The Economics of Cities

Bojos per l'Economia! 2025

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CREI, UPF, BSE and IPEG

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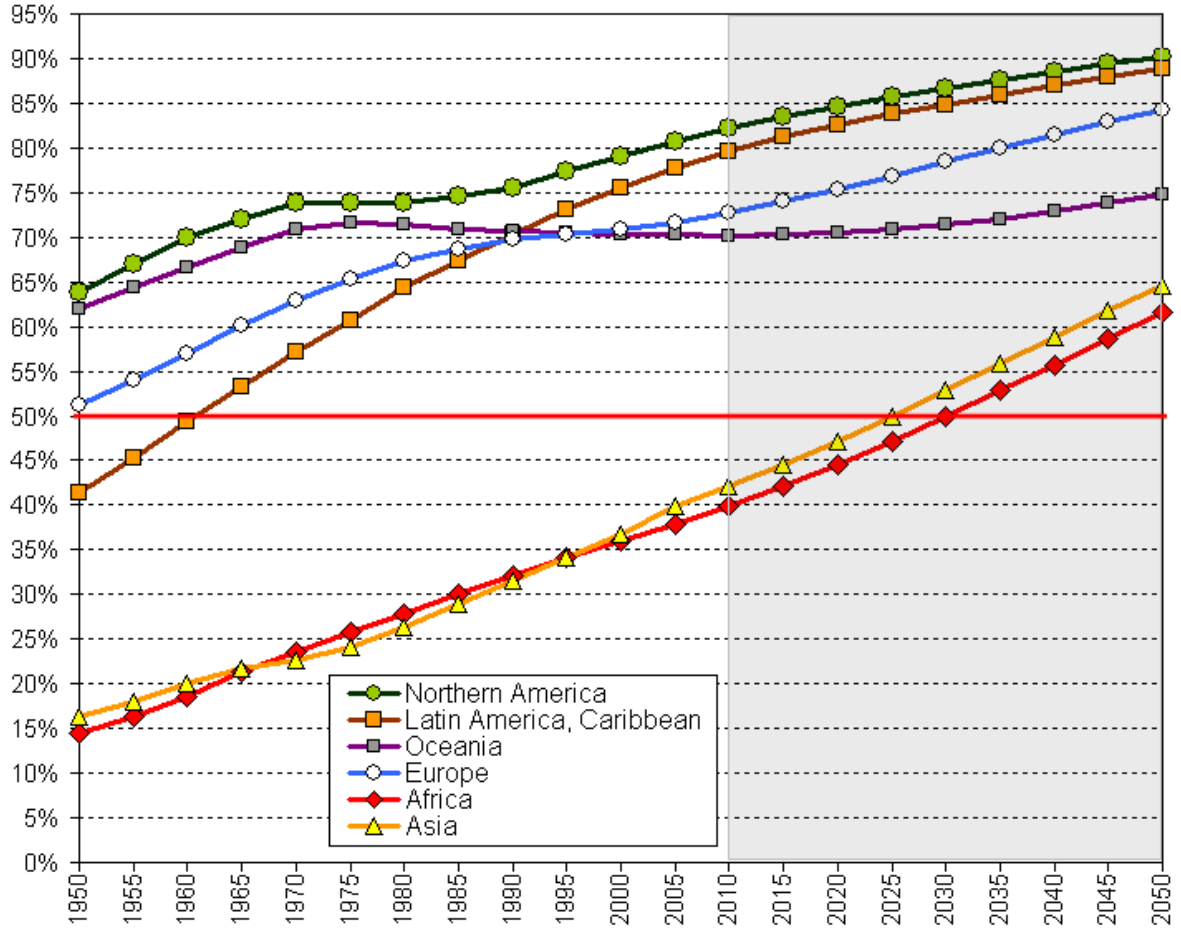
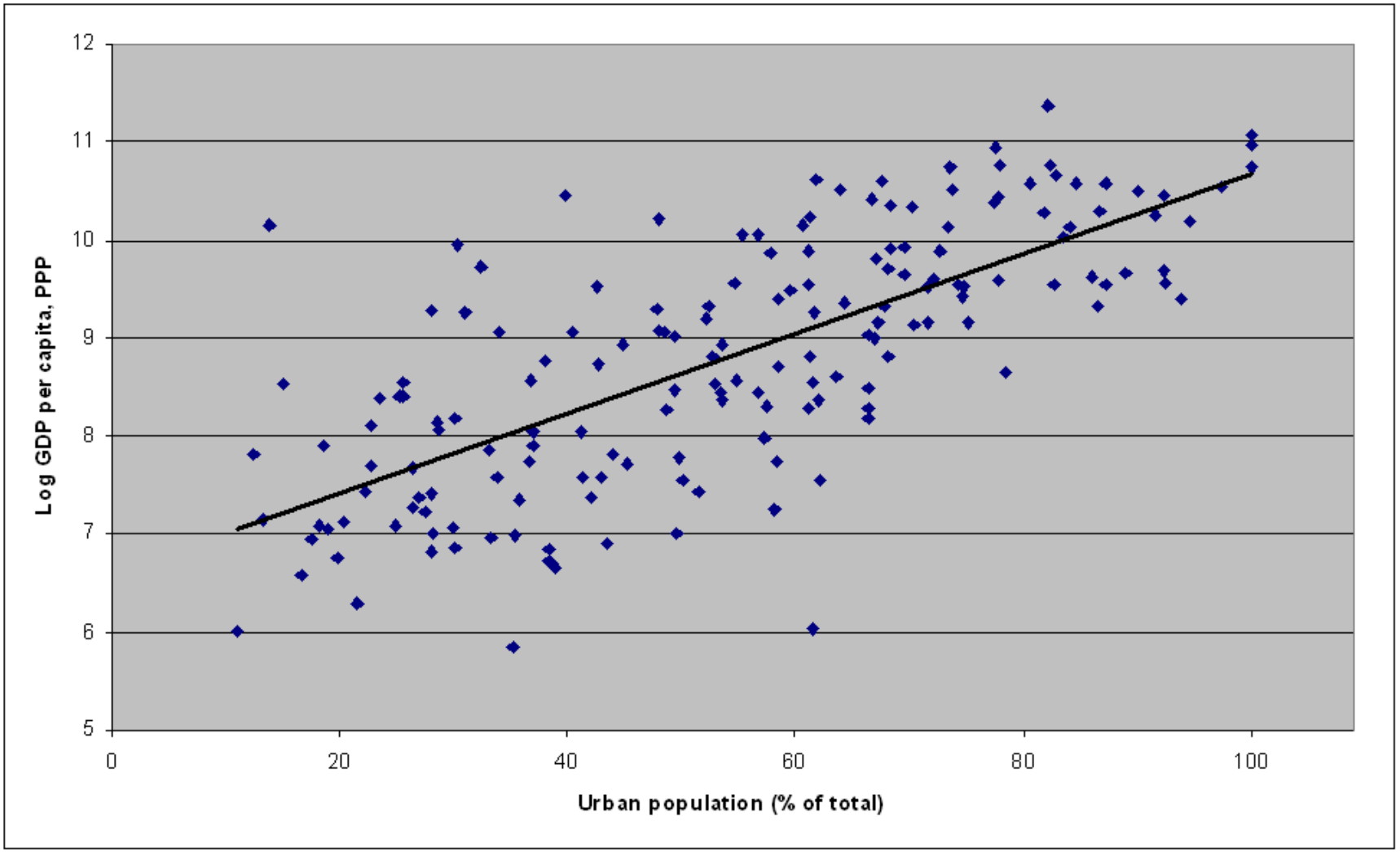
Increasing Urbanization Rates

- More than half of the World's population now lives in cities



Source: UN World Urbanization Prospects, 2009 Revision, esa.un.org/unpd/wup

Urbanization and Income Across Countries



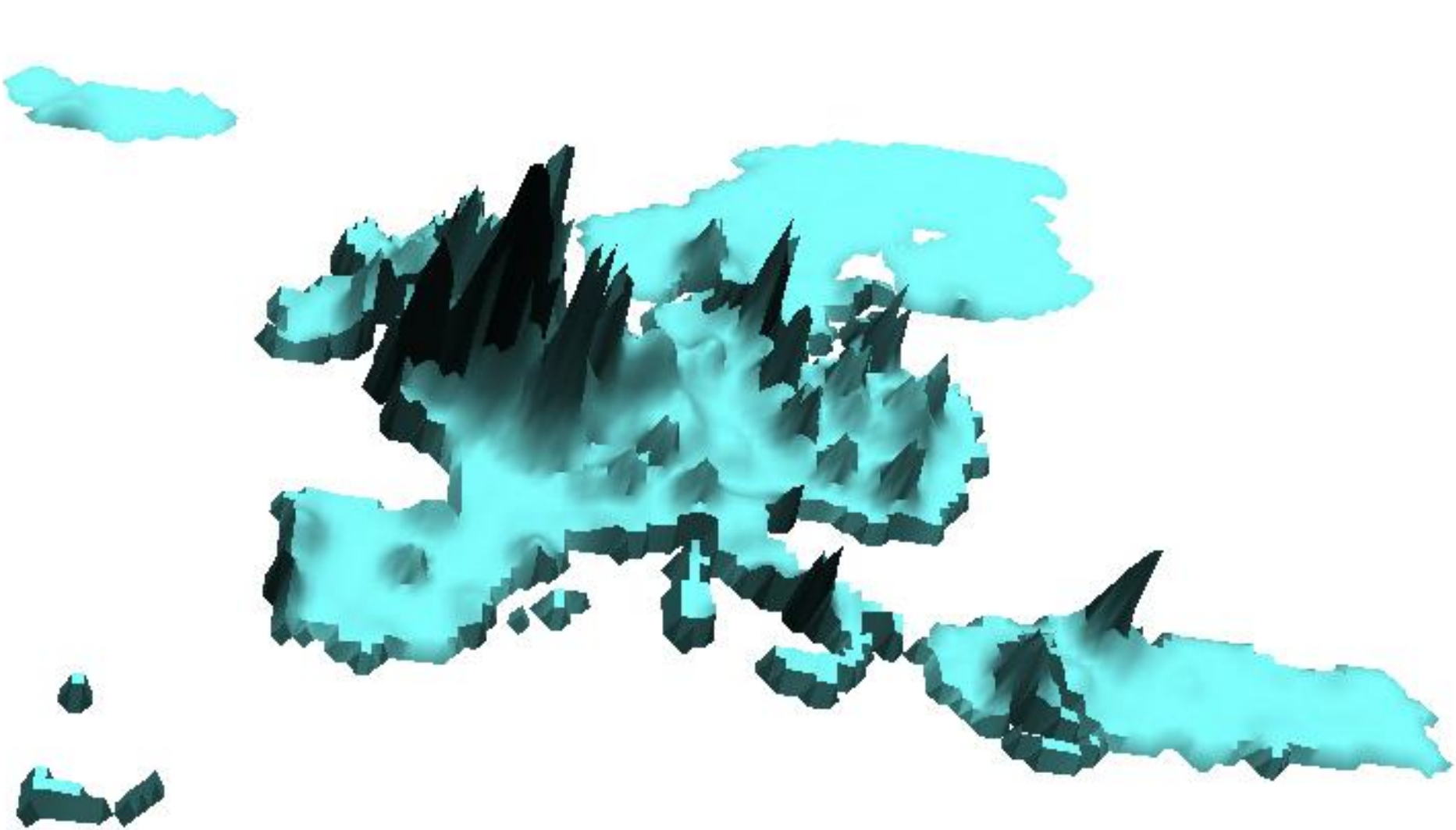
Source: World Development Indicators 2010

The Largest City Economies in the World

Rank	City	Country	GDP ($bn)	Pop. (mn)	GDP/person
-	-	*Spain*	*1,512*	*44.45*	*$33,201*
1	Tokyo	Japan	1,479	35.83	$41,300
2	New York	USA	1,406	19.18	$73,300
3	Los Angeles	USA	792	12.59	$62,900
4	Chicago	USA	574	9.07	$63,300
5	London	UK	565	8.59	$65,800
6	Paris	France	564	9.92	$56,900
7	Osaka	Japan	417	11.31	$36,900
8	Mexico City	Mexico	390	19.18	$20,400
15	Moscow	Russia	321	10.47	$30,700
26	Madrid	Spain	230	5.64	$40,800
-	-	*Ireland*	*189*	*4.41*	*$42,810*
35	Barcelona	Spain	177	4.98	$35,500
-	-	*Morocco*	*137*	*31.75*	*$4,315*

Sources: Hawksworth, Hoehn, Tiwari (2009) PricewaterhouseCoopers Economic Outlook; WDI

Urban Concentration in Europe



Population density in 2005 by OECD TL3 region

Source: Kamal-Chaoui and Robert (2009) Competitive Cities and Climate Change

Economic Concentration in Europe

GDP per km^2 in 2005 by OECD TL3 region

Extremes of Density

- Paris: the French metropolis

Variable	Paris	France	Share
Surface (km^2)	12,012	543,965	2.21%
Population (mn, 2008)	11.599	61.965	18.72%
GDP (PPP $bn, 2000)	587.70	2,113.97	27.80%

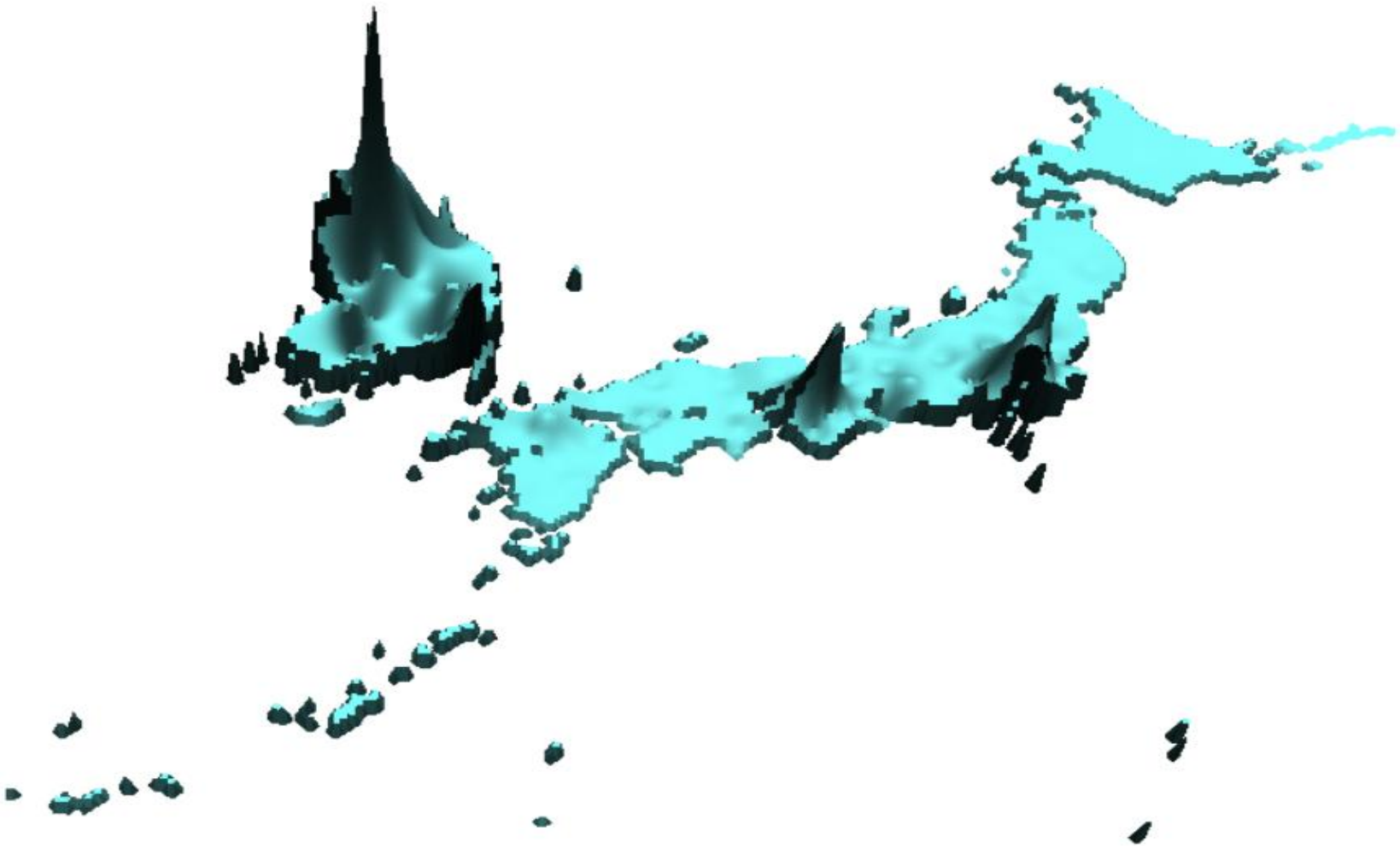
In greater Paris, 55% of the land area is agricultural, another 25% green space

- Japan's three main urban areas: Tokyo, Osaka, Nagoya (map)

Variable	Tokyo	Osaka	Nagoya	Japan	Share
Surface (km^2)	13,112	14,400	10,585	373,530	10.20%
Population (mn)	34.826	17.036	9.236	127.771	47.82%
GDP (PPP $bn)	1,374.89	567.81	378.08	4,284.87	54.16%

Source: OECD StatExtracts 2007, stats.oecd.org

Urban Concentration in Japan and Korea



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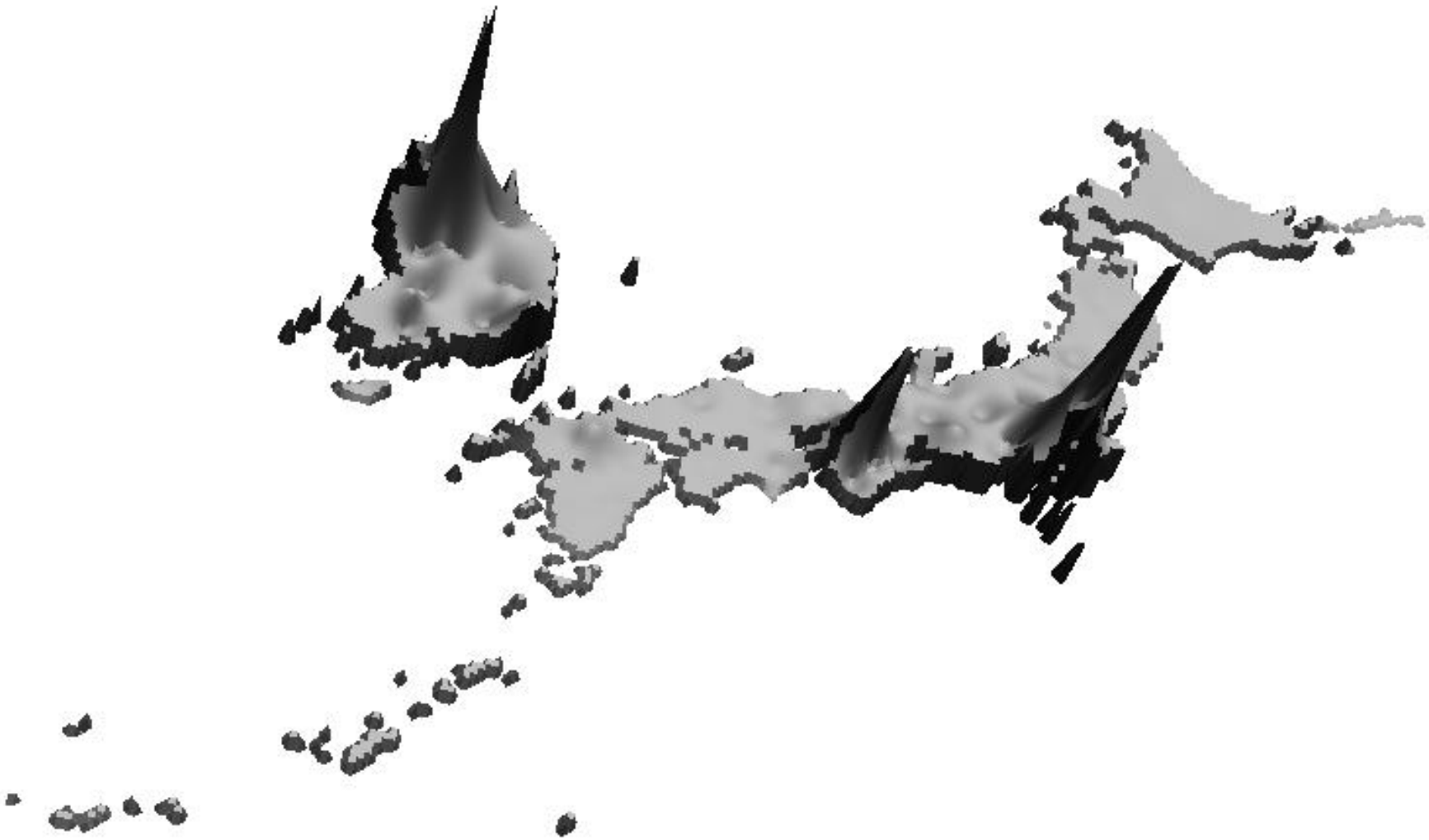
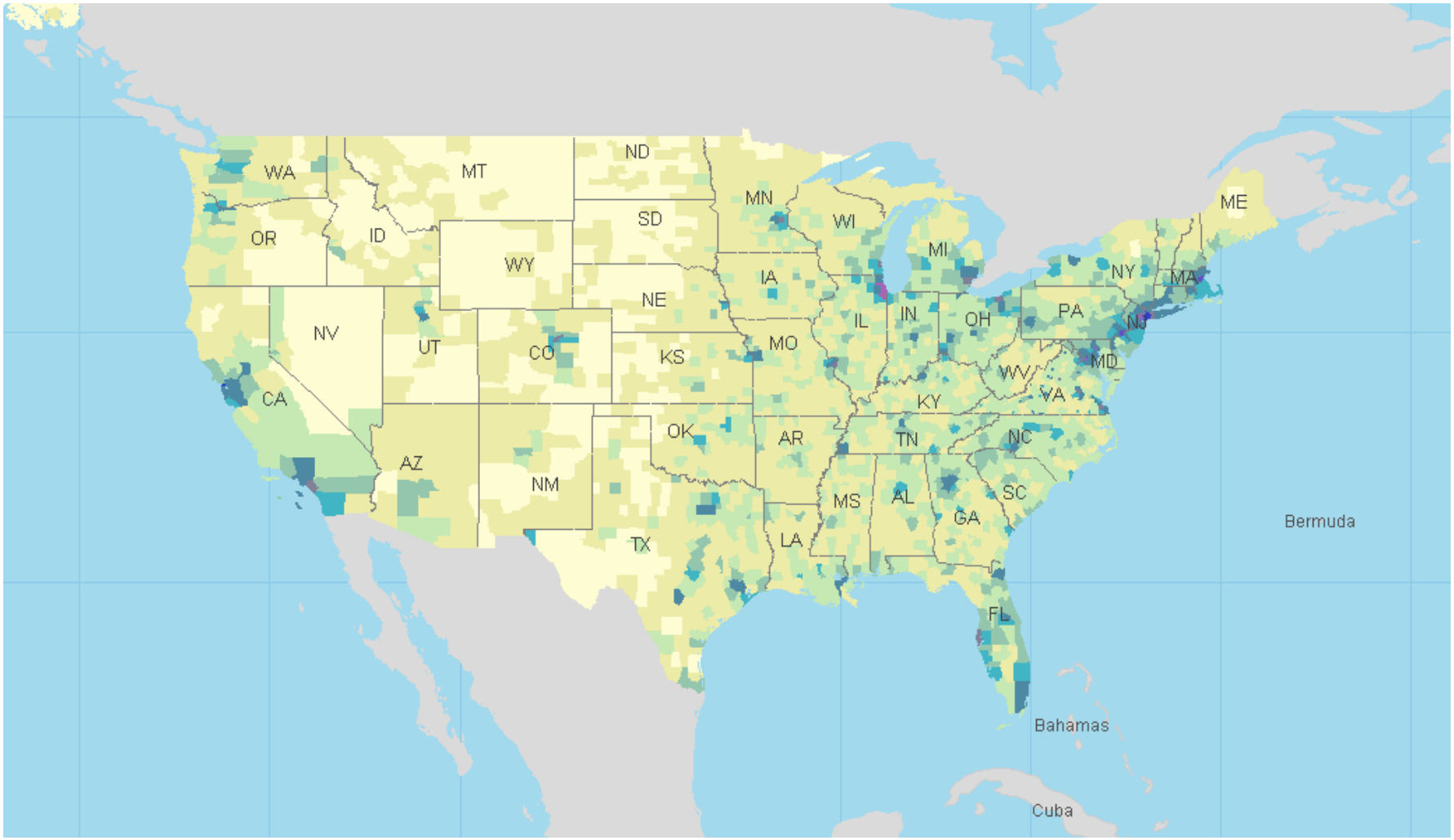


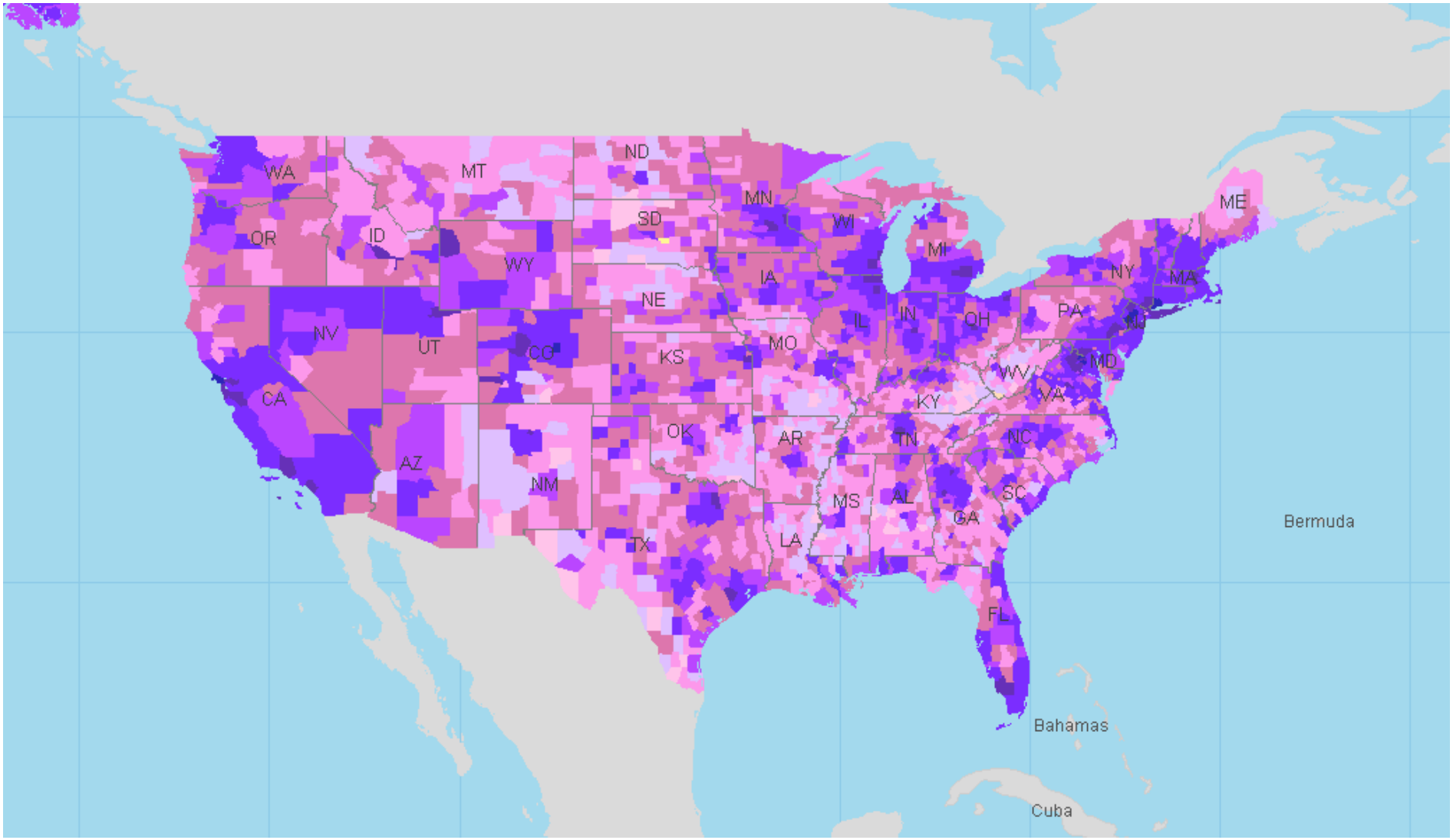
GDP per km^2 in 2005 by OECD TL3 region

Population Density in the United States



Source: 2000 Census; maps by Social Explorer, socialexplorer.com

Average Household Income in the United States



The Economics of Cities

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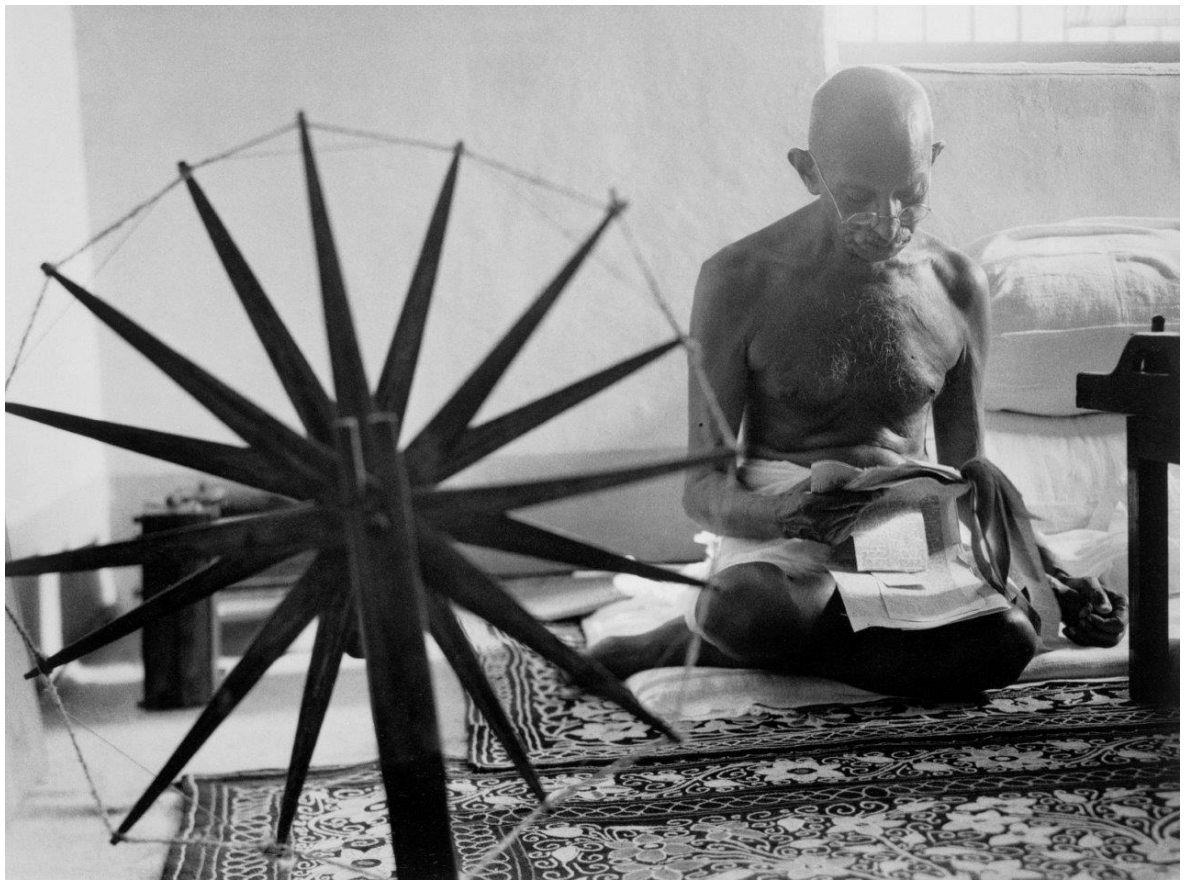
Gandhi, Mohandas K. 1946. "Some Mussooree Reminiscences." *Harijan*, June 23



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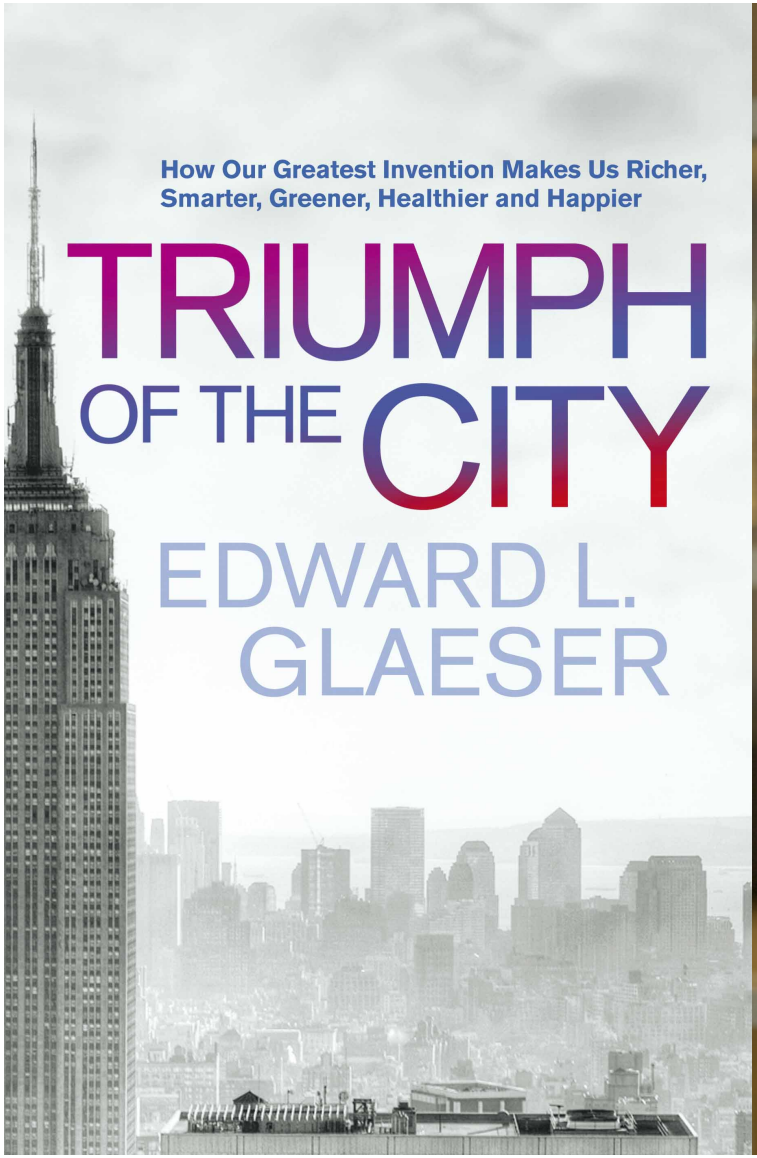


Social Formation of Values and Beliefs

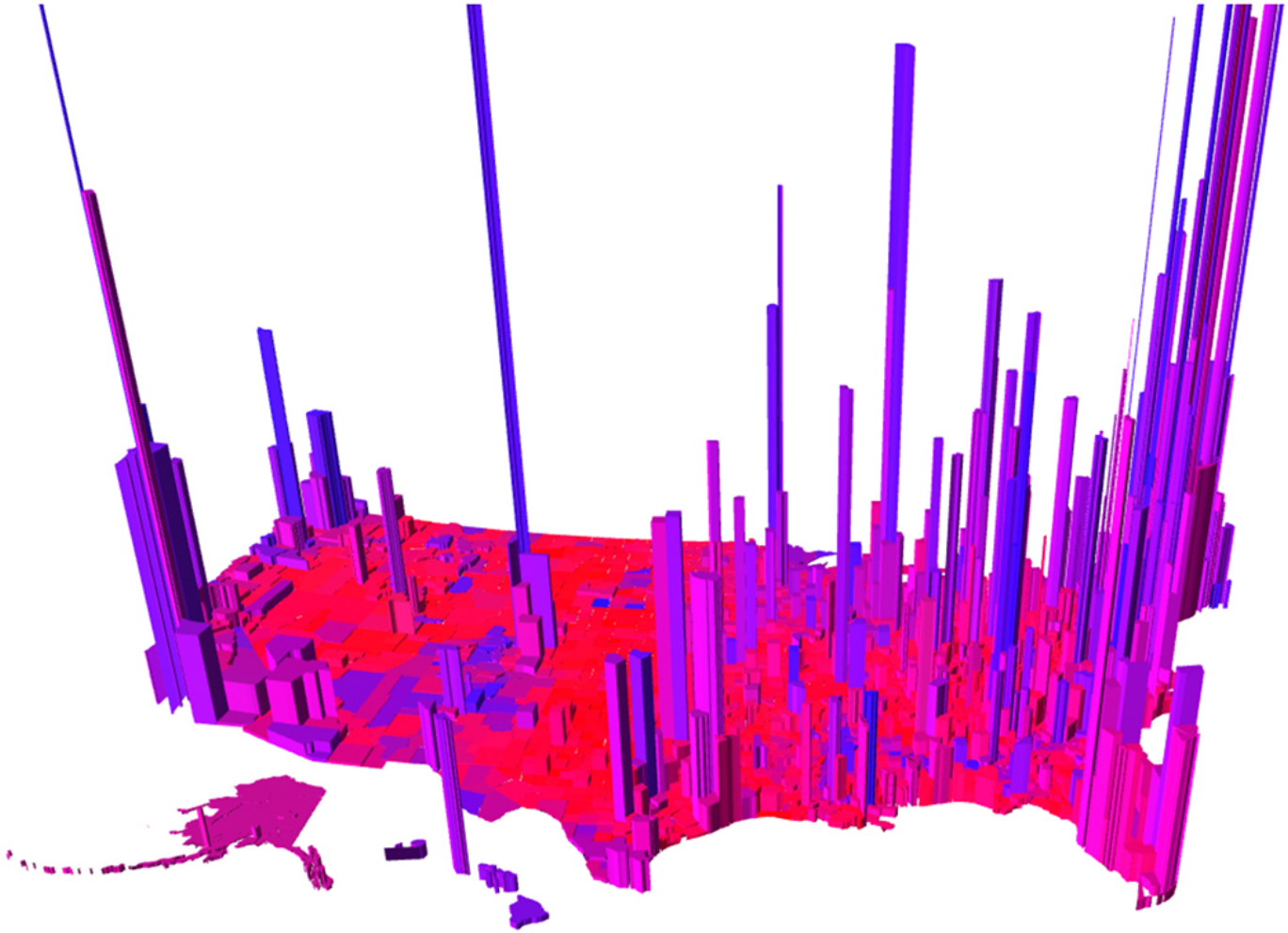
Fraction of respondents who agree with the given statement

3. State	*N*	*AIDS Might be God's Punishment for Immoral Sexual Behavior*	*4. State*	*N*	*The Best Way to Ensure Peace is Through Military Strength*
Rhode Island	83	0.16	District of Columbia	77	0.36
Connecticut	243	0.19	Vermont	52	0.40
New Hampshire	74	0.24	Oregon	257	0.42
Oregon	226	0.24	Delaware	62	0.42
Maryland	375	0.25	Minnesota	418	0.47
Kentucky	309	0.46	Idaho	122	0.66
Tennessee	438	0.47	Oklahoma	265	0.68
Oklahoma	221	0.48	Mississippi	281	0.69
Alabama	364	0.49	Arkansas	230	0.70
Mississippi	232	0.56	South Carolina	330	0.73

Source: Glaeser and Ward (2006) Myths and Realities of American Political Geography

Red State, Blue City

Voting patterns in the 2024 presidential election



Source: Robert J. Vanderbei, princeton.edu

Spatial Equilibrium

- Why do so many people live in so few places?
- Spatial equilibrium: the central tool of the urban economist
- There is at least someone on the margin across space

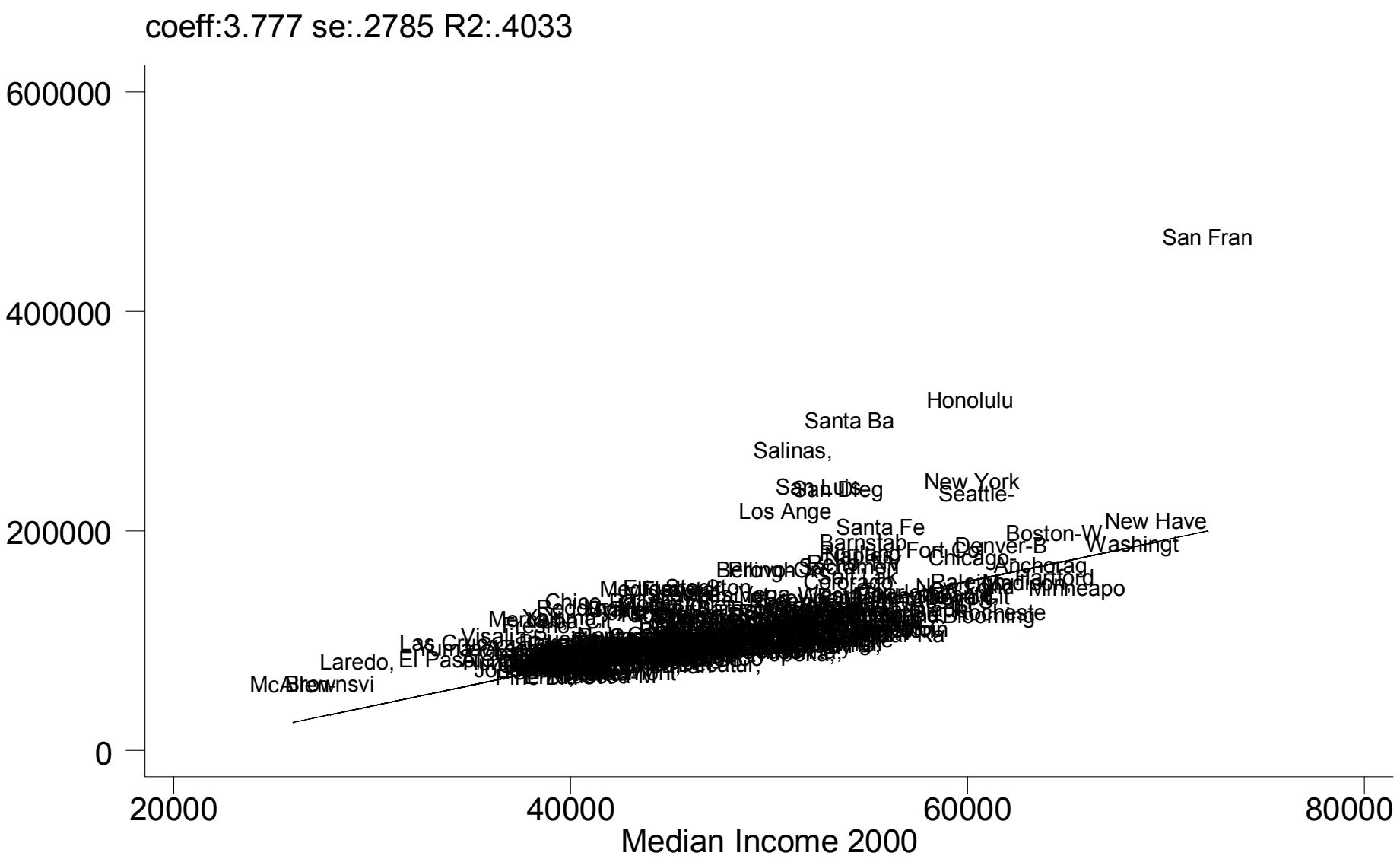
$\Rightarrow$ Their utility must be equalized across space

- Spatial equilibrium for individuals requires

$$U\left(w_c, p_c, a_c\right) = \bar{U} \text{ for all places } c$$

1. Higher income w_c
2. ... is offset by higher prices p_c
3. ... or by lower "amenities" a_c

House Prices and Income



Is The Rent Too Damn High?

- Net income = wages – housing costs
- Simplest model of worker welfare: $U = w - p + a$
  - Every household requires one unit of housing
- Common measure of housing affordability: p/w
  - Influential in policy circles, attributed to economists
- Does this make sense?

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1. $w_1 = \$50,000,\ p_1 = \$10,000 \Rightarrow p_1/w_1 = 20\%$
2. $w_2 = \$75,000,\ p_2 = \$30,000 \Rightarrow p_2/w_2 = 40\%$

- Where would you rather live?

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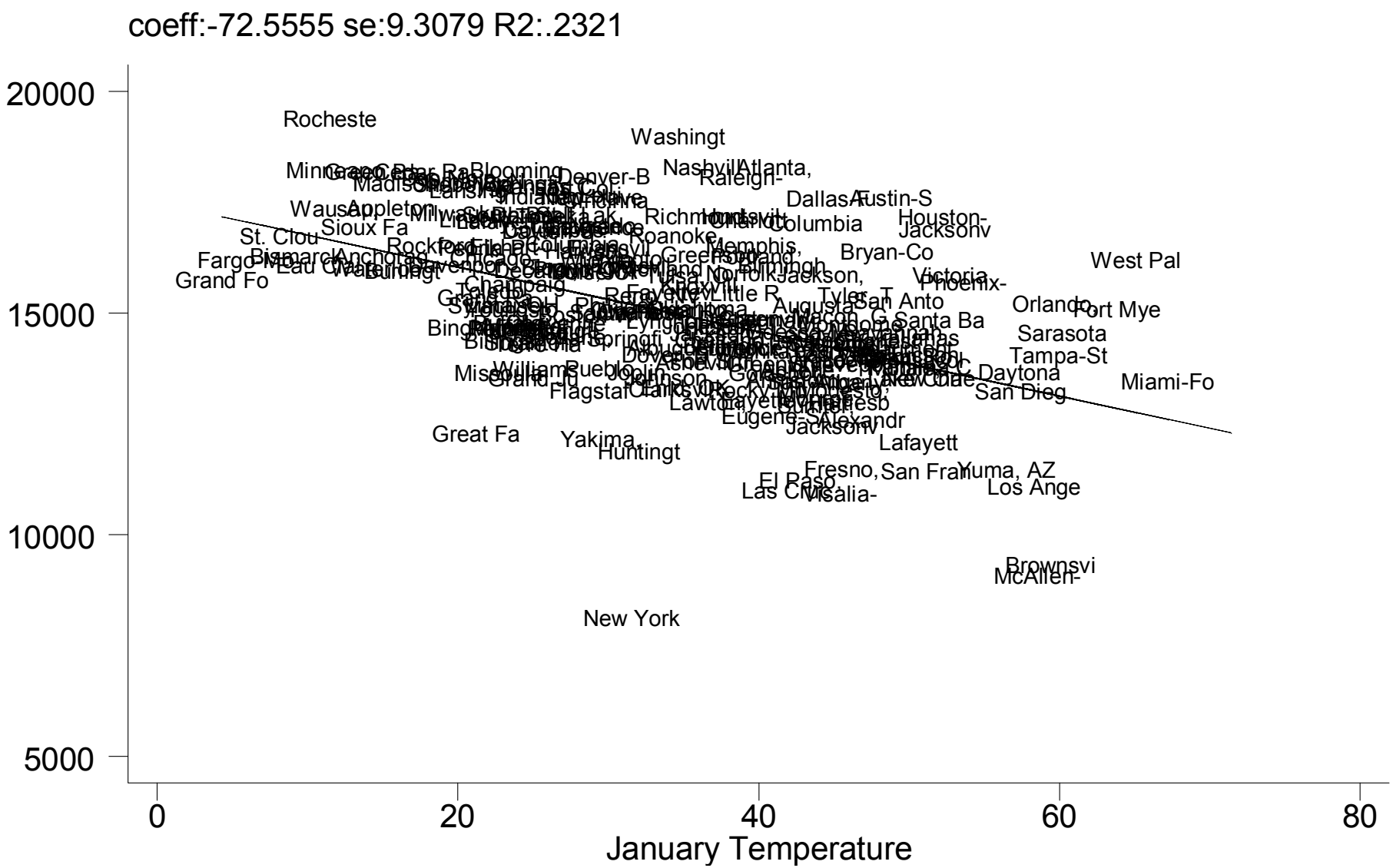
- Where would you rather live?
- A more sophisticated utility function won't change much

Income and Climate



Hedonics

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- The power of spatial equilibrium: spatial hedonics (Rosen 1979)
- How can you identify consumption amenities?
- They are associated with lower incomes, controlling for house prices
  - Or with higher house prices, controlling for incomes
- A mild climate is the most obvious natural amenity
- There are also man-made amenities, such as good public services
  - Trickier empirically because they are endogenous

Bricks and Mortar

Demand for Housing

- You cannot understand cities—or the spatial economy—without understanding housing markets
- House prices are the main determinant of real wages
- A house is most households' main asset by a wide margin
- Not any other asset: it reflects demand for a location
- Demand for housing is the worker's side of spatial equilibrium

$$U\left(w_c, p_c, a_c\right) = \bar{U} \text{ for all } c$$

- With our simplified welfare function, housing demand yields

$$p_c = w_c + a_c \text{ for all } c$$

Housing and Urban Dynamics

- Population and the stock of housing units co-move almost perfectly

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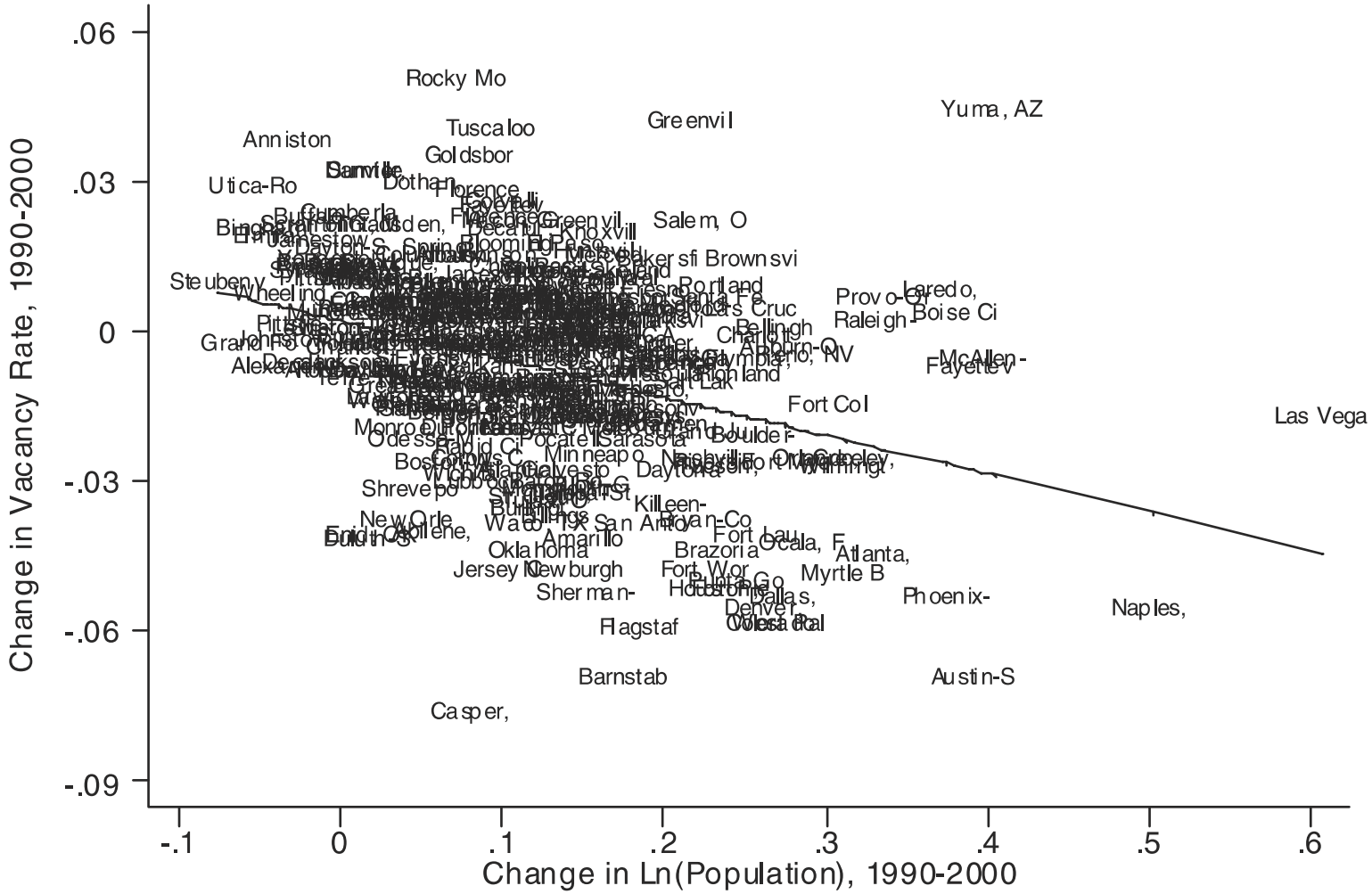
   - 10th percentile: 4.9% – 90th percentile: 14.8%
   - Small effect of population growth on vacancies

Housing and Urban Dynamics

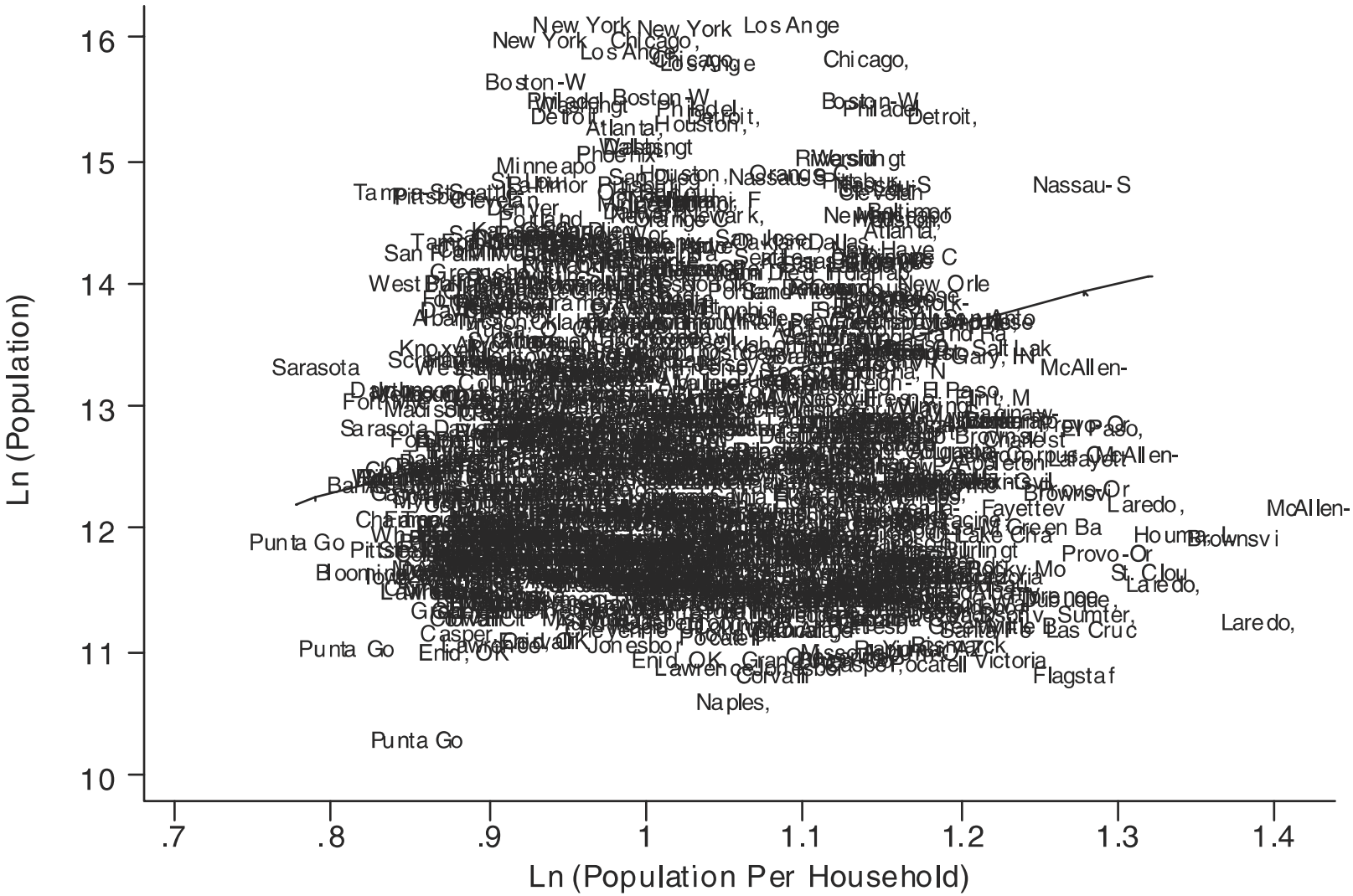
- Population and the stock of housing units co-move almost perfectly

1. Variation in vacancy rates is modest
   - 10th percentile: 4.9% – 90th percentile: 14.8%
   - Small effect of population growth on vacancies
2. Variation in household size is modest
   - Overall decline: 1970 average: 3.15 – 1980 average: 2.75
   - The R^2 of household size on population is 0.06

Changes in Population and Vacancy Rates



Population and Household Size



The Housing Market

- Demand for housing = demand for productivity and amenities

$$p_c = w_c + a_c \text{ for all } c$$

- The quantity of housing coincides with population L_c
- House prices p_c and quantity L_c are determined in equilibrium
- The other half of the market is the supply of housing
- Houses are a physical good supplied by builders

Supply of Housing

- Several interesting idiosyncratic features of housing supply

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1. Housing is extremely durable
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   - The downward elasticity of housing supply is very low
   - Cities grow much faster than they decline

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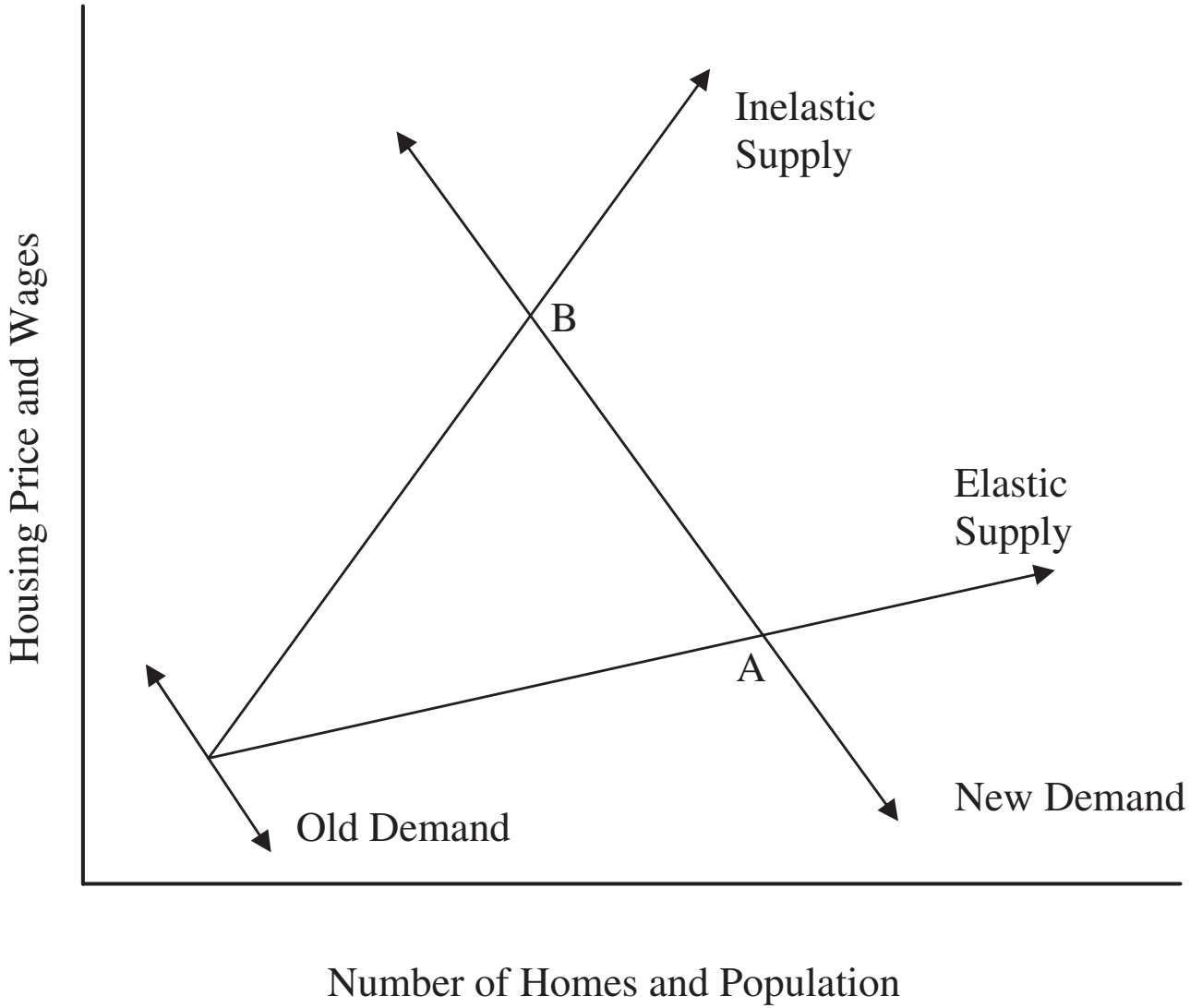
1. Housing is extremely durable
   - Permanent loss of housing units below 1% per year
   - The downward elasticity of housing supply is very low
   - Cities grow much faster than they decline
2. The upward elasticity of housing supply is variable
   - Significant differences in topography (Saiz 2010)
   - Huge differences in regulation (zoning, etc.)

Housing Unit Growth in Cities with 100,000+ Residents

Bottom five		Top five	
1970–1980			
St. Louis	−16.5%	Colorado Springs	64.1%
Detroit	−11.5%	Austin	53.7%
Cleveland	−9.8%	Albuquerque	52.2%
Buffalo	−6.0%	Stockton	48.4%
Pittsburgh	−5.8%	San Jose	46.4%
1980–1990			
Newark	−16.9%	Las Vegas	49.1%
Gary	−14.5%	Raleigh	47.1%
Detroit	−14.0%	Virginia Beach	46.9%
Youngstown	−10.0%	Austin	39.3%
Dayton	−7.7%	Fresno	37.7%
1990–2000			
Gary	−10.5%	Las Vegas	53.5%
Hartford	−10.3%	Charlotte	28.8%
St. Louis	−10.2%	Raleigh	25.0%
Youngstown	−9.6%	Austin	22.3%
Detroit	−9.3%	Winston-Salem	21.3%

Data source: Decennial censuses for 1970, 1980, 1990, 2000. Housing units defined to include owner-occupied and rental units.

Housing Supply and the Impact of Productivity Shocks



A Simple Model of Housing Supply

- Housing supply is the product of land T and building height h
- The cost of building at height h on a surface T is

$$C(h, T) = \psi \left(\frac{h}{\delta} \right)^{\delta} T \text{ for } \delta > 1$$

  - Convex cost of building up
  - Linear cost of building out

- Each city c has an exogenous endowment of land T_c
  - Natural and regulatory constraints
- Profit-maximizing landowners in city c build at height

$$h_c = \arg\max_h \left\{ p_c h T_c - \psi \left(\frac{h}{\delta} \right)^{\delta} T_c \right\} = \delta \left(\frac{p_c}{\psi} \right)^{\frac{1}{\delta - 1}}$$

Housing Market Equilibrium

- Housing supply is

$$H_c \equiv h_c T_c = \delta \left(\frac{p_c}{\psi} \right)^{\frac{1}{\delta - 1}} T_c$$

or identically

$$p_c = \psi \left(\frac{H_c}{\delta T_c} \right)^{\delta - 1}$$

- Housing demand is given by spatial equilibrium

$$p_c = w_c + a_c$$

- In equilibrium, the market clears: supply = demand
- The equilibrium quantity of housing in city c is

$$H_c = \delta \left(\frac{w_c + a_c}{\psi} \right)^{\frac{1}{\delta - 1}} T_c$$

A Simple City Model

- The goal of a city model is to understand why cities grow and change
- Many interesting models look within cities
  - Maybe we'll have time to start doing that too
- Three equilibrium conditions are needed

1. Workers need to be indifferent across cities
   - Spatial equilibrium
2. Housing markets need to clear in each city
   - The supply of housing equals the demand for housing
3. Labor markets need to clear in each city
   - The demand for labor equals the supply of labor

The Firm's Problem

- Firms produce output using labor and capital

$$f(K, L) = AL^{\beta}K^{1-\beta} \text{ for } \beta \in (0, 1)$$

  - Cobb-Douglas technology, constant returns to scale
- Output is sold on the world market at a price of 1
- Each city c has an exogenous endowment of capital K_c
- Profit-maximizing capitalists in city c employ

$$L_c = \arg\max_h \left\{ AL_c^{\beta}K_c^{1-\beta} - w_c L_c \right\} = \left(\frac{\beta A}{w_c} \right)^{\frac{1}{1-\beta}} K_c$$

Labor Market Equilibrium

- Labor demand is

$$L_c = \left(\frac{\beta A}{w_c}\right)^{\frac{1}{1-\beta}} K_c$$

or identically

$$w_c = \beta A \left(\frac{K_c}{L_c}\right)^{1-\beta}$$

- Labor supply is given by the housing market equilibrium
  - We have already incorporated spatial equilibrium there
- Each worker needs one unit of housing, so labor supply is

$$L_c = H_c = \delta \left(\frac{w_c + a_c}{\psi}\right)^{\frac{1}{\delta-1}} T_c$$

or identically

$$w_c = \psi \left(\frac{L_c}{\delta T_c}\right)^{\delta-1} - a_c$$

Equilibrium City Size

- Our three-fold equilibrium yields city size L_c such that

$$\beta A \left(\frac{K_c}{L_c} \right)^{1-\beta} = \psi \left(\frac{L_c}{\delta T_c} \right)^{\delta - 1} - a_c$$

1. Increasing in consumption amenities: $\partial L_c / \partial a_c > 0$
2. Increasing in the supply of land: $\partial L_c / \partial T_c > 0$
   - Construction amenities: also building costs $\partial L_c / \partial \psi_c < 0$
3. Increasing in the supply of capital: $\partial L_c / \partial K_c > 0$
   - Production amenities: also productivity $\partial L_c / \partial A_c > 0$

Equilibrium Prices

- The equilibrium simultaneously yields wages w_c such that

$$\delta \left(\frac{w_c + a_c}{\psi} \right)^{\frac{1}{\delta - 1}} T_c = \left(\frac{\beta A}{w_c} \right)^{\frac{1}{1-\beta}} K_c$$

- Comparative statics: $\partial w_c / \partial a_c < 0$, $\partial w_c / \partial T_c < 0$ and $\partial w_c / \partial K_c > 0$
- Finally, house prices are p_c such that

$$\delta \left(\frac{p_c}{\psi} \right)^{\frac{1}{\delta - 1}} T_c = \left(\frac{\beta A}{p_c - a_c} \right)^{\frac{1}{1-\beta}} K_c$$

- Comparative statics: $\partial p_c / \partial a_c > 0$, $\partial p_c / \partial T_c < 0$ and $\partial p_c / \partial K_c > 0$
- What's the intuition? How about the returns to capital K_c?

The Rosen–Roback Approach

- How does a measurable variable x_c impact city characteristics?
- We can invert our comparative statics and we will know!

1. Worker's spatial equilibrium gave us hedonics:

$$\frac{\partial a_c}{\partial x_c} = \frac{\partial p_c}{\partial x_c} - \frac{\partial w_c}{\partial x_c}$$

2. Identically, production amenities from profit maximization:

$$\frac{\partial \ln K_c}{\partial \ln x_c} = \frac{\partial \ln L_c}{\partial \ln x_c} + \frac{1}{1-\beta}\frac{\partial \ln w_c}{\partial \ln x_c}$$

   - What does this tell us about weather and production amenities?

3. Finally, construction amenities from optimal housing supply:

$$\frac{\partial \ln T_c}{\partial \ln x_c} = \frac{\partial \ln L_c}{\partial \ln x_c} - \frac{1}{\delta - 1}\frac{\partial \ln p_c}{\partial \ln x_c}$$

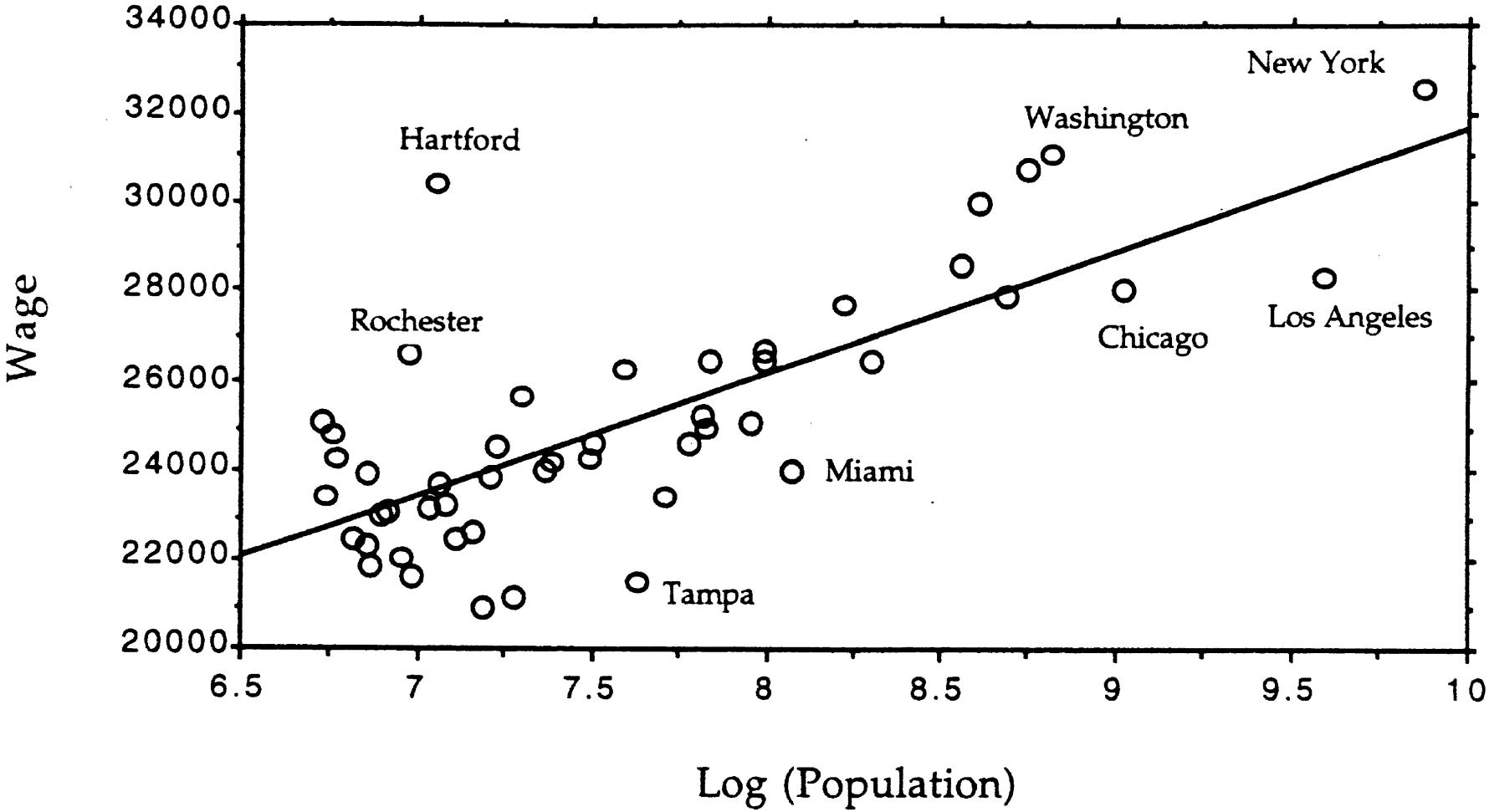
   - Weakest empirically because δ is hard to estimate convincingly

Why Cities?

- Our simple model links urban success to city amenities

1. Consumption amenities
   - Increasing consumer appeal of cities
   - Historically, though, cities were pretty bad places to live
   - Crime, social distress, epidemics
2. Construction amenities
   - Important across cities: the rise of the Sun Belt
   - But high-density building is always much more expensive
3. Production amenities
   - The main and historically the only reason for cities to exist
   - Productivity appears to be considerably higher in cities

Wages and City Population

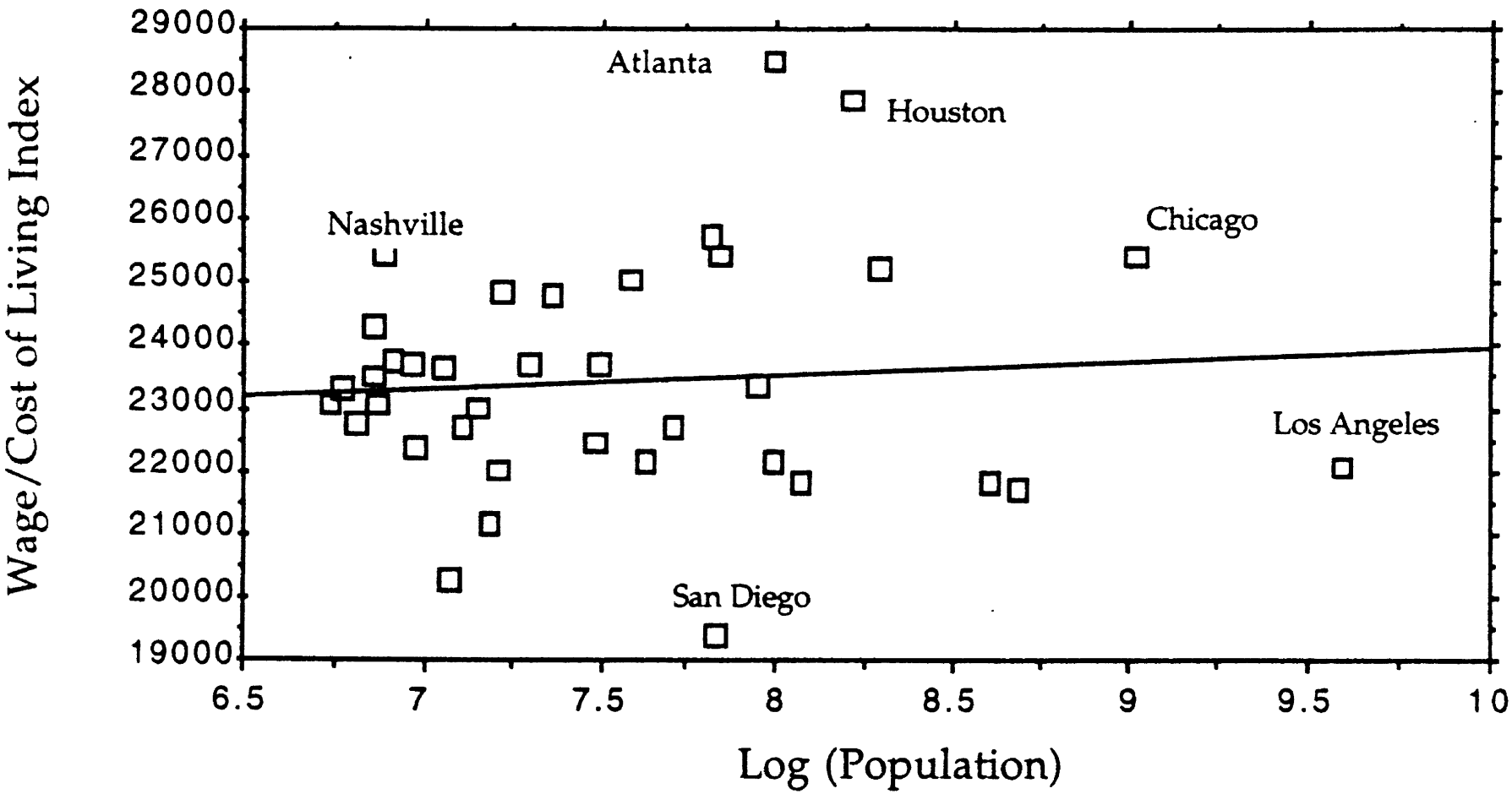


The Urban Wage Premium

- Wages are higher in larger cities
  - True in history and around the world
- Why are firms in larger cities willing to pay higher wages?
- Workers must be more productive there
  - $w = pf_L(K, L)$ in our model and approximately in reality
- Could it be that better workers live in larger cities?
- Sorting doesn't seem to be the whole story

1. Firms pay workers higher nominal wages
2. But workers don't enjoy higher real wages

Wages Adjusted by Cost of Living



Urban Productivity

Three classes of explanations for the greater productivity of cities

1. Cities have more capital
   - But why? Isn't capital pretty mobile over the long run?
2. Cities have natural advantages
   - Certain places are geographically blessed
   - People congregate there, so they form cities
3. Density itself makes cities more productive
   - The concentration of people and firms raises productivity
   - This is called *agglomeration economies*
   - People still prefer agglomerating in places with natural advantages

Natural Advantages

1. Farmland
   - The fertile crescent, Egypt, India, China
   - Chicago and the great plains
2. Waterways
   - Transportation, power, water supply and sewage
   - Classical antiquity in the Mediterranean; also the US
3. Mines
   - Coal and industrialization
   - Northern England, the Ruhr basin, Pittsburgh
4. Seats of political power
   - Not truly natural, but the sovereign has to be somewhere
   - In most countries the capital is the largest city; not in the US

Transport Costs and the Rise of US Cities

- American cities grew on waterways before 1900
  - 8 on the Atlantic (Boston, Providence, New York, Jersey City, Newark, Philadelphia, Baltimore, Washington)
  - 5 on the Great Lakes (Milwaukee, Chicago, Detroit, Cleveland, Buffalo)
  - 3 on the Ohio (Louisville, Cincinnati and Pittsburgh)
  - 3 on the Mississippi (Minneapolis, St. Louis, New Orleans)
  - 1 on the Pacific (San Francisco)
- Before railroads, it was a lot cheaper to ship by water than by land
- Canals and then railroads were built to complement natural waterways

Transport Costs and Agglomeration Economies

- Advantage of reducing transport costs = agglomeration economies
- New Economic Geography: Krugman (1991) and descendants

1. Transport costs
2. Increasing returns = fixed costs of production at the firm level

- Producers and consumers want to be close to each other
- Manufacturing locates in transportation hubs
  - Centralized to exploit economies of scale
  - Close to ports and railroads for market access
- Smaller cities throughout the US catering to diffuse agriculture

The Port of New York

- New York City takes off 1790–1860
  - Population: 33 to 814 thousand (117% to 300% of Philadelphia)
  - Exports: $13 to 145 million (108% to 853% of Boston)
- The best Atlantic harbor
  - Centrally located (vs. Boston, Charleston, New Orleans)
  - Deep water and close to the ocean (vs. Baltimore, Philadelphia)
  - Inland navigation on the Hudson and on the Erie Canal (1825)
- Complementary to shipping technology
  - Tonnage increases from $<$500 to $>$1500 tons
  - Specialized ships for hub and spoke network
  - Triangular trade with Europe and the South

Manufacturing Around the Port

- The main employer in NYC was manufacturing, not shipping
  - Already in the early 19th century, unlike in Boston
- Consistently three main industries

1. Sugar refining
   - Largest industry by value-added, 1810-1860
   - Large economies of scale
   - Best to refine after a long, humid shipment
2. Garment industry
   - Largest industry 1860-1970
3. Printing and publishing
   - Rises from third in 1860 to first in the 1970s
   - Originally pirating British books fresh off the ship

New York's Garment District

Chicago and the Great West

- Chicago was built on the Chicago portage
  - Connection between the Mississippi system and the Great Lakes
  - Illinois and Michigan Canal (1848)
  - Then it becomes a railroad hub
- Chicago takes off 1860-1920
  - Population: 112,000 to 2,702,000 (14% to 48% of New York)
- The hub for the Great Plains
  - How do you ship and consume corn?
  - By slaughtering pigs and curing pork

Chicago's Stockyards

Chicago and Urban Innovation

- Chicago was built on transportation
- However, it truly flourished thanks to innovation

1. The refrigerated rail car
   - A way to ship (corn in the form of) beef as well as pork
2. McCormick's reaper
   - Enhancing the productivity of agriculture supplying the city
3. Mail-order business: Ward and Sears
   - Increasing efficiency in sales to farmers in the great hinterland
4. The skyscraper
   - The city literally invents its own density
5. Trading in agricultural commodities and finance
   - The rise of what Chicago mostly does today

Secular Decline in Transport Costs

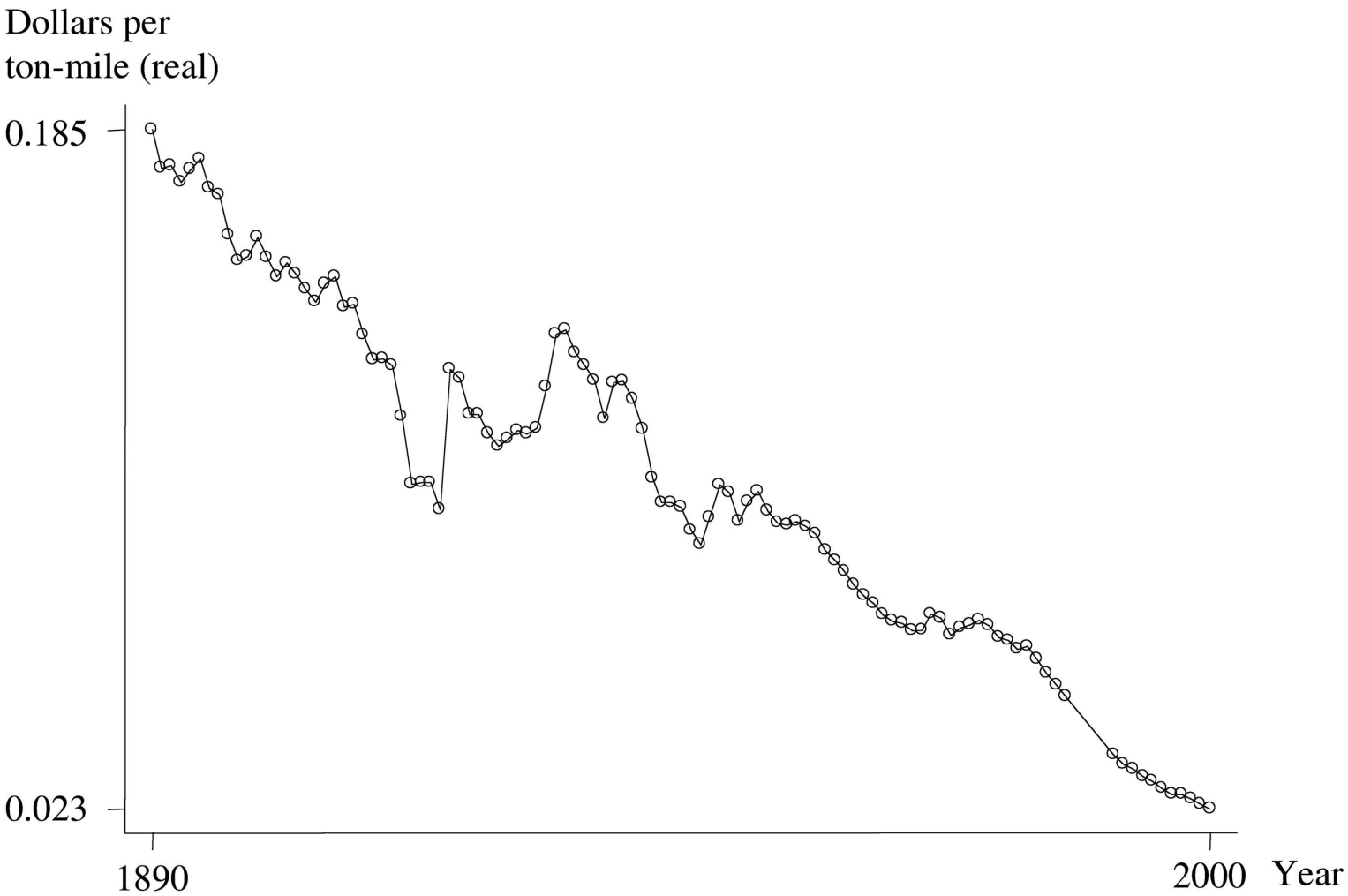


Fig. 3. The costs of railroad transportation over time. *Source:* Historical Statistics of the US (until 1970), 1994, Bureau of Transportation Statistics Annual Reports 1994 and 2002

What Do Declining Transport Costs Imply?

1. People are no longer tied to natural resources ▸ Longitude
2. Consumer amenities are becoming more important ▸ Weather
   - Los Angeles: the 20th century consumer city built on great weather
3. Services are in dense areas; manufacturing is not ▸ Services ▸ Manufacturing
   - Manufacturing no longer needs proximity to customers or suppliers
   - But service firms now do—more than they did in the past

- Also changes in urban form: Los Angeles and sprawl
  - Increasing concentration in a few metro areas
  - Increasing dispersion within each metro area

▸ Forward

The Emptying of the Hinterland

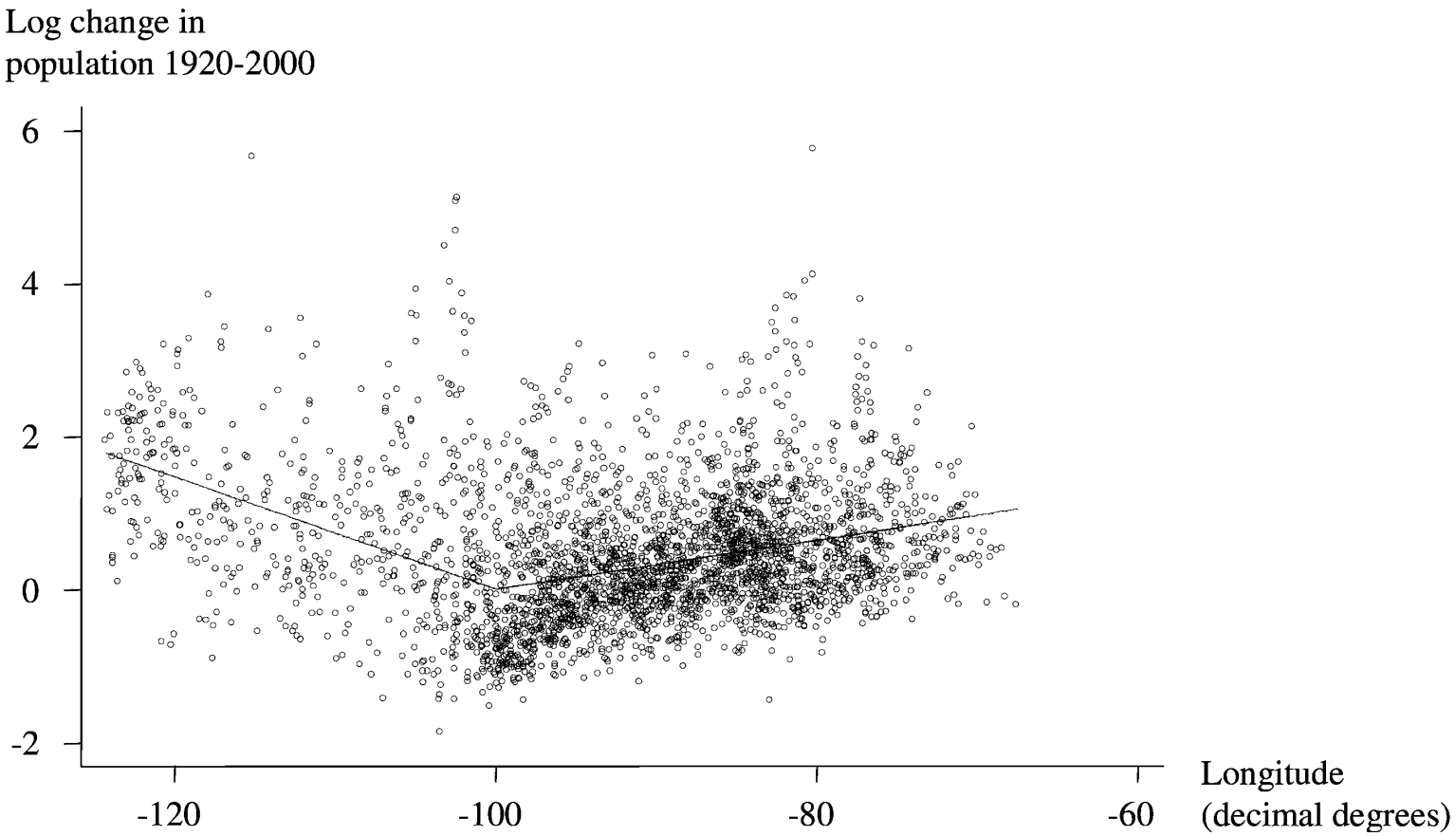


Fig. 11. The emptying of the hinterland, 1920–2000

$$\log\left(\frac{N_{2000}}{N_{1920}}\right) = \underset{(0.35)}{-7.3} - \underset{(0.003)}{0.07}\, L_{<-100^o} + \underset{(0.002)}{0.03}\, L_{>-100^o}$$

Back

The Growth of Temperate Places

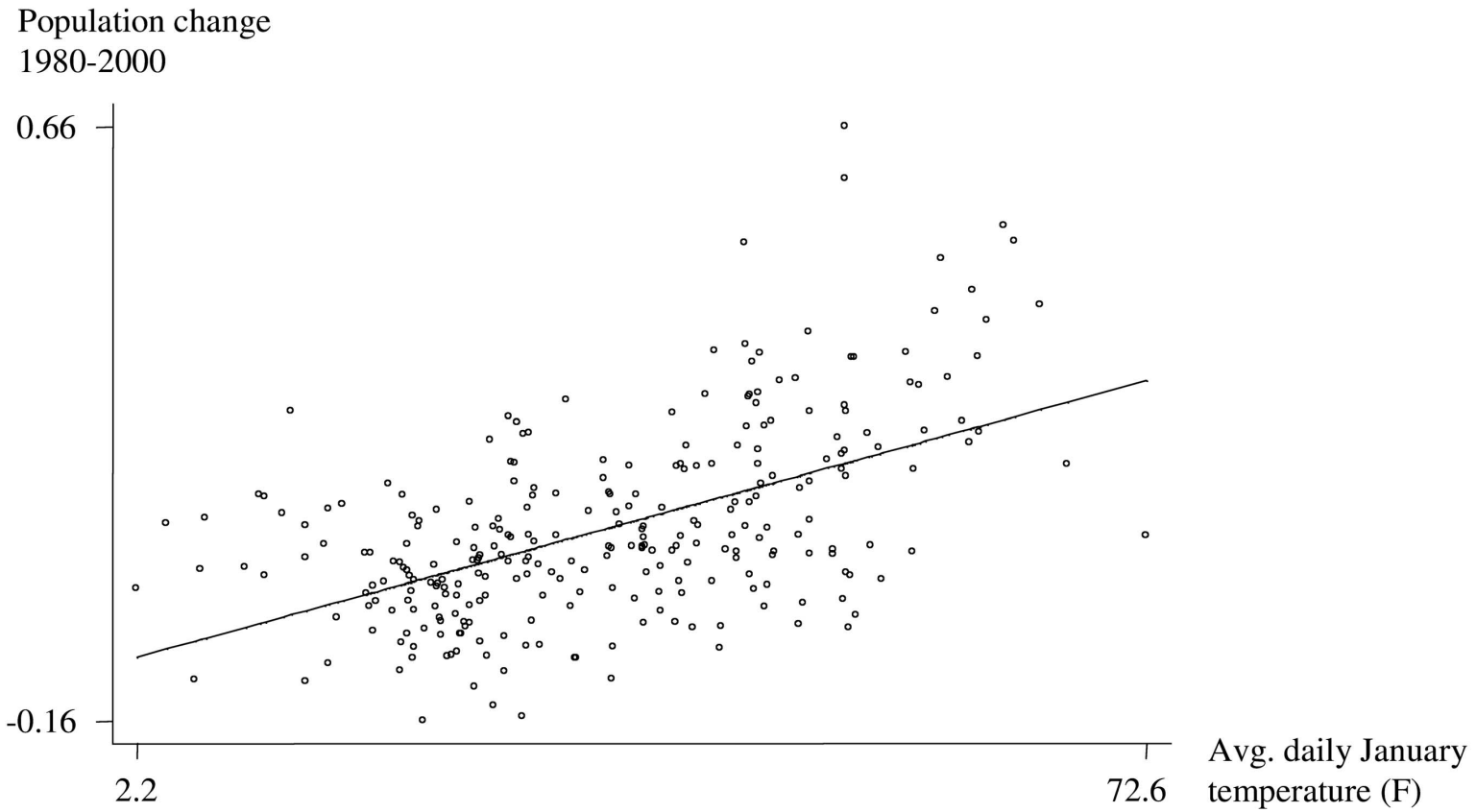


Fig. 12. The growth of temperate places, 1980–2000

$$\log\left(\frac{N_{2000}}{N_{1980}}\right) = \underset{(0.02)}{-0.08} + \underset{(0.0005)}{0.054}\ \text{Jan. Temp.}$$

Back

Services and Density

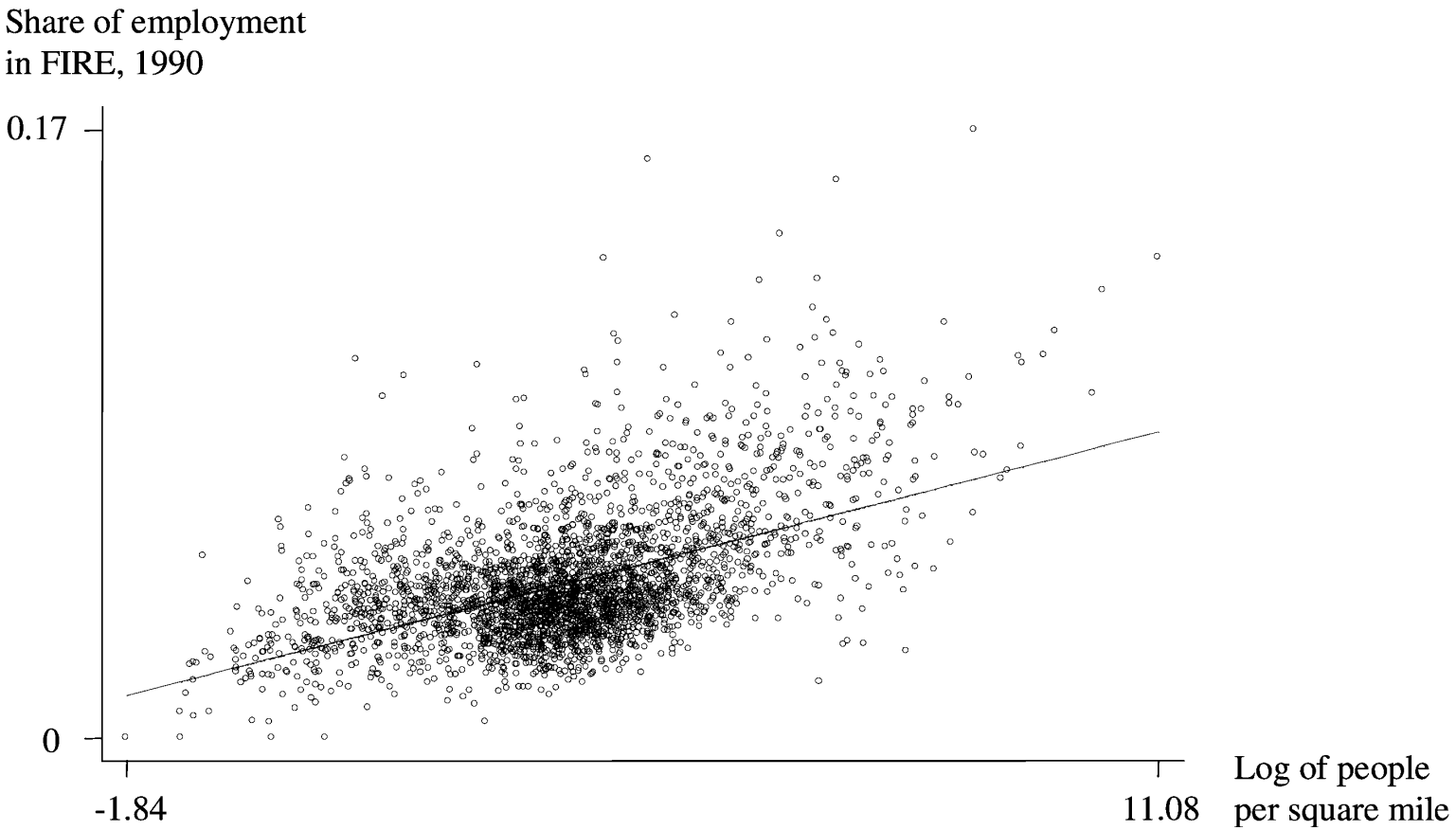


Fig. 13. Services and density

$$\frac{\text{Employment in FIRE}}{\text{Total Employment}} = \underset{(0.0007)}{0.023} + \underset{(0.00016)}{0.0057} \log \frac{N_{1990}}{L}$$

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Manufacturing and Density

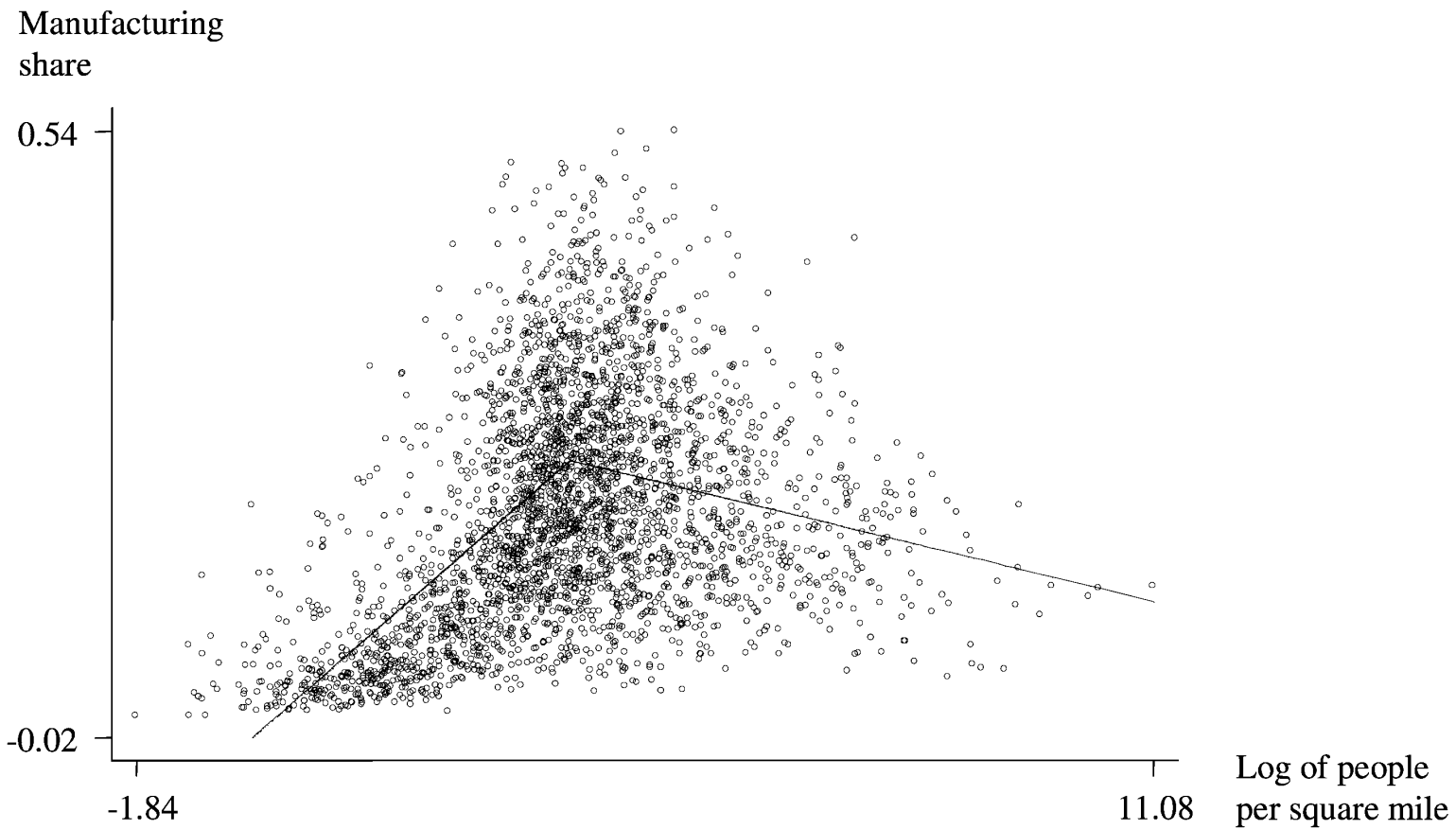

Fig. 14. Manufacturing and density

In the densest half: $\frac{\text{Employment in Mfg.}}{\text{Total Employment}} = \underset{(0.01)}{0.31} - \underset{(0.002)}{0.02} \log \frac{N_{1990}}{L}$

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Connecting People

- A city is the absence of physical space between people and firms
- Transport costs for goods may no longer matter too much
- Transport costs for people and ideas matter ever more
  - Despite IT, perhaps because of IT: Silicon Valley

1. Benefits of deep local labor markets
   - Pooling, matching, division of labor
   - Also for consumers: restaurants, dating, ...
2. Human capital and innovation spillovers

> *so great are the advantages which people following the same skilled trade get from near neighbourhood to one another. The mysteries of the trade become no mysteries; but are as it were in the air*

Marshall, Alfred. 1890. *Principles of Economics*. Book IV, Ch. X, § 3

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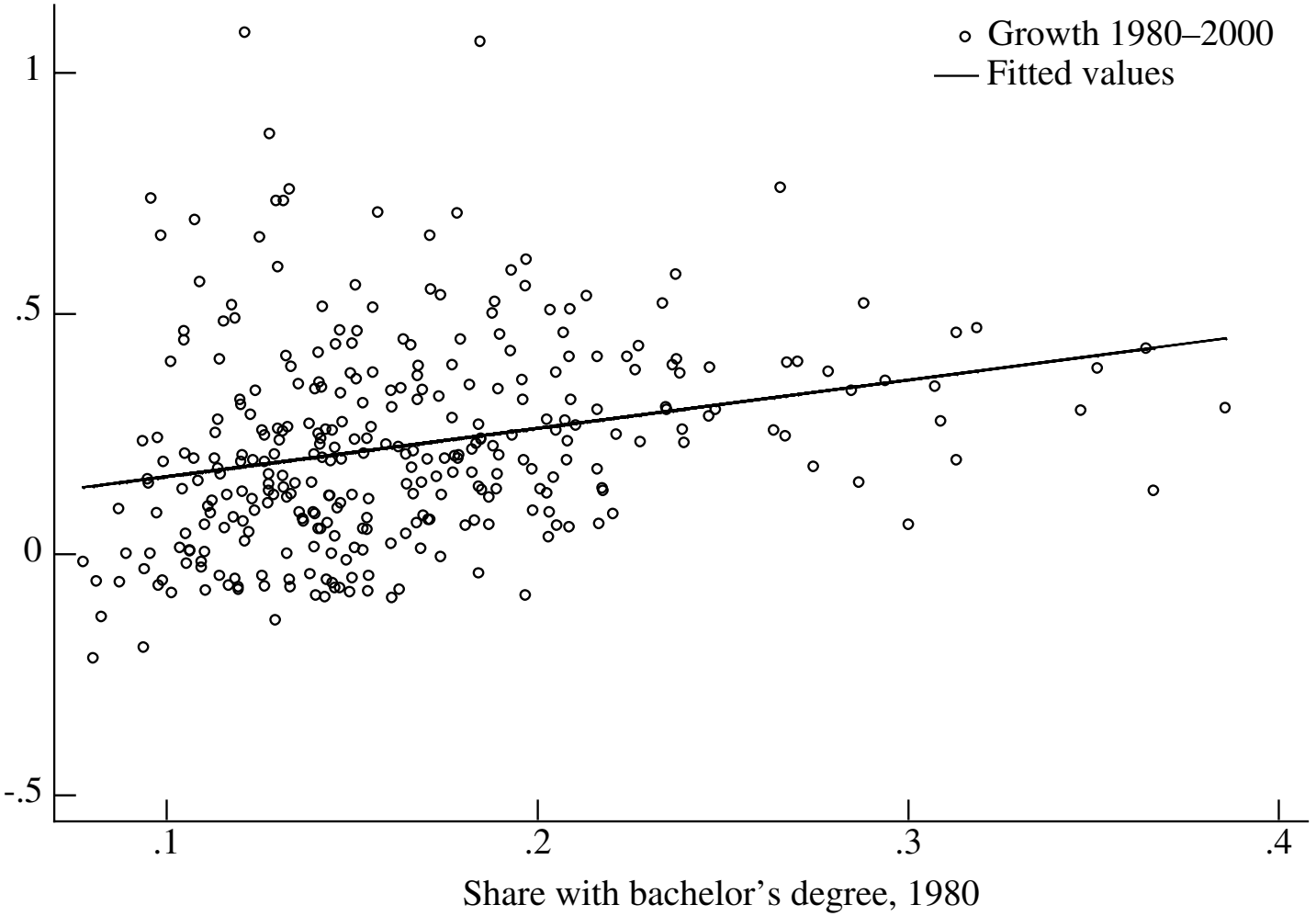
Human Capital and Urban Growth, 1980-2000



Fitted line from the regression: log(pop2000/pop1980) = 0.0611 + 1.001 × share with bachelor's degree in 1980.
(0.036) (0.209)

R squared: 0.067, N: 318.

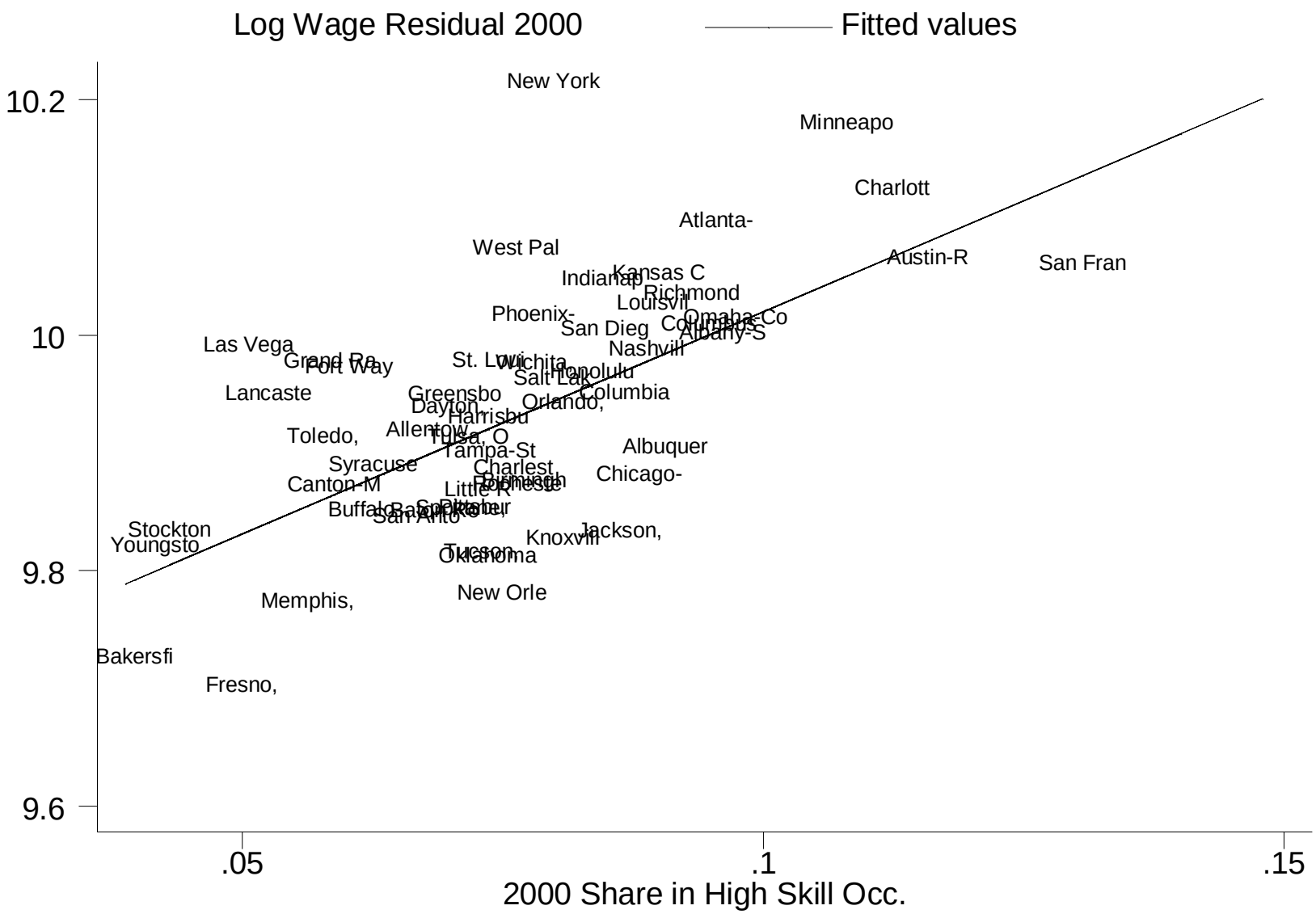
Human Capital and City Growth

- Cities with more educated residents have faster population growth
  - $+\sigma \approx 1\%$ share of college graduates
  - $\Rightarrow +\sigma/4 \approx 0.5\%$ decennial growth

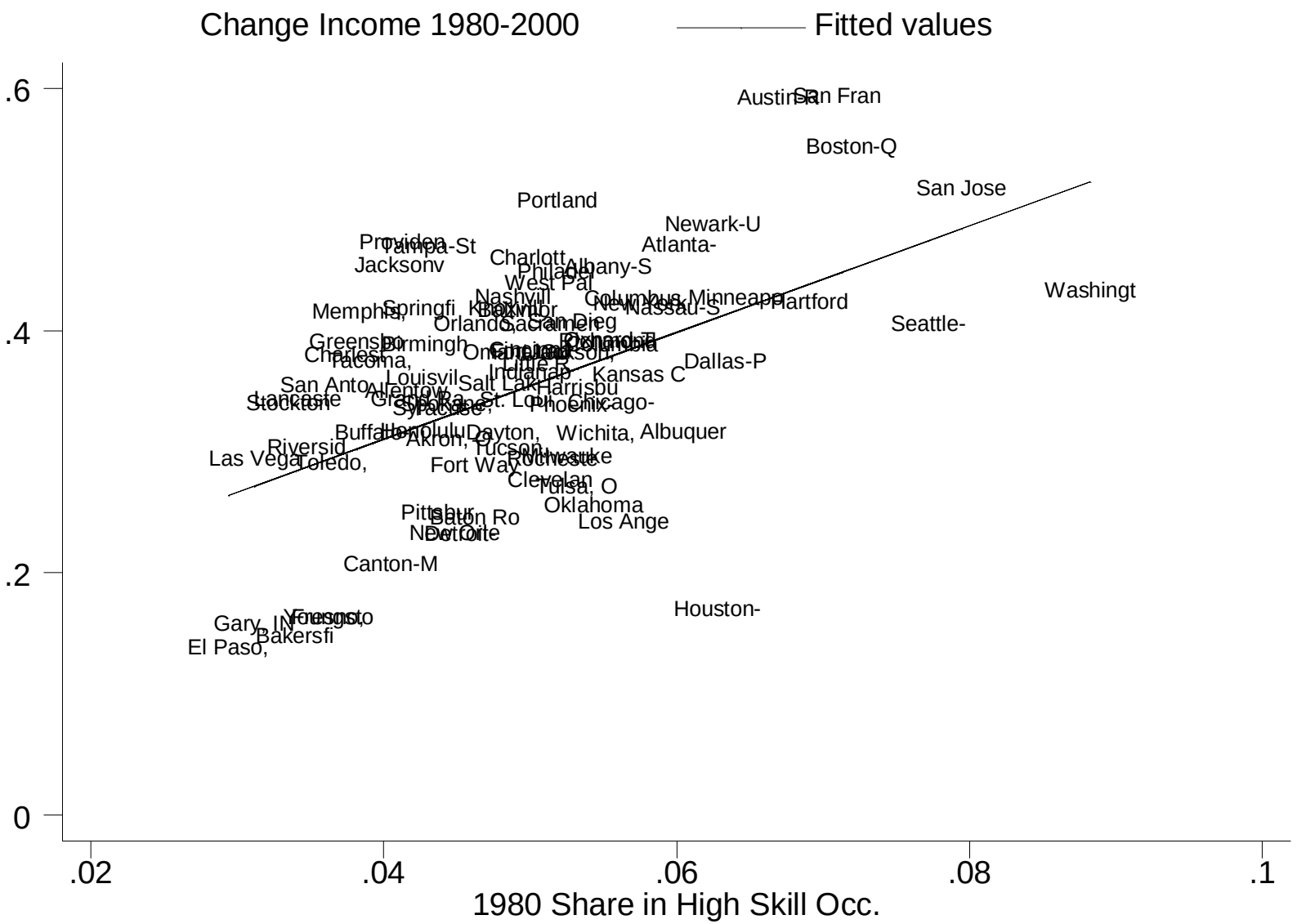
1. *Consumer City*: cities increasingly depend on consumption amenities
   - Educated neighbors are a consumption amenity
2. *Information City*: cities exist to facilitate the flow of ideas
   - Educated workers specialize in ideas
3. *Reinvention City*: cities survive by adapting to new technologies
   - Educated people are the drivers of change

- Productivity drives the connection between skills and growth
  - Education predicts future growth in house prices and nominal income
  - Real wages are not declining and may be rising with skill

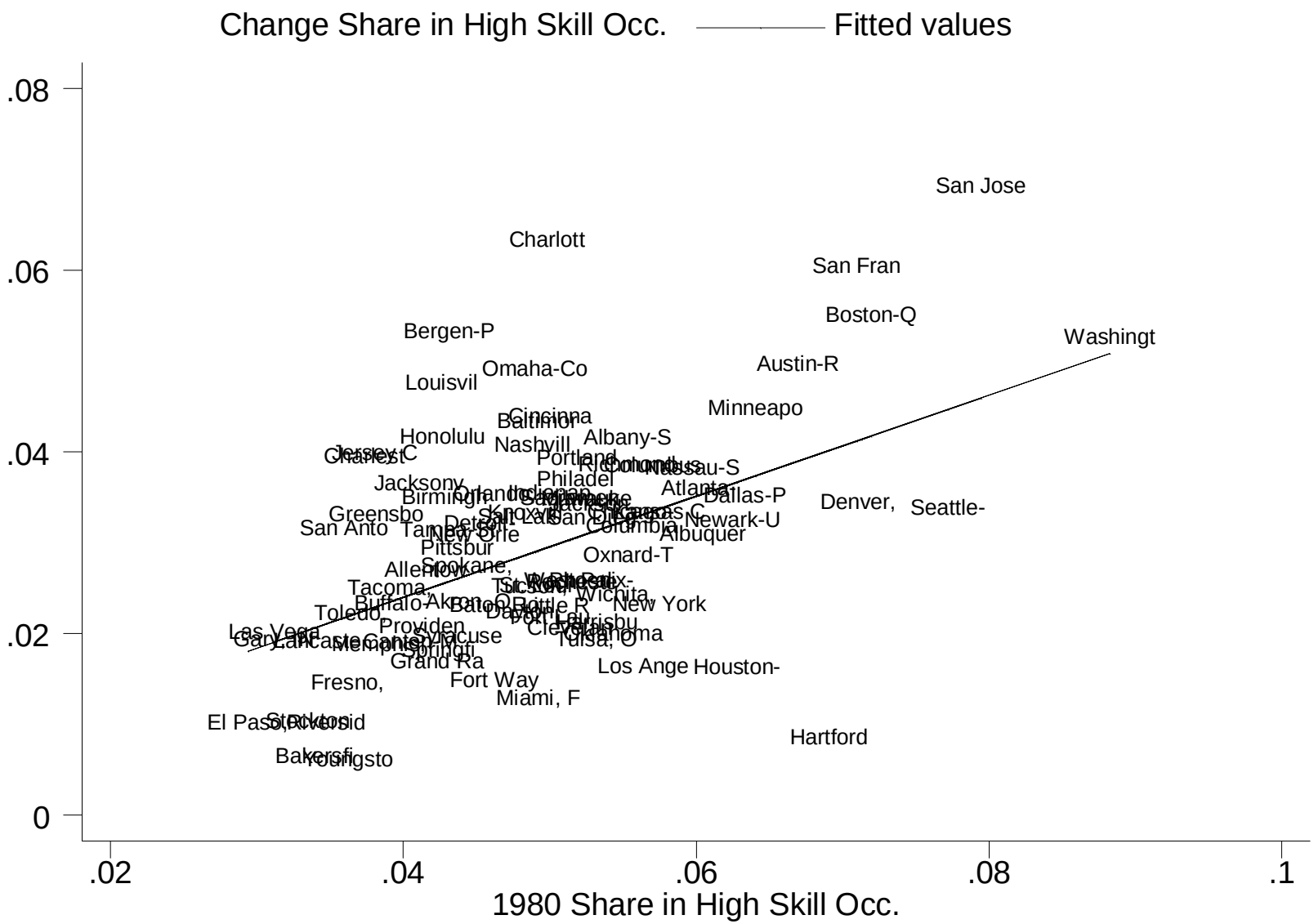
Employment in Knowledge Sectors and Spillovers



Specialization in Knowledge Sectors and Income Growth



Increasing Specialization in Knowledge Sectors



Cities and Ideas

- Human knowledge is based on interactions with others
- Urban density facilitates interactions and enables the flow of ideas
- New ideas generally come from combining old ideas
- Cities thrive from bringing together disparate activities
  - Beware of concentration and specialization (Chinitz, Jacobs)
  - Small average firm size strongly predicts employment growth
- Cities are hubs of economic, social, cultural, political innovation
- Rising importance of ideas: this role is more important than ever

Reinvention in the Frost Belt

- All older, colder US cities were in huge trouble in the 1970s
- Diverging paths explained by skills and innovation
  - The role of human capital is stronger in this subsample

1. New York, Chicago and Boston have thrived
   - Switched from manufacturing to idea-oriented industries
   - Profited from globalization: a world market for their innovation
2. Detroit, St. Louis and most of the Rust Belt are in deep decline
   - No new development to replace manufacturing
   - But manufacturing decentralized, even before outsourcing

Boston: Commerce to Manufacturing

- Founded in 1630 as Winthrop's "City upon a Hill"
  - A religious community, not a production-oriented colony
  - Human capital: Boston Latin (1635), Harvard College (1636)
- Exports foodstuff and wood to other colonies
  - New England had cheaper land than the South and the Caribbean
- Overtaken by New York and Philadelphia after 1740
- Maritime reinvention, 1820-1850
  - New York provides the port
  - Boston provides the ships, sailors, merchants
  - Sail-specific human capital declines after 1840
- Manufacturing reinvention, 1860-1920
  - China-trade capital and immigrant Irish workers
  - Switch from water to steam power
  - New England's railroad hub

Boston: Manufacturing to Services

- Decades of population decline
  1. Relative to the U.S., 1920-1950
  2. Absolute, 1950-1980
- Nation-wide trends working against Boston
  - Manufacturing left cities
  - Car cities replaced higher-density old cities
  - People fled cold places
  - The rich fled local redistribution
- Nadir in the 1970s
  - 75% of homes were worth less than construction costs
- Skill-driven reinvention
  - Higher education
  - Professional, scientific, and technical services
  - Finance