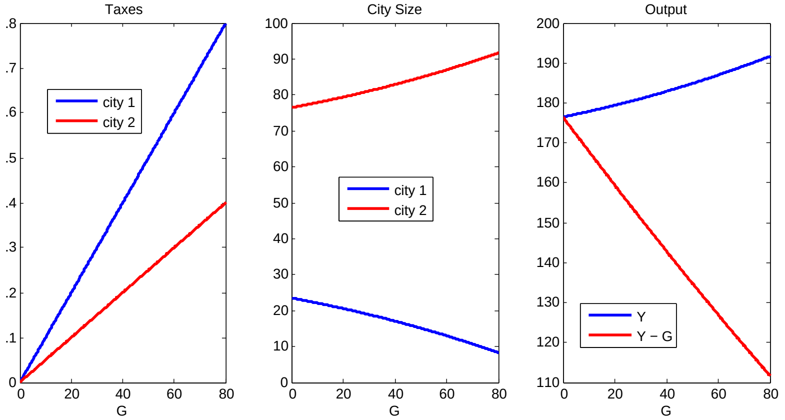


Figure : A. Optimal taxes t_1, t_2; B. Population l_1, l_2; C. Output. ($A_1 = 1, A_2 = 2, \mathcal{L} = 100, \alpha = 0.31, \psi = 0$)

Constrained Optimal: Ramsey Taxes

Zero measure landlords: $\psi = 1$

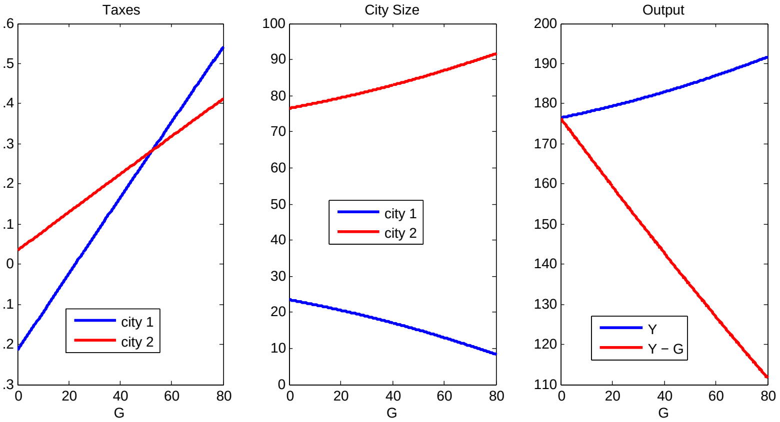


Figure : A. Optimal taxes t_1, t_2; B. Population l_1, l_2; C. Ouput. $(A_1 = 1, A_2 = 2, \mathcal{L} = 100, \alpha = 0.31, \psi = 1)$

Constrained Optimal: Ramsey Taxes

Zero measure landlords

- When land ownership is concentrated

  $\rightarrow$ No effect on productivity

- More people in big cities $\Rightarrow$ higher value of land (no value to utilitarian planner)

  $\rightarrow$ $\psi \uparrow \Rightarrow$ optimal urbanization $\downarrow$

Constrained Optimal: Ramsey Taxes

Benchmark: $\psi = 0.5$

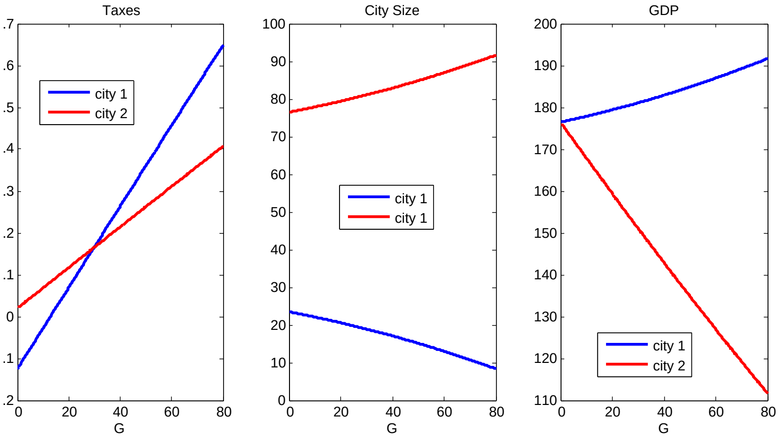


Figure : A. Optimal taxes t_1, t_2; B. Population l_1, l_2; C. Ouput.
$(A_1 = 1, A_2 = 2, \mathcal{L} = 100, \alpha = 0.31, \psi = 0.5)$

Optimal Spatial Tax

Unconstrained Optimal

- The planner chooses the bundles l_j, c_j, h_j to maximize Utilitarian welfare:

$$\max_{l_j, c_j, h_j} \sum_j c_j^{1-\alpha} h_j^{\alpha} l_j$$

$$\text{s.t. } \sum_j c_j l_j + \sum_j K_j + G = \sum_j A_j l_j, \quad h_j l_j = H_j, \quad \sum_j l_j = \mathcal{L}.$$

- Solution:
  - Equate MU_j and MP_j (Ramsey: $MU, MP \neq$ across cities)
  - $\Rightarrow$ Few in small city: unproductive, large consumption

Optimal Spatial Tax

Unconstrained Optimal

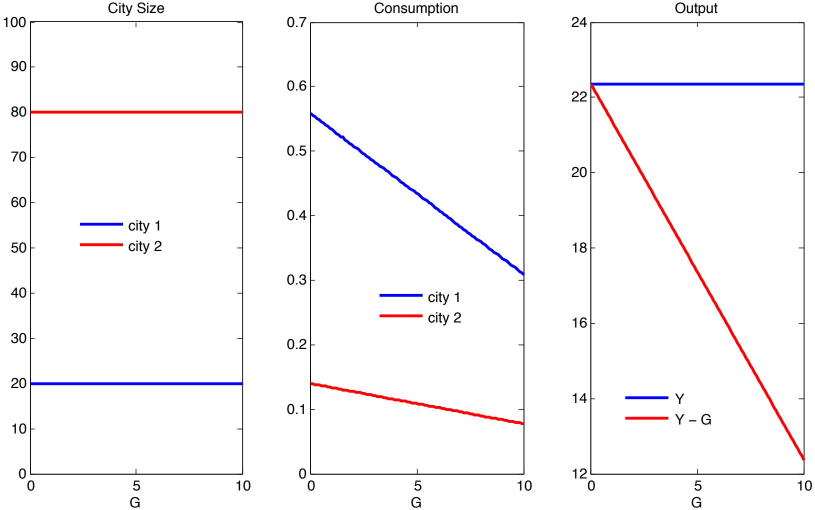


Figure : $A_1 = 1, A_2 = 2, \mathcal{L} = 100, \alpha = 0.31, u = c^{0.8}$:

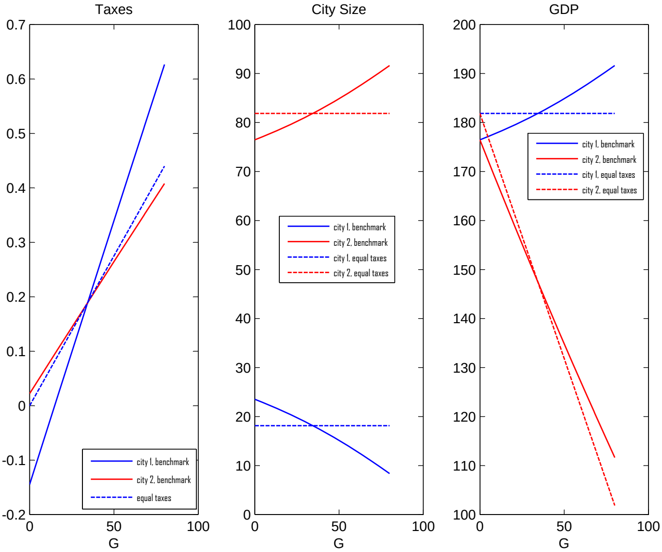
Optimal Spatial Tax

Lotteries

- Constrained optimal: utility equal. $\neq$ marginal utility equal. With mobility (Ramsey): tradeoff productivity–utility (low G):
  - too little consumption in small cities
  - too little production in large cities
- Can we implement first best in this economy?
- Yes, with lotteries (as in labor supply - Rogerson)
- Maybe not in a static world, but over life cycle
- But:
  - What with those who live in NY MSA for their whole life?
  - Lottery with zero probability if $\gamma = 1$...

Optimal Spatial Tax

Sensitivity: Equal Taxes



Sensitivity Analysis

Land Ownership I

Outcomes	Benchmark $\psi = 0.5$	All bond $\psi = 0$	All landlord $\psi = 1$
Optimal τ	0.046	-0.067	0.134
Output gain (%)	6.92	16.93	-1.31
Population top 5 cities (%)	3.85	9.04	-0.75
Fraction population that moves (%)	1.67	3.90	0.33
Change in average prices (%)	2.55	6.34	-0.47
Welfare gain (%)	0.026	0.14	0.001

Sensitivity Analysis

Land Ownership II

- Asset distribution to reflect owner occupied housing rate 67%
- Generates ex post heterogeneity
- Short cut (but land is not correctly priced!):

$$T_j = \theta \frac{r_j L_j}{l_j} + (1 - \theta) \frac{\sum_j r_j L_j}{\sum_j l_j}$$

  instead of landlords: get equal share of land value in the city
- "as if" within city redistribution

Sensitivity Analysis

Land Ownership II

Outcomes	Benchmark $\psi = 0.5$	owner occupied $\theta = 0.67$
Optimal τ	0.046	0.061
Output gain (%)	6.92	5.78
Population top 5 cities (%)	3.85	3.23
Fraction population that moves (%)	1.67	1.40
Change in average prices (%)	2.55	2.16
Welfare gain (%)	0.026	0.018

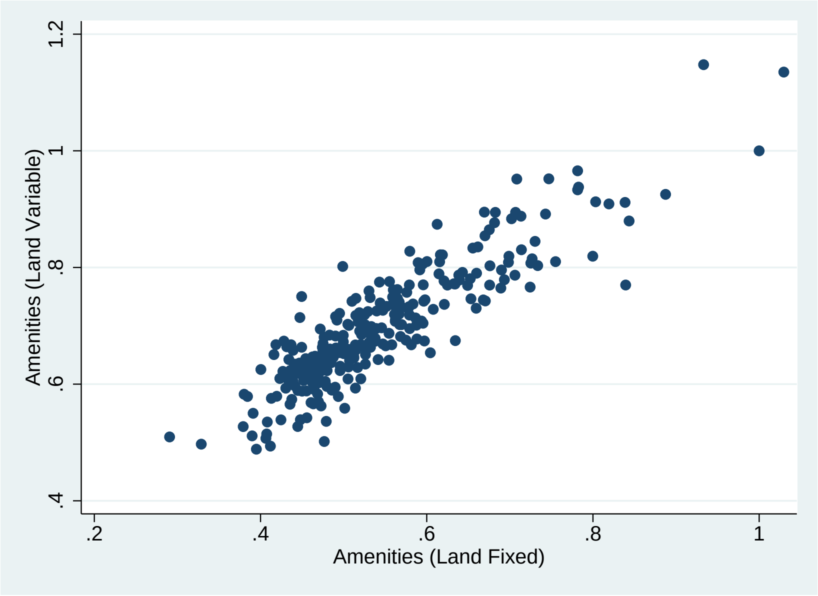
Sensitivity Analysis

Initial Tax Policy

	$\lambda = 0.9$			$\lambda = \mathbf{0.85}$			$\lambda = 0.815$		
τ	0.053	0.12	0.2	0.053	**0.12**	0.2	0.053	0.12	0.2
Optimal τ^*	0.0092	0.0133	0.0153	0.0429	**0.0457**	0.0490	0.0969	0.0990	0.1010
Output gain (%)	3.78	9.50	16.98	0.91	**6.92**	14.53	-4.21	2.11	10.22
Pop top 5 (%)	2.13	5.23	9.07	0.52	**3.85**	7.83	-2.46	1.20	5.61
Pop moves (%)	0.93	2.26	3.91	0.23	**1.67**	3.38	1.07	0.52	2.43
Avg. prices (%)	1.40	3.53	6.30	0.33	**2.55**	5.34	-1.53	0.77	3.71
Welfare gain (%)	0.0082	0.0512	0.1499	0.0004	**0.0264**	0.1090	0.0103	0.0024	0.0520

Sensitivity Analysis

Fixed Land Area (5000km^2)



Sensitivity Analysis

Fixed Land Area (5000km^2)

Outcomes	Benchmark	Fixed Land Area
Optimal τ	0.046	0.059
Output gain (%)	6.92	5.17
Population change top 5 cities (%)	3.85	2.88
Fraction Population that Moves (%)	1.67	1.30
Change in average prices (%)	2.55	2.56
Welfare gain (%)	0.026	0.016

Sensitivity Analysis

No Rebate of Tax Revenue ($\phi = 0$)

Outcomes	Benchmark	No Tax Rebate
Optimal τ	0.046	0.045
Output gain (%)	6.92	7.43
Population change top 5 cities (%)	3.85	4.12
Fraction population that moves (%)	1.67	1.79
Change in average prices (%)	2.55	2.89
Welfare gain (%)	0.026	0.030

The Role of Heterogeneity

Heterogeneity in:

1. Housing asset holdings
2. Skills: $\tau^{US} = 0.12$? Redistribution *heterogeneous* agents

$\Rightarrow$ Role of a city-specific tax

Concluding Remarks

- Federal Taxation can lead to spatial misallocation
- Taxes location specific $\Rightarrow$ optimal Ramsey tax not flat
  - Gvt. spending $G \uparrow \Rightarrow$ tax big city $\downarrow$
  - Asset concentration $\uparrow \Rightarrow$ tax big city $\uparrow$
- US benchmark economy, optimal tax:
  1. Tax big cities more: $\tau^\star \sim 0.04$ (less than current)
  2. Large effects on output (6.9%) and population (1.67%)
  3. Small effects on welfare

$\Rightarrow$ Big GE effects from gvt. spending and ownership structure

Optimal Spatial Taxation
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