Notes on Mian et al. (2013): "Household Balance Sheets, Consumption, and the Economic Slump"

and

Mian and Sufi (2014): "What Explains the 2007-2009 Drop in Employment?"

The Mian and Sufi narrative

2002 to 2006: A housing boom.

- Supply of sub-prime mortgages increases.
- As house prices increase, households increase leverage.
- House prices increase primarily in areas with inelastic housing supply.

2007 to 2009: A housing bust.

- Decline in household wealth due to a drop in house prices.
- Consumption declines most in areas with high leverage, large declines in house prices.
- The household wealth shock accounts for slightly less than half of the drop in GDP.
- Due to real frictions, employment in non-tradable industries collapses in areas with negative wealth shocks.
- Housing bust explains around half of the increase in unemployment between 2007-2009.

Overview of the method and results

- Construct a measure of changes in household net worth, largely reflecting changes in house prices.
- Relate change in local consumption with change in household net worth.
  - On average, 1 dollar decline in household net worth is associated with a 6 cent decline in consumption.
  - Marginal propensity to consume out of wealth is highest for low-income, low-wealth, levered households
- Relate change in local employment with change in household net worth
  - A 1 standard dev. decline in the change in housing net worth is associated with a 3.1 percentage point drop in non-tradable industries.
  - Change in employment in tradable industries is uncorrelated to change in household net worth.

Contribution

- Does heterogeneity matter?
  - Krussel and Smith (1998): A model in which, for most of the wealth distribution, marginal propensity to consume is independent of wealth.
    - The behavior of aggregate variables can be nearly perfectly described using only the average of the wealth distribution.
    - In terms of matching the volatility of aggregate variables, a representative-agent framework seems to due a pretty good job.
- Can households insure against consumption risk?

Contribution

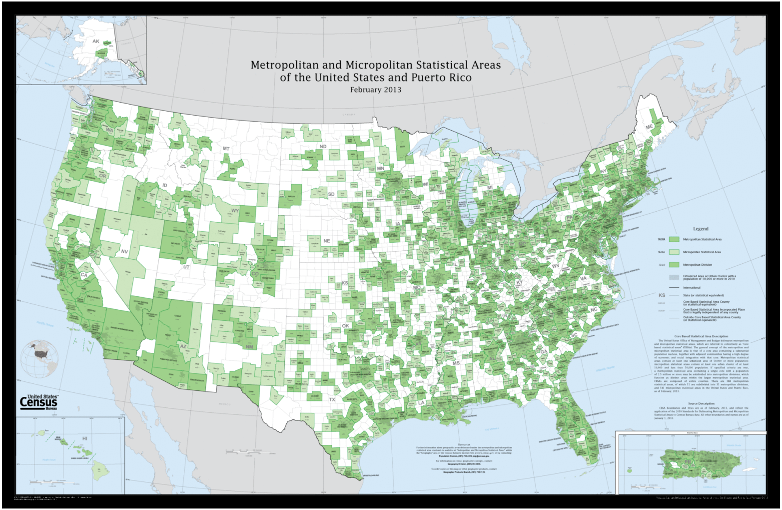
- What were the sources of the Great Recession?
  - Uncertainty about government policy: Bloom (2009), Baker, Bloom, and Davis (2013).
  - Generous unemployment insurance: Mulligan (2012).
  - Firms were credit constrained.
- Policy recommendations are different, depending on the cause.
  - Resolve policy uncertainty as soon as possible
  - Shorten duration of unemployment insurance
  - TARP; Small Business Jobs Act.
  - Forgiveness of some potion of housing debt.

Outline

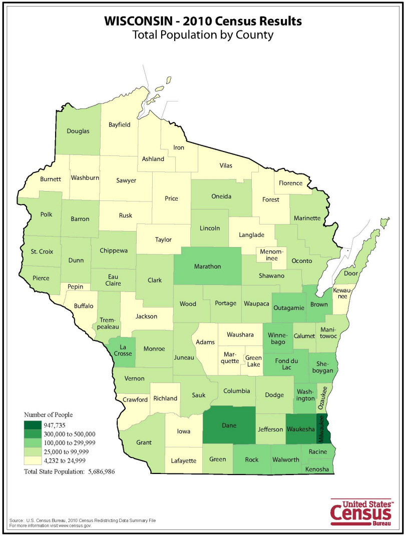
- Data
- Saiz (2010): Housing supply elasticities
- Housing net worth shocks and financial net worth shocks
- The effect of net worth shocks on consumption expenditures
- The effect of net worth shocks on employment

Data

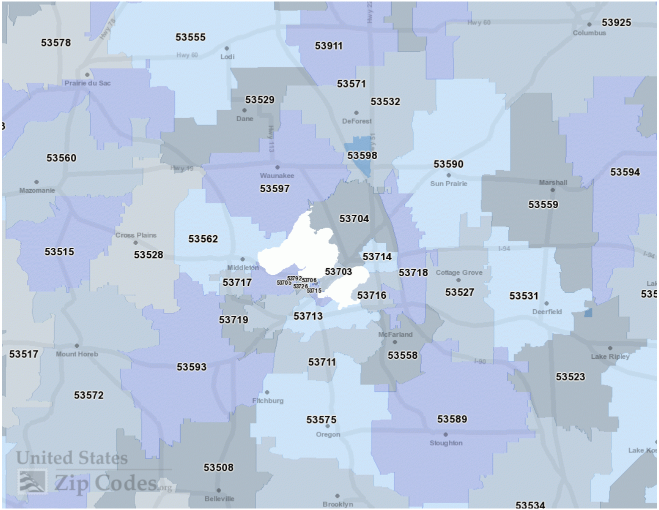
There are 388 Metropolitan Statistical Areas (MSAs), 929 Core Based Statistical Areas (CBSAs)



The average county has approximately 100 thousand people (3000 counties)



The average zip code has approximately 7 thousand people (43000 zip codes)



Data

- Saiz housing supply elasticities:
  http://web.archive.org/web/20100619052721/
  http://real.wharton.upenn.edu/~saiz/
- Housing net wealth.
  - House price data, at the zip code level are from CoreLogic.
  - 2000 Census: Value of houses in each zip code; home ownership rates.
  - Publicly available data at the CBSA level are at the Federal Housing Finance Agency (FHFA) website.
- Financial net wealth.
  - IRS Statistics of Income: Non-wage income in each zip code; publicly available.
  - Equifax debt at the zip-code level, not publicly available.

Data

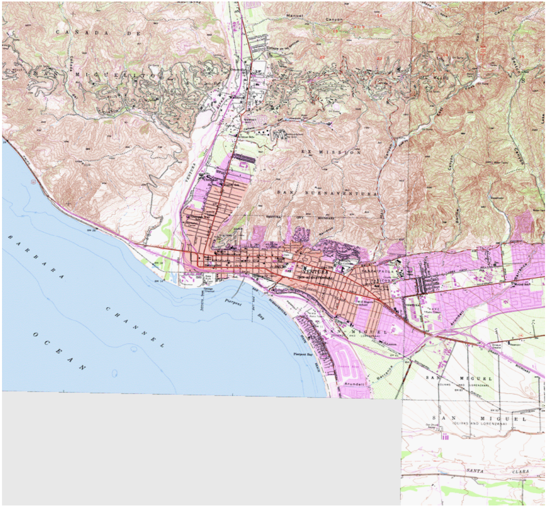
- Consumption data (Neither is publicly available):
  - RL Polk Auto Sales, 1998-2012
    - Data on auto registrations; prices not available.
    - Available at the zip code level.
  - MasterCard, 2005-2009
    - 5% of all transactions, broken down to groceries, other nondurable expenditures, durable expenditures
    - Available at the county level.
- Employment data
  - County Business Pattern: Data on employment for each MSA for each 4-digit industry. Publicly available. http://www.census.gov/econ/cbp/
  - American Community Survey: Hourly wage data. Publicly available.

Housing Supply Elasticities

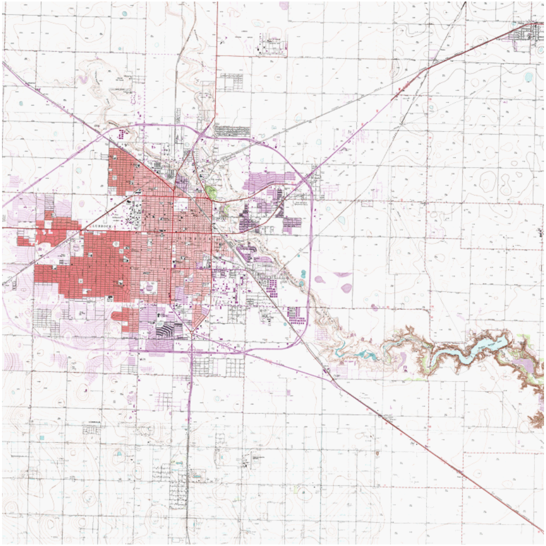
Saiz (2010)

- Housing supply in a region is more inelastic if parts of the region are unamenable for building due to topography or regulation.
- Why?
  - Assume: Demand for housing is a function of wages and amenities, both of which are subject to some congestion costs, and that there is a disutility of living far from the center.
  - $H_k \equiv$Stock of housing in city $k = \pi\Lambda_k\left(\text{Radius}_k\right)^2$
  - Rental prices, within the region, are linearly decreasing (at rate t) from distance to the city center.
  - Average real estate price in the city is the sum of construction costs plus land prices at $\frac{2}{3}$ of the way out of the city.
  - $P_k^s =$construction costs $+\kappa t\sqrt{\frac{H_k}{\pi\Lambda_k}}$
  - β^s is the *inverse* elasticity of supply.
  - Take the necessary derivatives: $\partial\beta^s/\partial\Lambda_k < 0$

Ventura, CA


EX MISSION
SAN BUENAVENTURA
BARBARA
CHANNEL
OCEAN
SAN MIGUEL
SANTA CLARA

Lubbock, TX



Measure of unavailable land

- For each MSA, k, with population greater than 500,000 people, draw a circle of radius 50 kilometers from the city center. Compute the fraction of land that is
  - water (ocean, wetlands, or river)
  - on steep terrain (a block group where over half the land has slope above 15%)
  - Share of unavailable land: 90/10 ratio 61% (Oakland, CA), 3% (Omaha, NE)
- Wharton Residential Land Use Regulatory Index.
  - Are developers required to supply mandatory dedication of open space, or open space, or a fee in lieu of dedication in order to build?
  - Is a local assembly involved in land regulation process?
  - The typical amount of time between application for subdivision approval and the issuance of a building permit for a project with multi family units.

Housing Supply Elasticity Estimation

$$\Delta \log \tilde{P}_k = \sigma_k \underbrace{\Delta \log CC_k}_{\text{change in construction costs}} + \underbrace{\beta^s}_{\text{inv. elasticity}} \Delta \log H_k + R^{\text{North}} + R^{\text{South}} + R^{\text{Midwest}} + R^{\text{West}} + \varepsilon_k$$

- $\tilde{P}_k$: median housing prices in each decennial Census.
- σ_k construction cost share.
- Instruments for $\Delta \log H_k$:
  - Hours of sun in MSA k
  - International migration to k.
  - Bartik Shocks: *National* change in employment in industries housed in MSA k
- $\beta^s = 0.65 \Rightarrow$ housing supply elasticity $=1.54$

Housing Supply Elasticity Estimation: Heterogeneous β^s

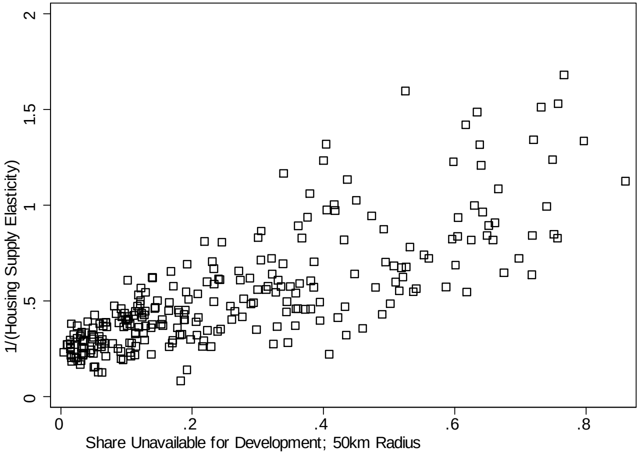
$$\begin{aligned}\Delta \log \tilde{P}_k = \sigma_k \Delta \log CC_k + \beta^s \Delta \log H_k \\ + \beta^{\text{Land}} (\text{Share of unavailable land}) \cdot \Delta \log H_k \\ + \beta^{\text{Regulation}} \log (\text{Regulation index}) \cdot \Delta \log H_k \\ + R^{\text{North}} + R^{\text{South}} + R^{\text{Midwest}} + R^{\text{West}} + \varepsilon_k\end{aligned}$$

- $\beta^{\text{Land}} \approx 0.5$
- $\beta^{\text{Regulation}} \approx 0.25$
- 90/10 ratio for β_k:
  - 0.94 (Jacksonville, FL)
  - 0.23 (Mansfield, OH)

Housing Supply Elasticities

	MSA	Elasticity	Unavailable Land	Regulation Index
1	Miami, FL	0.60	77%	0.94
2	Los Angeles, CA	0.63	52%	0.49
3	Ft. Lauderdale, FL	0.65	76%	0.72
4	San Francisco, CA	0.66	73%	0.72
5	San Diego, CA	0.67	63%	0.46
265	Terra Haute, IN	6.51	5%	-1.39
266	Alexandria, LA	7.15	19%	-1.68
267	Columbia, MO	7.84	6%	-1.53
268	St. Joseph, MO	7.94	6%	-1.51
269	Pine Bluff, AR	12.15	18%	-1.76

Housing Supply Elasticities



Changes in Household Net Worth

Net Worth Shocks

What we are after is the change in household net worth, for each county or zip code, between 2006 and 2009

$$NW_t^i = S_t^i + B_t^i + H_t^i - D_t^i$$

$$\Delta NW^i_{'06-'09} = \Delta logp^S_{06-09} \cdot \frac{S^i_{06}}{NW^i_{06}} + \Delta logp^B_{06-09} \cdot \frac{B^i_{06}}{NW^i_{06}} + \Delta logp^{H,i}_{06-09} \cdot \frac{H^i_{06}}{NW^i_{06}}$$

- H^i_{06}: Value of housing wealth in 2006:
  - 2000 Census: Number of homeowners in each zip code. Scale up number of homeowners using national trends in population growth (increases from 282 million to 298 million btw. 2000 and 2006) and home ownership rates (increases from 67.1% to 68.5%)
  - Scale up house prices in each zip code using CoreLogic Data

Net Worth Shocks

What we are after is the change in household net worth, for each county or zip code, between 2006 and 2009

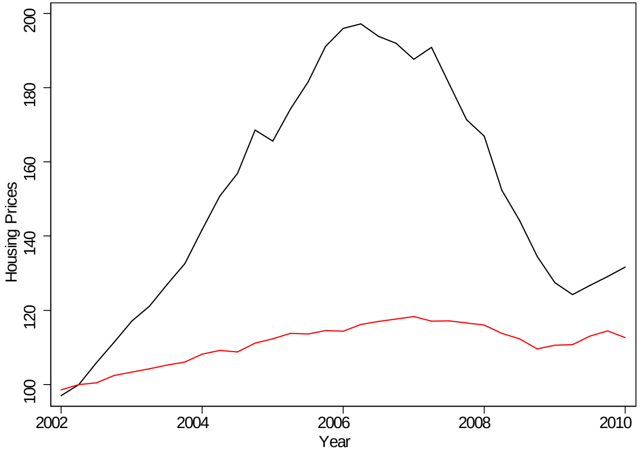
$$NW_t^i = S_t^i + B_t^i + H_t^i - D_t^i$$

$$\Delta NW^i_{'06-'09} = \Delta logp^S_{06-09} \cdot \frac{S^i_{06}}{NW^i_{06}} + \Delta logp^B_{06-09} \cdot \frac{B^i_{06}}{NW^i_{06}} + \Delta logp^{H,i}_{06-09} \cdot \frac{H^i_{06}}{NW^i_{06}}$$

- Know zip code financial asset income for each zip code (IRS Statistics of Income)
  - Assume change in financial assets are proportional to zip codes' financial asset income
  - Price changes are going to be the same for all zip codes⇒ Understate the financial component of the net worth shock.

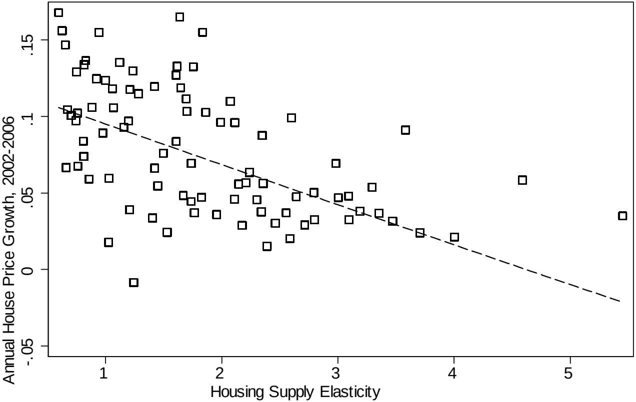
Net Worth Shocks

House Prices in Ventura and Omaha: Δp^{H_i}



Net Worth Shocks

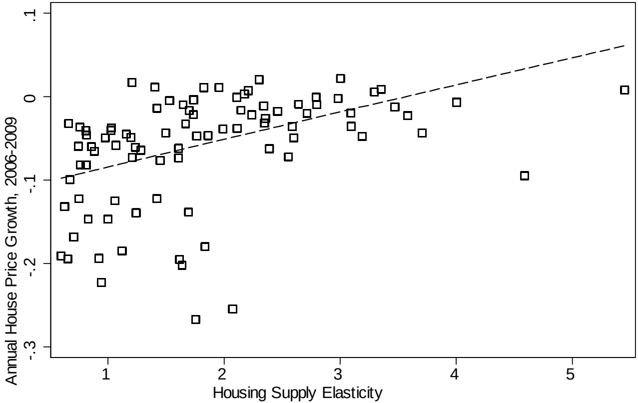
House Prices and Housing Supply Elasticities



Correlation$=-0.51$

Net Worth Shocks

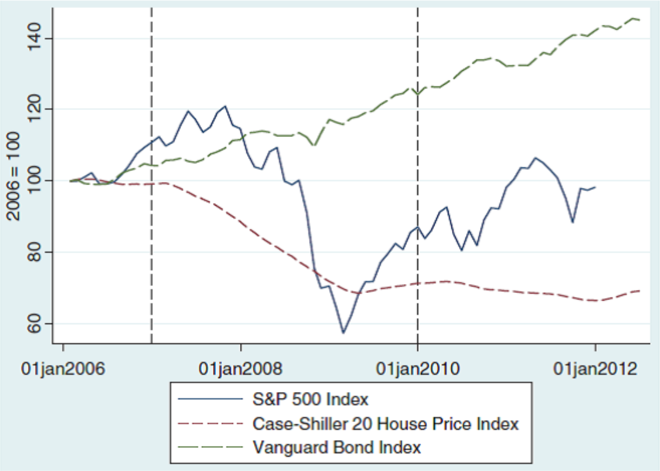
House Prices and Housing Supply Elasticities



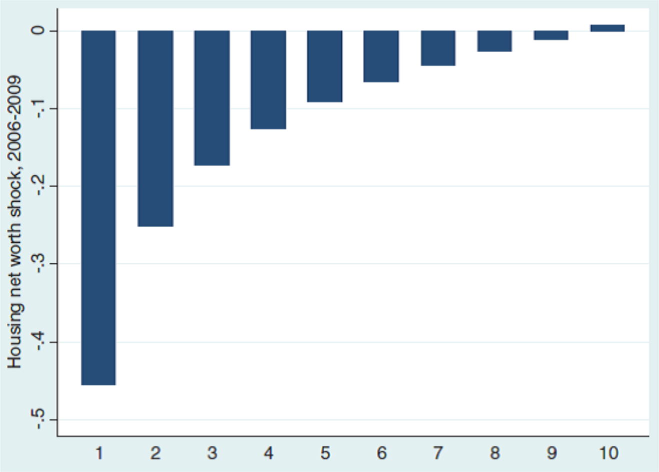
Correlation=0.46

Net Worth Shocks

Financial Asset Prices Δp^S and Δp^B



Housing Net Worth Shocks



- Huge variation, across zip codes, in the net worth shocks
  - Top decile has a slight increase in net work.
  - Bottom decile has a decline of net worth of almost half.

Relationship between changes in net worth and changes in consumption expenditures.

Relationships between Saiz's housing supply elasticities and other county-level variables

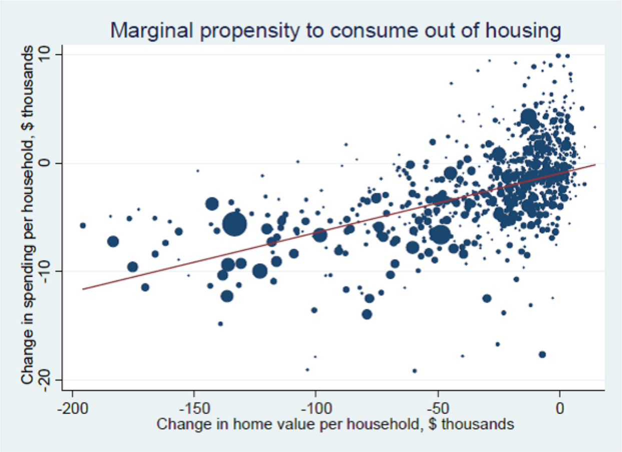
	β	se	R^2
Housing net worth shock, 06-09	0.046**	0.01	0.19
Change in home value, 06-09	27.795**	7.87	0.28
Change in wage growth, (02-06)-(98-02)	-0.002	0.00	0.00
Employment share in construction, (02)	0.002	0.00	0.00
Construction employment growth, (02-06)	0.005	0.01	0.00
Population growth, (02-06)	0.012*	0.01	0.03
Income per household (06)	-5.378**	0.99	0.08
Net worth per household (06)	-88.389**	20.69	0.08

- Punchline: Housing supply elasticity related to net worth shock (relevance); income and net worth per household (will get differenced out in a panel regression), but not much else. $\Rightarrow$ No evidence against exclusion restriction.

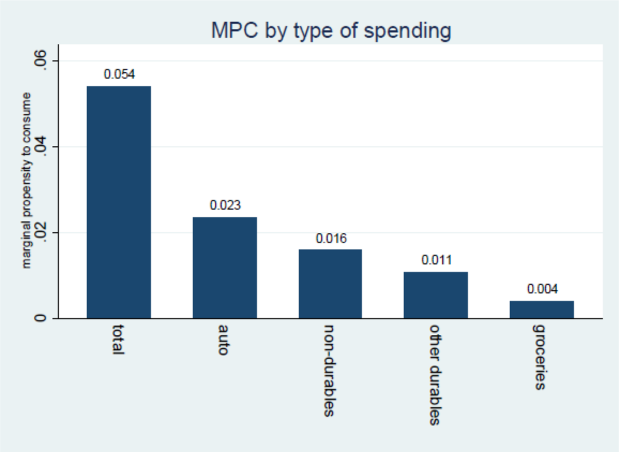
MPC out of household net worth is approximately 6%.

$$\Delta C_{i,06-09} = \alpha + \beta \cdot \Delta \log X^i_{06-09} + \Gamma^i_{2006} + \varepsilon^i_t$$

- $\Gamma^i_{2006} \in$ employment shares in different industries, income per household, net worth per household.



MPC out of housing wealth is highest for autos.

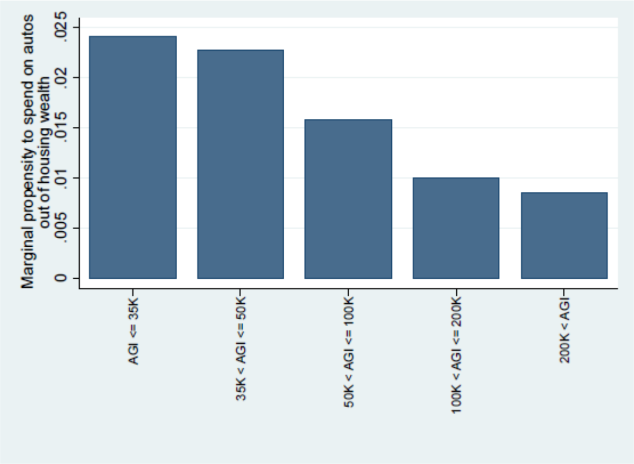


Little power to identify differential MPC using county-level data

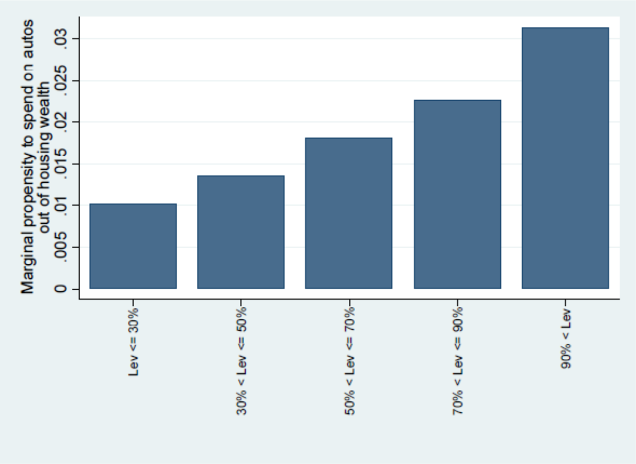
- Within-county standard deviation in net worth is $440,000.
- Between-county standard deviation in net worth is $237,000.

	Δ Total spending	Δ Auto spending	Δ Auto spending
Δ Home value	0.076**	0.034**	0.023**
$000, 2006-09	(0.012)	(0.005)	(0.002)
Net worth	-4.289*	-1.810**	-0.354
$millions, 2006	(2.132)	(0.665)	(0.243)
Δ Home values*	-0.038	-0.024*	-0.007**
'06 Net worth	(0.024)	(0.009)	(0.001)
Constant	1.247	-1.300**	-1.883**
	(0.679)	(0.200)	(0.121)
N	944	944	6220
R^2	0.462	0.427	0.153

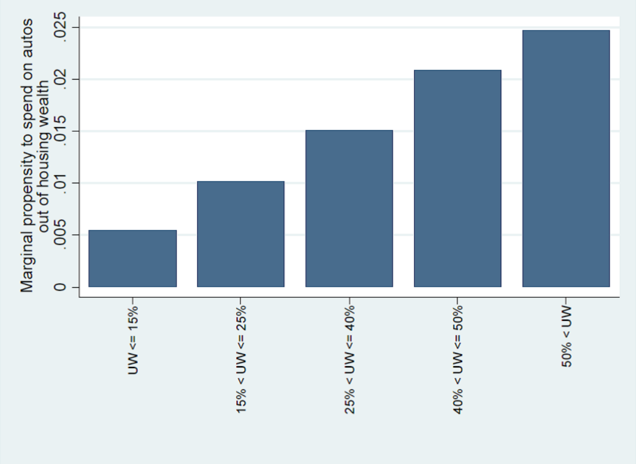
MPC out of housing wealth is highest for low-income zip codes.



MPC out of housing wealth is highest for high leverage zip codes.



MPC out of housing wealth is highest for zip codes with a high fraction of underwater households.



Summarizing and interpreting the coefficient estimates

- MPC is, on average, 0.06.
  - Total decline in spending relative to trend, $870 billion.
  - Home values in the US fell from $5.6 trillion between 2006 and 2009.
  - Drop in household spending of 0.06*5.6 trillion = $336 billion from housing net worth shock.
  - So, out approximately 40% (=336 billion/870 billion) of spending is due to the housing net worth shock.
  - This estimate is generated from cross-sectional data; can't account for potential countervailing general equilibrium effects affecting the whole country.
- MPC varies substantially: It is more than two times higher in zip codes with average gross income is less than 50K, compared to zip codes with average gross income greater than 100K.

Association between changes
in net worth and changes
in employment

Question and Strategy

- Question: How much of the aggregate decline in employment is due to the housing net worth shock?
- From before: Consumption expenditures vary considerably by region due to heterogeneity in the net worth shock.
- Strategy:
  - Employment in certain industries (non-tradable industries) is tied to local consumption.
  - Compute the change in employment in these industries.
  - If there are general equilibrium adjustments, the cross-sectional changes in employment in tradable industries will compensate for the loss in non-tradable industry employment.
  - Look at change in employment in tradable industries.
- Other explanations: Uncertainty? Supply of credit to businesses?

A model of the employment response to demand shocks

Set-up

- S states indexed by s; D_s units of consumer demand in state s
- Consumers have Cobb-Douglas preferences; α is the consumption share of non-traded goods
  - Consumption of traded goods: $c_s^N = \alpha D_c$
  - Consumption of non-traded goods: $c_s^T = (1-\alpha) D_c$
- No productivity shocks:
  - $y_s^N = e_s^N$ is the production function for non-traded goods; wage is P_s^N
  - $y_s^T = e_s^T$ is the prod. function for traded goods; wage is P^T
  - If there is labor mobility across sectors, within states, $P_s^N = P^T \; \forall \; s$.
- Market-clearing in the non-traded and traded sectors:

$$y_s^N = c_s^N \text{ and } \sum y_{s'}^T = \sum c_{s'}^T \tag{1}$$

- If $D_s = \bar{D}$ for all states s, then
  - $e_s^N = \alpha$ and $e_s^T = (1-\alpha)$ for all states.
  - $P_s^N = P^T = w = \bar{D}$

A model of the employment response to demand shocks

Solution to the frictionless economy

- Negative demand shock so that $D_1 = (1-\delta)\,\bar{D}$ for state 1, $\bar{D}$ for all other states, $s \in \{2, ...S\}$
- Equation (1) and the prod. functions are as before
  - $c_1^N = \alpha\,(1-\delta)\,\bar{D}$ and $c_1^T = (1-\alpha)\,(1-\delta)\,\bar{D}$
  - $e_1^N = \frac{\alpha\bar{D}(1-\delta)}{P_1^N}$ and $e_1^T = 1 - \frac{\alpha\bar{D}(1-\delta)}{P_1^N}$
  - Market clearing in tradable sector:

$$\sum\left(1-\frac{\alpha D_s}{P^T}\right)=\frac{1-\alpha}{P^T}\left(\sum D_s\right)\Rightarrow$$

$$\sum\left(1-\frac{\alpha\bar{D}}{P^T}\right)=\frac{1-\alpha}{P^T}\left(\sum\bar{D}\right)-\frac{\delta\bar{D}}{P^T}\Rightarrow$$

$$P^T=\bar{D}-\frac{\delta\bar{D}}{S}$$

- Thus $P_s^N = w = \bar{D}\left(1-\frac{\delta}{S}\right)$
- $e_1^N = \alpha\frac{1-\delta}{1-\delta/S}$ and $e_1^T = 1-\alpha\frac{1-\delta}{1-\delta/S}$
- Drop in non-tradable employment, but is fully offset by increase in tradable employment.

A model of the employment response to demand shocks

Adding real or nominal frictions

- As in the last slide, there is a negative demand shock so that $D_1 = (1-\delta)\bar{D}$ for state 1, $\bar{D}$ for all other states, but that prices/wages are fixed at their non-shocked values ($\bar{D}$)
- $e_1^N = \alpha(1-\delta)$; $e_s^T = (1-\alpha)\left(1-\frac{\delta}{S}\right)$
- $e_1 = \alpha(1-\delta) + (1-\alpha)\left(1-\frac{\delta}{S}\right) = 1 - \alpha\delta\frac{(S-1)}{S}$
- Thus:
  1. ... employment in the tradable industry increases only slightly, not enough to make up for loss of employment in the non-tradable sector.
  2. ... employment in the tradable sector is the same for all regions, uncorrelated to the demand shock in that region.

Tradable vs. Non-tradable industries

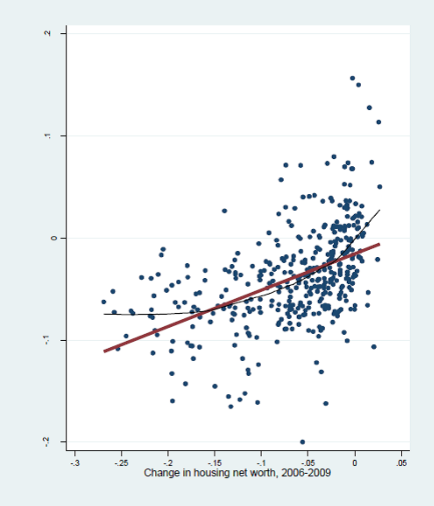
Method 1:

- Non-tradable industries: Restaurants, bars, and retail.
- Tradable industries: Industries that have a high share of imports/exports
  - Manufacturing, mining, software publishers, fisheries and forestry.
  - Alternative definition: Industries that have
- Construction
- Everything else:.E.g., health care and education.

Method 2: Classify industries by Herfindahl Index of locations in different counties.

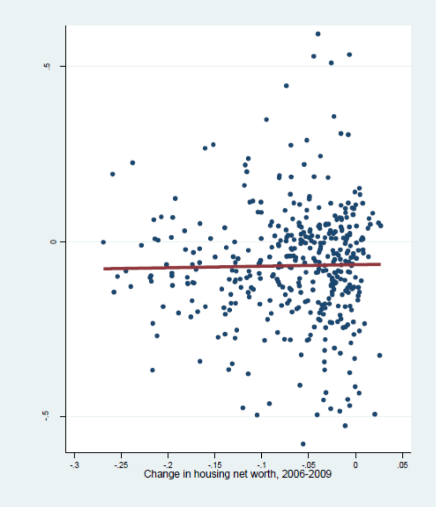
- Most concentrated: Securities and commodities exchanges; pipeline transportation of oil; apparel manufacturing; motion picture industries; agents for artists/athletes.
- Least concentrated: Garden equipment stores; Farm product wholesalers; Gas stations; Mineral mining; General merchandise stores

Changes in employment in non-tradable industries



$\beta = 0.31$

Changes in employment in tradable industries



$\beta = 0.02$ (not statistically significant)

Changes in wages, by county

Changes in population, by county

Aggregate implications of the cross-sectional estimates

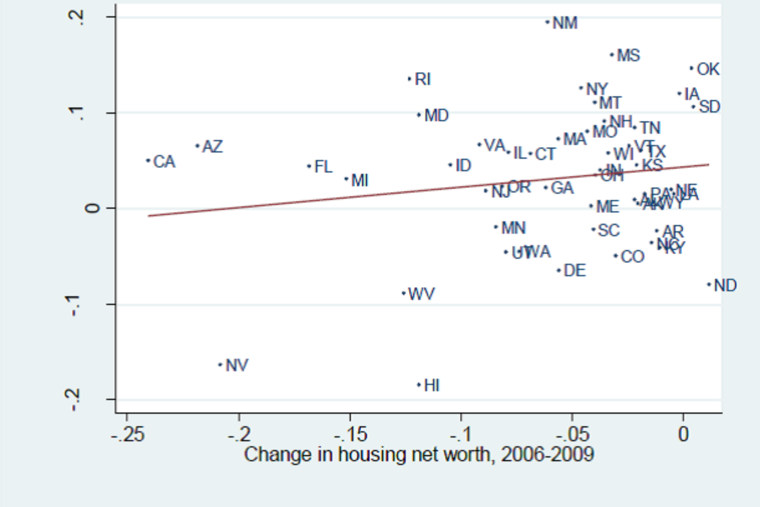
- 90/10 difference in the housing net worth shock = [-0.17, 0.00]
  - Going from the 90th percentile to the 10th percentile of housing net worth shock is associate with a change of approximately 0.31 * 0.17=6 percentage points in non-tradable employment
- 90/10 difference in non-tradable employment growth = approximately 12 percentage points
- Roughly half of the dispersion in the decline in non-tradable employment growth is explained by the housing net worth shock.

How much is uncertainty over taxes and regulation hindering employment?

Survey of small businesses from National Federation of Independent Businesses.

	2006	2010
Poor Sales	9	30
Taxes	18	20
Government Regulation	10	17
Cost of Insurance	23	8
Comp. from Large Bus.	9	7
Inflation	7	4
Interest Rates	3	3
Quality of Labor	4	3

How much is uncertainty over taxes and regulation hindering employment?



Does a "construction sector shock" explain the drop in non-tradable employment?

	Δ Non-tradable Employment Growth	Δ Non-tradable Employment Growth
Δ Housing net worth	0.305**	0.286**
$000, 2006-09	(0.125)	(0.125)
Δ Construction		0.027
employment, '07-'09		(0.063)
Constant	-0.010	-0.008
	(0.010)	(0.008)
N	540	540
R^2	0.057	0.075

Is firm access to credit likely to be an important source of employment loss?

- Three pieces of circumstantial evidence indicating that it might not be.
  - No clear reason why supply of credit to non-tradable firms, but not tradable firms, should be affected.
  - Can look at employment in small vs. big establishments (small are more likely to be credit constrained). Drop in non-tradable employment in big establishments is actually *bigger*, counter to the credit supply story.
  - Can look at areas services by national vs. local banks (which may be more hesitant to supply credit). No difference, across regions, in the drop in non-tradable employment across regions with different types of banks.

Is firm access to credit likely to be an important source of employment loss?

- Three pieces of circumstantial evidence indicating that it might not be (last slide).
- But there is other evidence indicating that real estate price changes may limit firms' ability to access credit. Chaney, Sraer, Thesmar (2012)
  - Corporate and residential real estate prices are correlated.
  - Firms use their own real estate as collateral when investing.
  - A $1 decrease in collateral value leads to a $0.06 decrease in investment.

Summary

- House prices increased considerably between 2002 and 2006 (by 75%) and declined considerably between 2006 and 2009 (by 34%).
  - Large decline in consumption expenditures due to housing worth shock.
  - Large decline in employment due to housing worth shock.

- What's behind the increase in the supply/demand of mortgages in the early 2000s?
  - Loose lending standards? Securitization?
  - Loose monetary policy? Global imbalances?
  - Fundamentals (credit demand)?
    - Consumers expected house prices to increase based on future income growth in the region.

Notes on Barro and Sala-I-Martin (1991): "Convergence Across States and Regions"

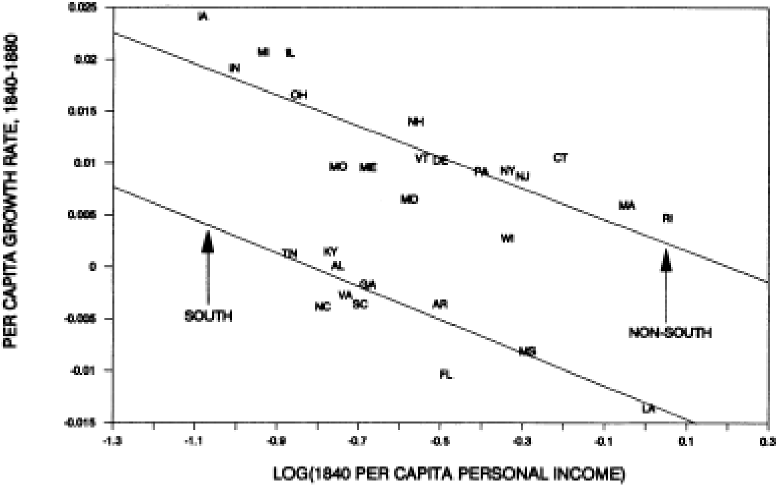
Question and Motivation

- Is there convergence in personal income per capita, among U.S. states?
- More general question: Are poor regions (could be states or countries) converging to rich regions?
- Motivation:
  - Implications for growth models, neoclassical vs increasing-returns-to-scale-based new growth models.
  - When looking across countries, the welfare implications of convergence are *huge*. Testing for convergence across states, within countries, may be an easier task.
    - Much easier to argue that technology and preferences are identical within countries than across.

Data Sources

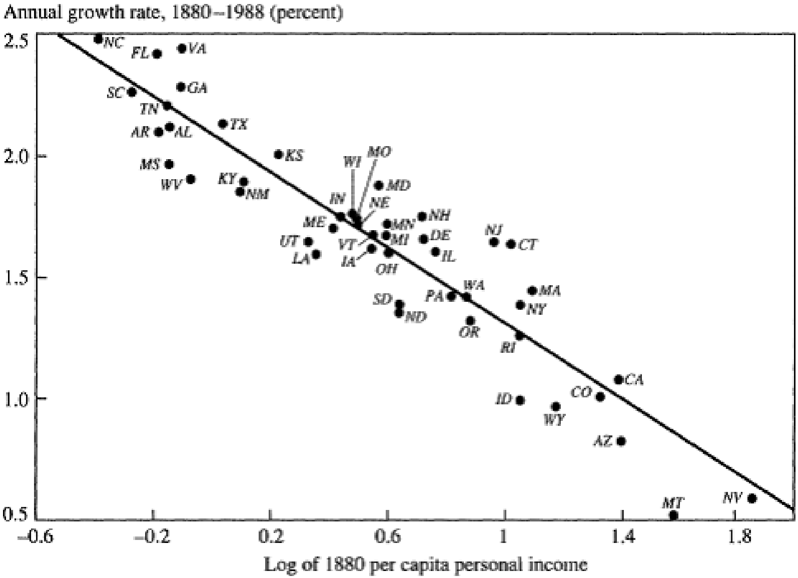
- Easterlin (1960a, 1960b): Per capita income by state for 1840, 1880-1920.
- Decennial Census: 1940 onwards
  - Wage income for males aged 21-65.
- IPUMS International:
  - Data on wage or total income by individual for a large sample of countries.

Regional divergence: 1840-1880

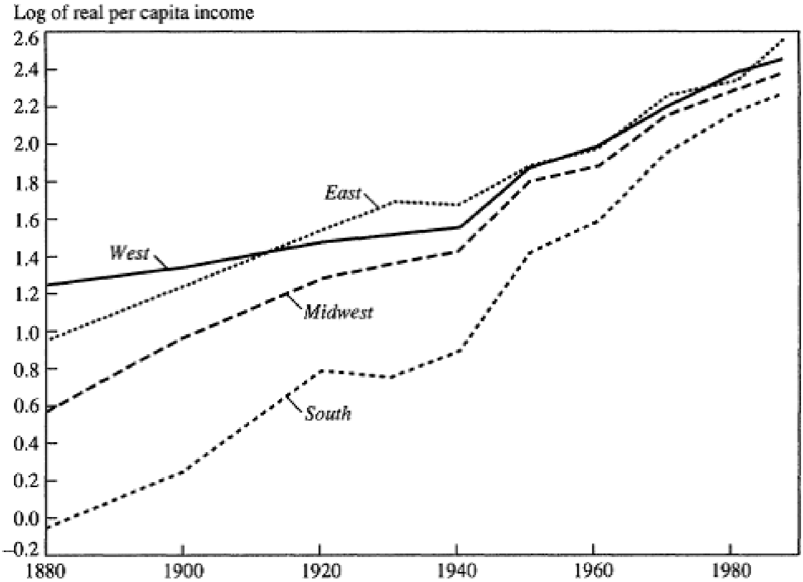


- From Barro and Sala-I-Martin (1992)

Regional convergence: 1880-1988



Regional convergence: 1880-1988



The basic framework is the Solow growth model

- Each state, i, in the U.S. is a closed economy (consider capital and labor mobility in a bit) with:
  - $\hat{y} = A\hat{k}^{\alpha}$; output per worker is a function of capital per "effective" worker
  - initial capital stock (per effective worker) may vary across locations
  - exogeneous identical (across states) labor-augmenting growth, x, population growth rates n; discount rate, ρ, depreciation rate δ, intertemporal elasticity of substitution $\frac{1}{\theta}$.
- Differential equation for output per effective worker, as is approaches the steady state y^*

$$\log\left(\frac{\hat{y}_{it}}{\hat{y}_{i,t-T}}\right) = \log\left(\frac{\hat{y}^*}{\hat{y}_{i,t-T}}\right)\left(1 - e^{-\beta T}\right)$$

β dictates the speed of convergence.

The basic framework is the Solow growth model

- Add stationary shocks, and factor out the labor-augmenting productivity growth term:

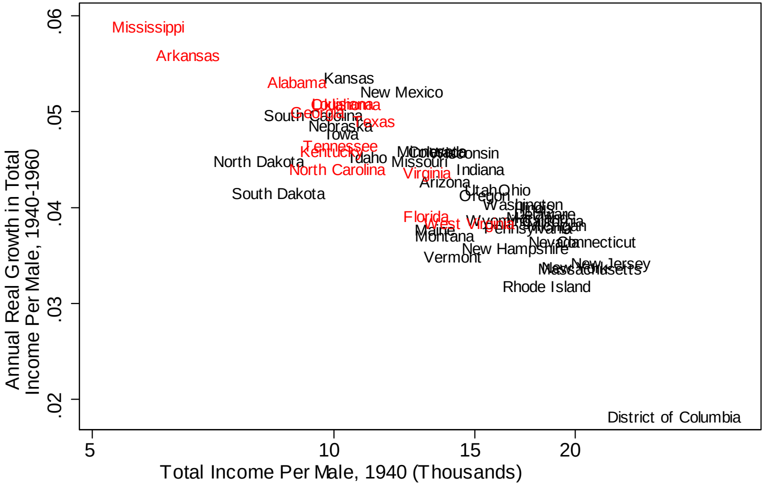
$$\frac{1}{T}\log\left(\frac{y_{it}}{y_{i,t-T}}\right) = x + \frac{1}{T}\log\left(\frac{y^*}{y_{i,t-T}}\right)\left(1 - e^{-\beta T}\right) + u_{it}$$

- β is a function of α, ρ (0.05), θ (1), n (0.02), x (0.02),,δ (0.05)
  - When $\alpha = 0.35$ then $\beta = 0.13$; convergence is pretty fast.
- Adding capital and labor mobility would only speed up the rate of convergence.
- Re-arranging the previous equation (for short time horizons, T):

$$\frac{1}{T}\log\left(\frac{y_{it}}{y_{i,t-T}}\right) \approx x - \beta\log\left(y_{i,t-T}\right) - \beta\log y^* + u_{it}$$

- (What would happen if x_i, y_i^* varied by state; correlated to $y_{i,t-T}$?)

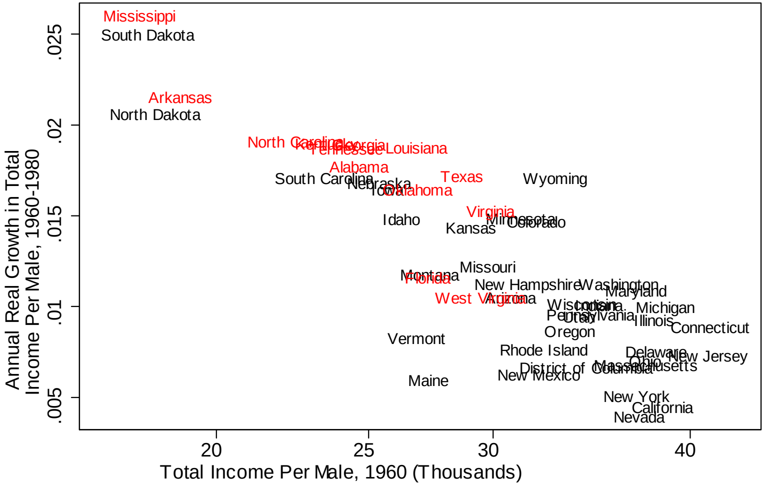
Regional convergence: 1940-1960



R-squared=77 percent

β =0.018

Regional convergence: 1960-1980



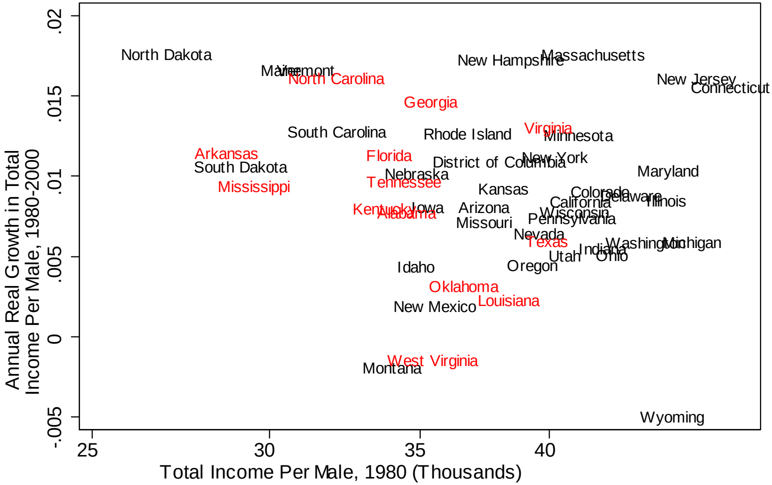
R-squared=77 percent

β =0.024

Regional convergence: 1800-1980

	Basic Equation		Controlling for Region + Sectoral Composition	
1880-1900	0.010	0.36	0.027	0.65
1900-1920	0.022	0.62	0.027	0.71
1920-1930	-0.015	0.14	0.022	0.64
1930-1940	0.014	0.35	0.011	0.46
1940-1950	0.043	0.72	0.024	0.89
1950-1960	0.019	0.42	0.031	0.66
1960-1970	0.025	0.51	0.017	0.72
1970-1980	0.020	0.21	0.004	0.46
P-value: H_0: β's the same	0.00		0.13	

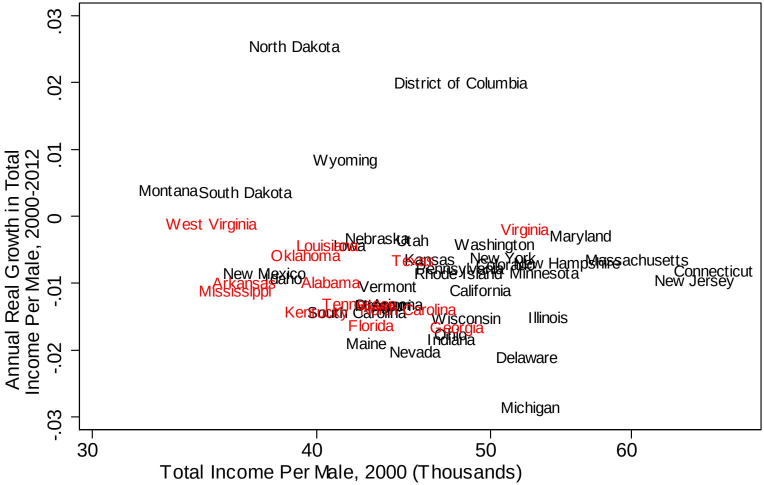
Regional convergence: 1980-2000



R-squared=3 percent

$\beta = 0.006$

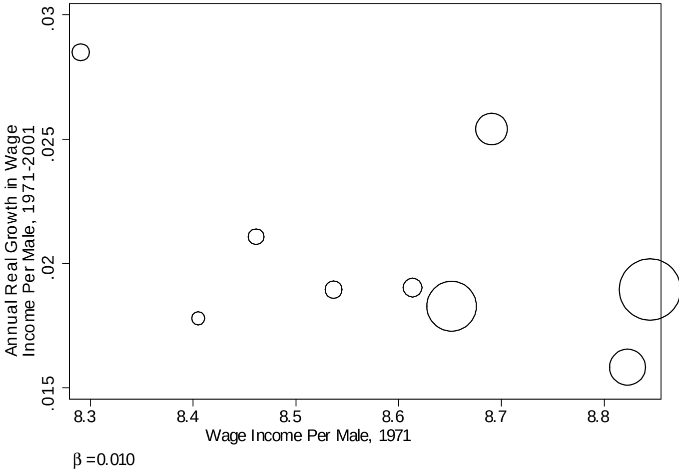
Regional convergence: 2000-2012



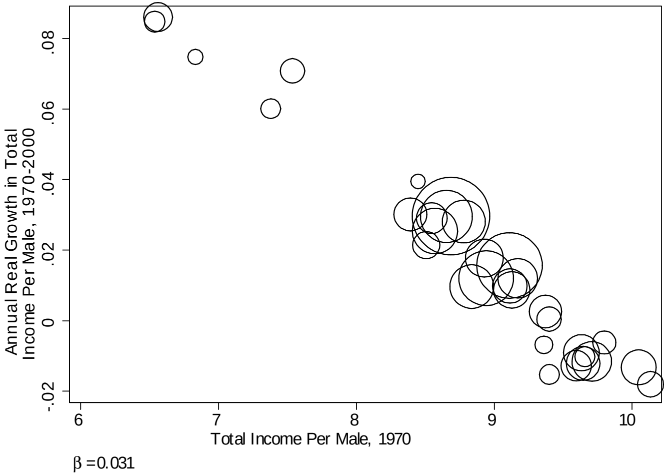
R-squared=1 percent

β =0.004

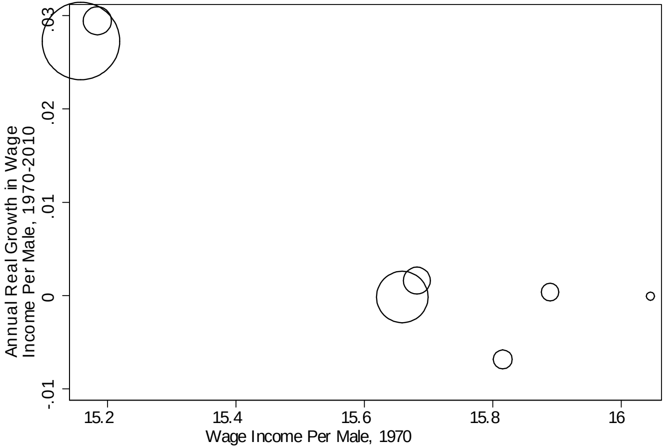
Regional convergence within Canada



Regional convergence within Mexico

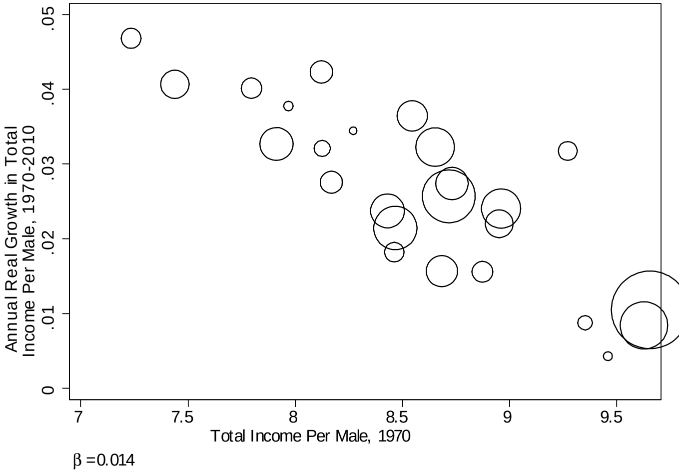


Regional convergence within Panama



$\beta = 0.050$

Regional convergence within Brazil



Conclusion

- Summary: Regional convergence in the U.S over 1880-1980, not so much after. Regional convergence also seems to be going on *within* other countries.
- Analogous literature looking at across-country convergence:

$$\frac{1}{T}\log\left(\frac{y_{it}}{y_{i0}}\right) \approx \log\left(y_{i,0}\right)\beta + Z_i\gamma + \epsilon_i$$

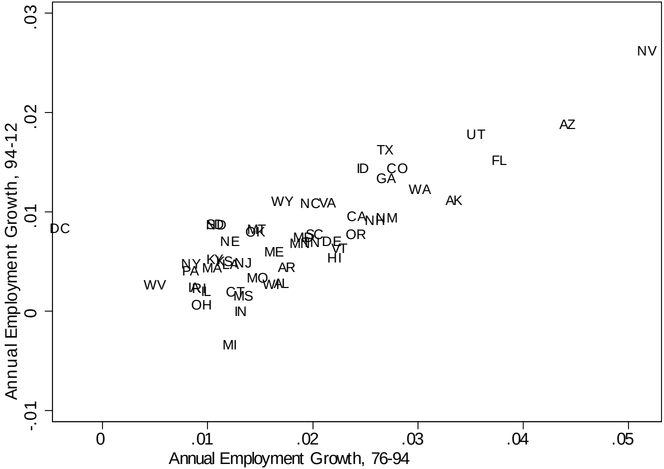
  - Lot of things have been put in γ (Sala-I-Martin 1997):
    - regional dummies
    - political rights indices, distance from the equator
    - fraction of population that is Muslim
    - fraction of population that is Confucian
    - fraction of GDP from mining
    - etc...
  - Good summary of the problems with this literature in Durlauf (2003)

Notes on Blanchard and Katz (1992): "Regional Evolutions"

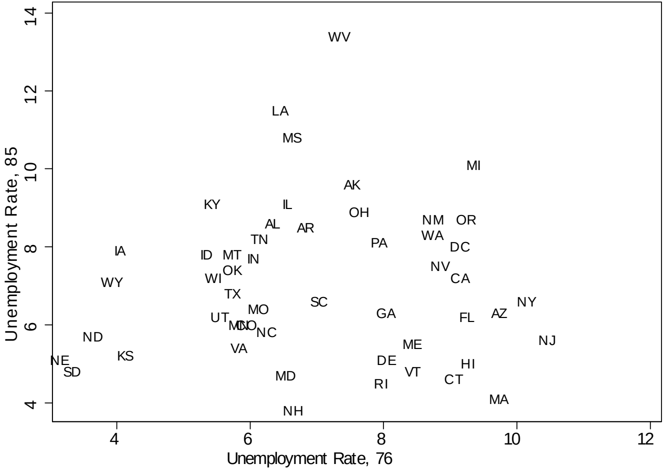
Question

- "When a typical U.S. state over the postwar period has been affected by an adverse shock to employment, how has it adjusted?" page 1
  - Does the wage decrease in the short run? In the long run?
  - Does the unemployment rate increase in the short run? In the long run?
  - Does the labor force decrease in the short run? In the long run?

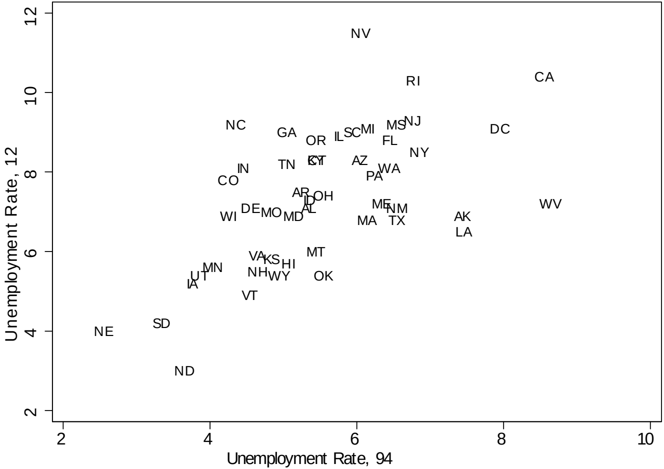
Persistence of Regional Variation in Employment Growth



Persistence of Regional Variation in Unemployment



Persistence of Regional Variation in Unemployment



A model with persistent employment growth, temporary unemployment/wages

- Key elements:
  - Perfectly elastic supply of labor in the long run.
  - Downward-sloping (but potentially very elastic) demand for labor in the long run.
- Predictions: A labor demand shock will
  - Decrease wages and raise unemployment in the short run.
  - The unemployment rate and wage will be at the pre-shock value.
  - Out-migration will reduce the labor force in the long run. A *permanent change to employment.*
- No micro-founded modeling of migration decisions. Kennan and Walker (2011) and Diamond (2013)

Labor Supply and Labor Demand

- Labor demand:
  - $w_{it} = -dn_{it} + z_{it}$
  - $z_{i,t+1} - z_{it} = -aw_{it} + x_{di} + \epsilon^d_{i,t+1}$
  - ϵ^d is a labor demand shock
  - x_{di} is the "amenity value" of state i : local taxes, regulatory environment, natural resources
- Labor supply: $n_{i,t+1} - n_{it} = bw_{it} + x_{si} + \epsilon^s_{i,t+1}$
  - ϵ^s is a labor supply shock
  - x_{si} is the "amenity value" of state i : non-wage factors that affect migration

Wages and employment

- Substitute out the z terms:

$$\begin{aligned} w_{it+1} + dn_{i,t+1} - w_{it} - dn_{it} &= -aw_{it} + x_{di} + \epsilon^d_{i,t+1} \\ n_{i,t+1} &= n_{it} + bw_{it} + x_{si} + \epsilon^s_{i,t+1} \end{aligned}$$

- Solve for wages:

$$w_{i,t+1} = (1 - db - a)\, w_{it} + x_{di} + \epsilon^d_{i,t+1} - d\left(x_{si} + \epsilon^s_{i,t+1}\right)$$

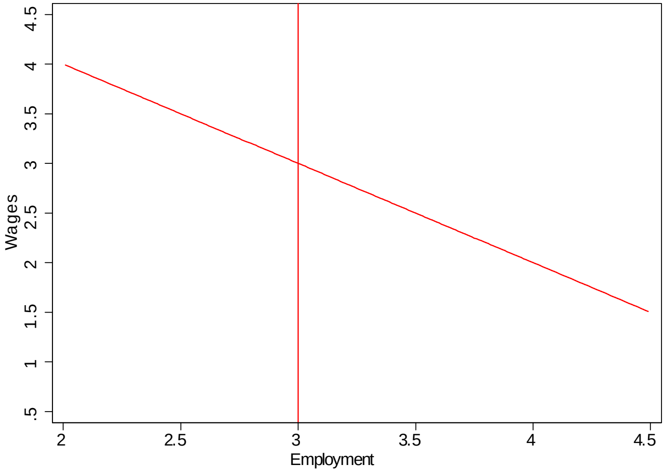
- And averages:

$$\bar{w}_i = \frac{x_{di} - dx_{si}}{a + db}$$

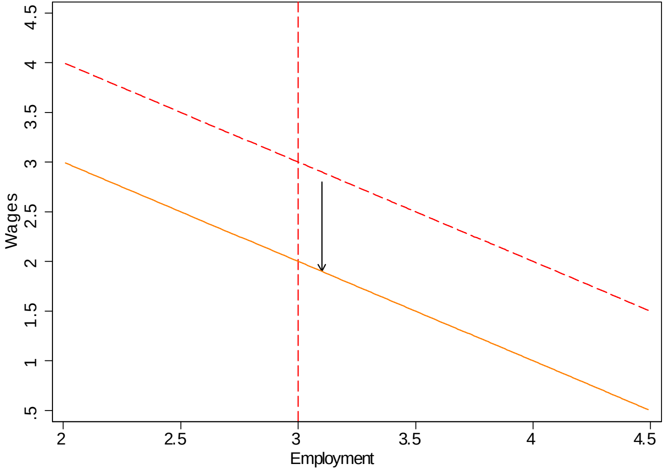
- Similar calculations for employment changes:

$$\begin{aligned} \Delta n_{i,t+1} &= (1 - db - a)\, \Delta n_{i,t+1} + bx_{di} + ax_{si} \\ &\quad + b\epsilon^d_{i,t+1} + \epsilon^s_{i,t+1} - (1 - a)\, \epsilon^s_{it} \\ \overline{\Delta n_i} &= \frac{bx_{di} + ax_{si}}{a + db} \end{aligned}$$

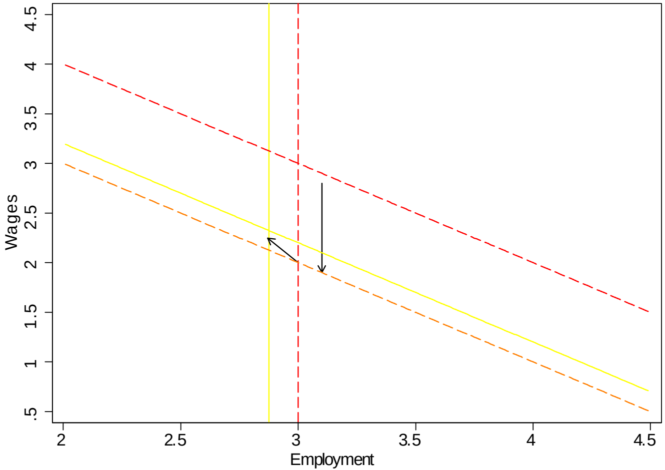
The effects of a labor demand shock



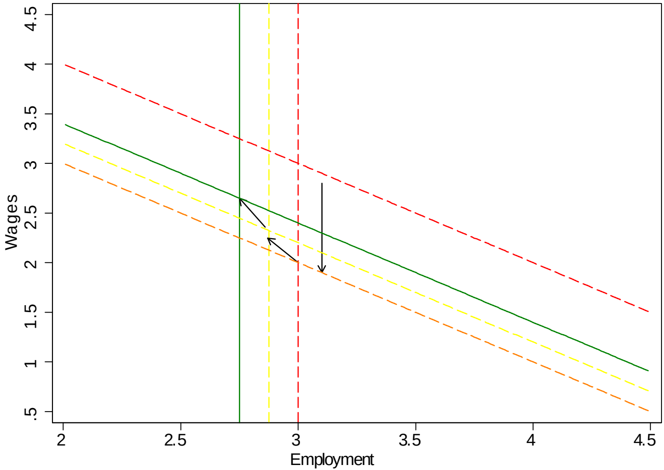
The effects of a labor demand shock



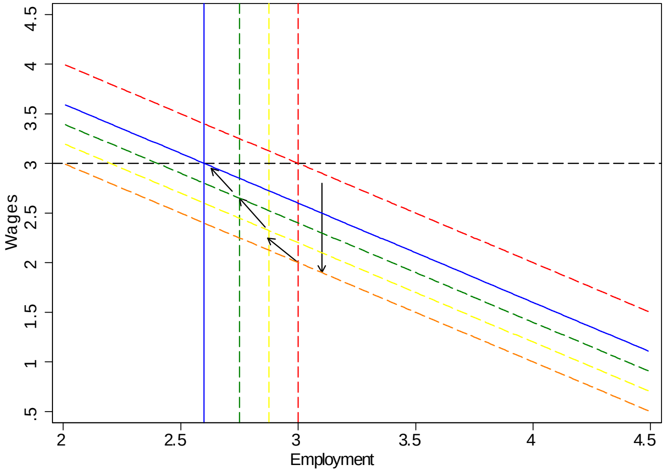
The effects of a labor demand shock



The effects of a labor demand shock



The effects of a labor demand shock



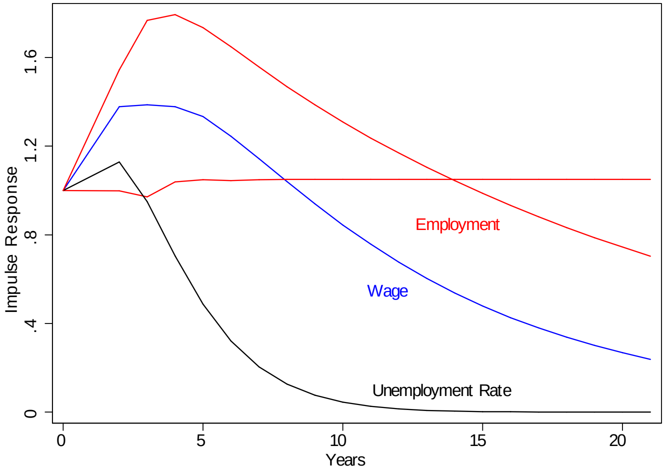
Lessons

- Eventually, after a labor demand shock, wages return to their starting value; employment shifts down.
- Can add an unemployment state, firm capital accumulation
  - Adding an unemployment state is important. From last week's lecture we know that the initial wage response is modest.

Data

- Bureau of Economic Analysis (1969 to present)
  - Wages and salaries; number of employed individuals (available also by industry)
- Bureau of Labor Statistics (1976 to present)
  - Unemployment rate, employment, size of labor force.
- All variables are stated relative to the national mean in that year

Univariate Regressions



Two VARs

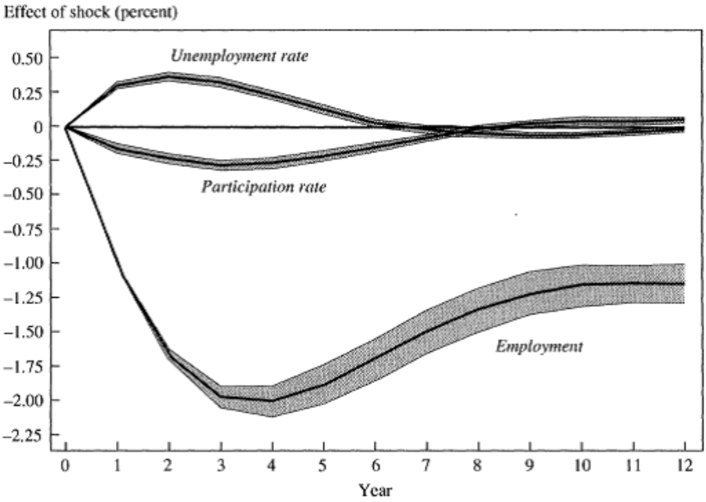
- ΔEmployment$\rightarrow$ unemployment rate $\rightarrow$ labor force participation

$$\begin{aligned}
\Delta e_{it} &= \alpha_{i10} + \alpha_{i11}(L)\,\Delta e_{i,t-1} + \alpha_{i12}(L) le_{i,t-1} \\
&\quad + \alpha_{i,13}(L)\, lp_{i,t-1} + \epsilon_{iet} \\
le_{it} &= \alpha_{i20} + \alpha_{i21}(L)\,\Delta e_{i,t-1} + \alpha_{i22}(L) le_{i,t-1} \\
&\quad + \alpha_{i,23}(L)\, lp_{i,t-1} + \epsilon_{iut} \\
lp_{it} &= \alpha_{i30} + \alpha_{i31}(L)\,\Delta e_{i,t-1} + \alpha_{i32}(L) le_{i,t-1} \\
&\quad + \alpha_{i,33}(L)\, lp_{i,t-1} + \epsilon_{ipt}
\end{aligned}$$

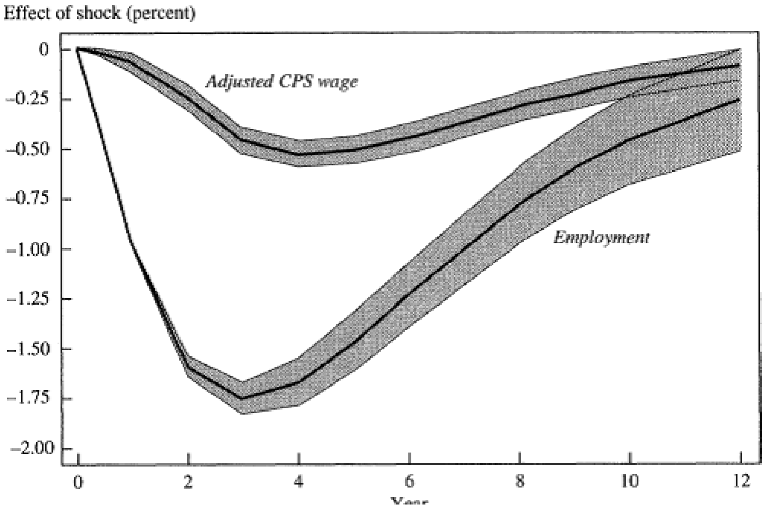
- ΔEmployment$\rightarrow$ wages

$$\begin{aligned}
\Delta e_{it} &= \beta_{i10} + \beta_{i11}(L)\,\Delta e_{i,t-1} + \beta_{i12}(L) w_{i,t-1} + \epsilon_{iet} \\
w_{it} &= \beta_{i20} + \beta_{i21}(L)\,\Delta e_{i,t-1} + \beta_{i22}(L) w_{i,t-1} + \epsilon_{iwt}
\end{aligned}$$

The effects of a labor demand shock



The effects of a labor demand shock



Notes on Diamond (2013): "The Determinants and Welfare Implications of US Workers' Diverging Location Choices by Skill: 1980-2000"

Introduction

Motivating facts:

- College wage premium has increased since the 1980s.
- Residential rental prices are higher (and increasing) in areas with larger (and increasing) fraction of college-educated workers.
  - Moretti (2013): Rise in inequality, as conventionally measured, may be overstated because college educated workers face a higher cost of living.
- Areas with a large fraction of college educated workers in the 1980s have become nicer places to live.
- Influx of college-educated workers is associated with an increase in city amenities.

Question:

- What is (and has been) the amenity value of different cities? To what extent do high rental prices reflect high amenities?

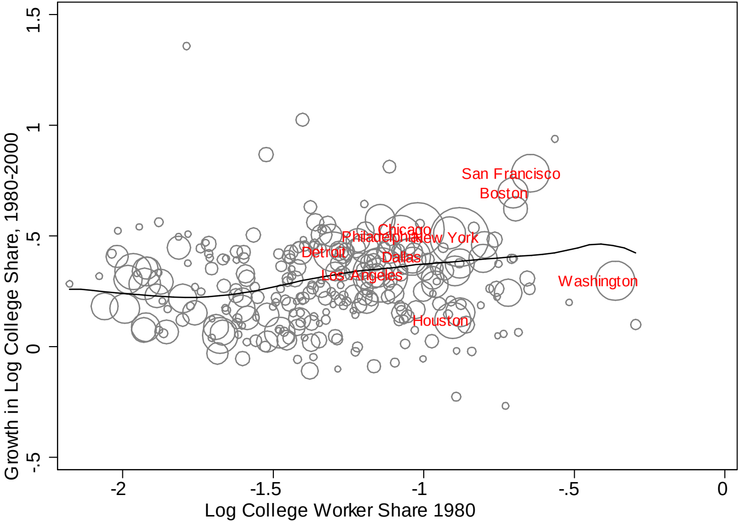
Outline

1. Motivating Facts
2. Model
3. Estimation Outline
4. Parameter Estimates and Welfare Calculations

Data

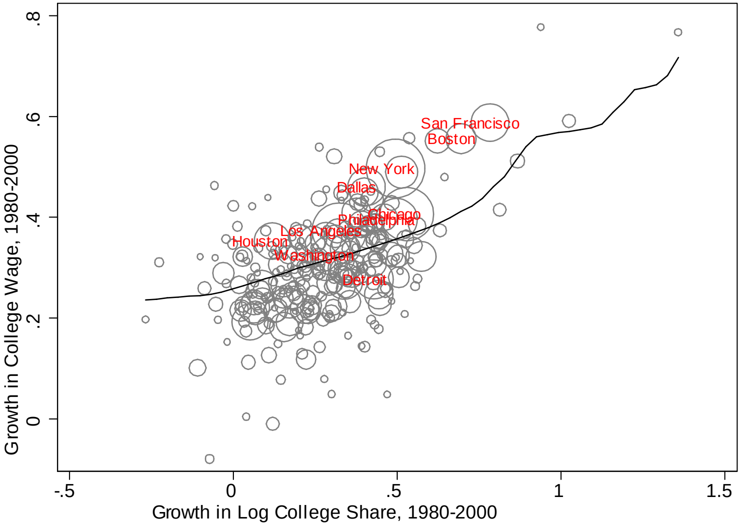
1. 5% Sample of Decennial Census (1980, 1990, 2000)
   - Restrict sample to age $\in [25, 55]$, full-time workers (≥ 48 weeks per year, ≥ 35 hours per week).
   - Key variables: wages, educational attainment, industry, rental prices, state of birth.
2. County Business Patterns: Used to compute certain amenities by MSA
3. Saiz (2010) housing supply instruments.
4. (In paper) FBI Crime Statistics, EPA air quality measures.

College population grew most in already-educated cities

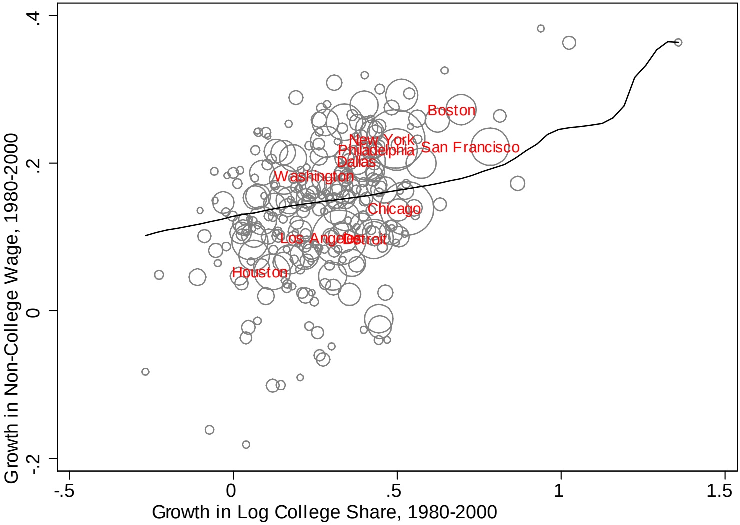


Growth in college population and rental prices are correlated

Growth in college population and college wages are correlated



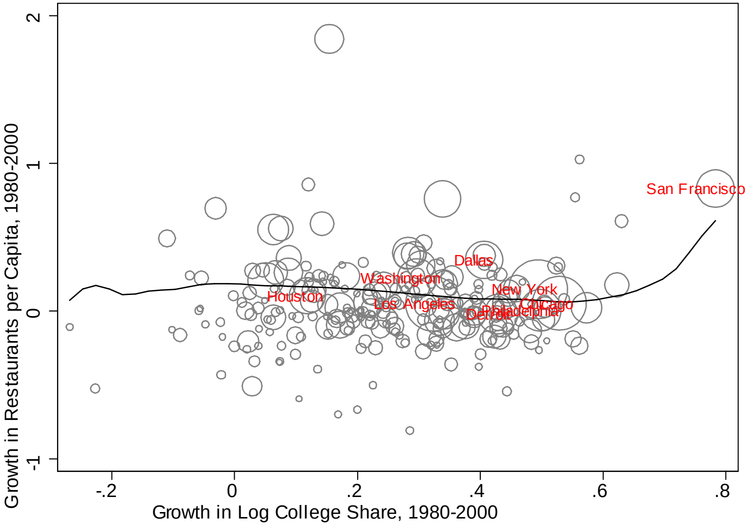
Growth in college population and non-college wages are correlated



Growth in college population and some amenities are correlated

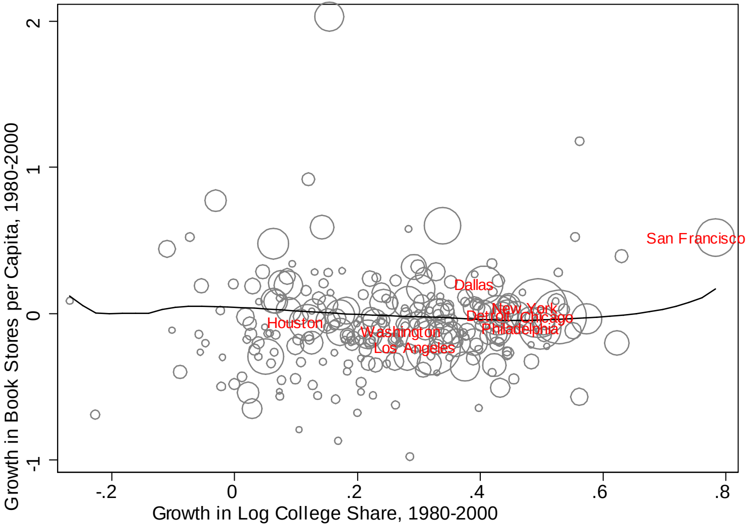
	Avg. (per 1000 cap)			Correlation With
	1980	1990	2000	Δlog(College Proportion)
Apparel Stores	0.36	0.21	0.16	0.24*
Groceries	2.34	2.05	1.70	0.04
Restaurants/Bars	5.63	4.99	6.09	-0.01
Book Stores	1.69	1.75	1.64	-0.01
Cleaners	0.80	0.75	0.72	0.13*
Movie Theaters	0.19	0.11	0.08	0.01
Museums	0.03	0.04	0.06	-0.35*

Growth in college population and some amenities are correlated



Growth in college population and some amenities are correlated

Growth in college population and some amenities are correlated



Growth in college population and changes in other amenities

	Δ log(Property crimes per 1000)	Δ log(Violent crimes per 1000)	Δ log(EPA index)
Δ college emp ratio	-0.274**	0.105	-0.251*
	(0.113)	(0.147)	(0.148)
R^2	0.027	0.002	0.014

Production and labor demand

- Production is function of capital (K), low-skill (L) and high-skill (H) labor:

$$Y_{djt} = K_{djt}^{\alpha} \underbrace{\left[\left(\frac{H_{jt}}{L_{jt}} \right)^{\gamma_L} e^{\varepsilon_{jt}^L} L_{djt}^{\rho} + \left(\frac{H_{jt}}{L_{jt}} \right)^{\gamma_H} e^{\varepsilon_{jt}^H} H_{djt}^{\rho} \right]}_{N_{djt}^{\rho}}^{\frac{1-\alpha}{\rho}}$$

  - γ_L and γ_H: strength of productivity spillovers.
- Take FOC to write out labor demand for each city j at time t.

$$\log W_{jt}^H = \log \alpha + (1-\alpha) \log \left(\frac{K_{jt}}{N_{jt}} \right) + (1-\rho) \log \frac{N_{jt}}{H_{jt}} + \gamma_H \log \frac{H_{jt}}{L_{jt}} + \varepsilon_{jt}^H$$

$$\log W_{jt}^L = \log \alpha + (1-\alpha) \log \left(\frac{K_{jt}}{N_{jt}} \right) + (1-\rho) \log \frac{N_{jt}}{L_{jt}} + \gamma_L \log \frac{H_{jt}}{L_{jt}} + \varepsilon_{jt}^H$$

Housing and amenity

- Housing supply

$$r_{jt} = \log CC_{jt} + \log \iota_t + \gamma_j \log \{H_{jt} + L_{jt}\}, \text{ where}$$

$$\gamma_j = \gamma + \gamma^{\text{Use Regulation}} \exp\left\{x_j^{\text{Regulation}}\right\} + \gamma^{\text{Land Unavail}} \exp\left\{x_j^{\text{Land}}\right\}$$

- Amenities:

$$A_{jt} = \left(x_{jt}^{A}, x_j^{\text{st}}, x_j^{\text{div}}, \frac{H_{jt}}{L_{jt}}\right)$$

$$x_{jt}^{A} \in \{\text{Air quality, Property Crimes, Violent Crimes, Retail}\}$$

Worker preferences

- Two steps:
  - Solve for where to live (depending on prices, wages, and amenities)
  - Solve for consumption of national and local (housing) good.
- A worker living in city j solves the following maximization problem over local and national goods:

$$\max_{M,O} \zeta_i \log M + (1 - \zeta_i) \log O + s_i (A_j), \text{ s.t.}$$
$$W^i_{jt} \geq OP_t + MR_{jt}, \text{ where } \zeta_i = \beta^r z_i$$

  and z_i is a vector of worker demographics (education, education$\times$ black, education$\times$ immigrant)
- FOC:

$$M = \beta^r z_i \frac{W^i_{jt}}{R_{jt}}, \qquad O = (1 - \beta^r z_i) \frac{W^i_{jt}}{P_t},$$

  and $s_i (A_j)$ is the same for all residents of MSA j.

Worker preferences

- The solution to the problem from the previous slide gives the indirect utility for city j as a function of relative wages $\frac{W^i_{jt}}{P_t}$ and rental prices $\frac{R_t}{P_t}$:

$$V_{ijt} = \log \frac{W^i_{jt}}{P_t} - \beta^r z_i \log \frac{R_{jt}}{P_t} + s_i\left(A_j\right)$$

- For future reference: $w^i_{jt} \equiv \log \frac{W^i_{jt}}{P_t}$ and $r_{jt} \equiv \log \frac{R_{jt}}{P_t}$.
- Assume:

$$s_i\left(A_{jt}\right) = \beta^A z_i x^A_{jt} + \beta^{\text{col}} z_i \log \frac{H_{jt}}{L_{jt}} + \beta^{\text{st}} z_i x^{\text{st}}_{ij} + \beta^{\text{div}} z_i x^{\text{div}}_{ij} + \varepsilon_{ijt}$$

where ε_{ijt} is a T1EV distributed random variable.

Worker preferences

Normalize utility function so that ε has unit SD for all workers.
Group terms that are constant within a demographic group:

$$\delta_{jt}^{z} = \beta^{w} z_i w_{jt}^{i} - \beta^{r} z_i r_{jt} + \beta^{A} z_i x_{jt}^{A} + \beta^{\text{col}} z_i \log \frac{H_{jt}}{L_{jt}},$$

Then

$$V_{ijt} = \delta_{jt}^{z} + \beta^{\text{st}} z_i x_{ij}^{\text{st}} + \beta^{\text{div}} z_i x_{ij}^{\text{div}} + \varepsilon_{ijt}$$

Given the T1EV assumption, the labor supply in skill j for educated workers is

$$\sum_{i \in \mathcal{H}_t} \Pr\left\{ V_{ijt} > \max_{j' \neq j} V_{ij't} \right\} = \sum_{i \in \mathcal{H}_t} \frac{\exp\left\{ V_{ijt} \right\}}{\sum_{j'} \exp\left\{ V_{ij't} \right\}}$$

where $\mathcal{H}_t$ is the set of high-skilled workers.
A similar expression holds for the supply of low-skilled workers.

Estimation overview

Parameters to estimate:

1. Production function estimates: ρ, γ^{H}, γ^{L} and ε_{jt}^{L} and ε_{jt}^{H}
2. Housing supply parameters: γ, $\gamma^{\text{Use Regulation}}$, $\gamma^{\text{Land Unavail}}$
3. Taste for wages, rents, amenities: β^{w}, β^{r}, β^{col}, β^{st}, β^{div}

Parameters are estimated via GMM:

- (1) are estimated to minimize $\mathbb{E}\left[\Delta\tilde{\varepsilon}_{jt}^{H} Z_{jt}\right]$ and $\mathbb{E}\left[\Delta\tilde{\varepsilon}_{jt}^{L} Z_{jt}\right]$
- (2) are estimated to minimize $\mathbb{E}\left[\Delta \log\left(CC_{jt}\right) Z_{jt}\right]$
- (3) are estimated to minimize $\mathbb{E}\left[\Delta\xi_{jt}^{z} Z_{jt}\right]$

Z_{jt} are combinations of Bartik and Saiz instruments.

Estimation of the labor demand moments

- The labor demand equations (similar for low-skilled):

$$\Delta w_{jt}^{H} = (1-\alpha)\,\Delta \ln \frac{K_{jt}}{N_{jt}} + (1-\rho)\,\Delta \ln \frac{N_{jt}}{H_{jt}} + \gamma_H \Delta \ln \frac{H_{jt}}{L_{jt}} + \Delta\varepsilon_{jt}^{H}$$

- Issues:
  - N_{jt} depends on ρ, γ_L, γ_H Relatively easy to solve, because of the CES functional form.
  - $\Delta\varepsilon_{jt}^{H}$ is correlated with $\Delta \log \frac{H_{jt}}{L_{jt}}$, $\Delta \log \frac{K_{jt}}{N_{jt}}$, and $\Delta \log \frac{N_{jt}}{H_{jt}}$ + other stuff.

Estimation of the labor demand moments

$$\Delta w_{jt}^H = (1-\alpha)\,\Delta\ln\frac{K_{jt}}{N_{jt}} + (1-\rho)\,\Delta\ln\frac{N_{jt}}{H_{jt}} + \gamma_H\Delta\ln\frac{H_{jt}}{L_{jt}} + \Delta\varepsilon_{jt}^H$$

- Step 1: Get productivity shocks (Guess values of ρ, γ_L, γ_H) and corresponding instruments.
  - Define skill-specific Bartik shocks:

    $$\Delta B_{jt}^H = \sum_{\text{ind}} \left(w_{ind,-j,t}^H - w_{ind,-j,t-10}^H\right) \frac{H_{ind,j,t-10}}{H_{j,t-10}},$$

    similar instrument for low-skilled workers
  - Regress $\Delta\varepsilon_{jt}^H$ on ΔB_{jt}^H and ΔB_{jt}^L. Residuals $\Delta\tilde{\varepsilon}_{jt}^H$ will be uncorrelated with j-specific labor demand.
  - Labor demand equation now looks like

    $$\Delta w_{jt}^H = (1-\alpha)\,\Delta\ln\frac{K_{jt}}{N_{jt}} + (1-\rho)\,\Delta\ln\frac{N_{jt}}{H_{jt}} + \gamma_H\Delta\ln\frac{H_{jt}}{L_{jt}}$$
    $$\beta_H^i\Delta B_{jt}^H + \beta_L^i\Delta B_{jt}^L + \Delta\tilde{\varepsilon}_{jt}^H$$

Estimation of the labor demand moments

- $\Delta\tilde{\varepsilon}^{H}_{jt}$ (and $\Delta\tilde{\varepsilon}^{L}_{jt}$) are uncorrelated with supply-side variables (which will define Z_{jt})
  - By construction, they are uncorrelated with ΔB^{H}_{jt} and ΔB^{L}_{jt}.
  - Also will be uncorrelated with $\Delta B^{H}_{jt} x_j^{\text{Regulation}}$, $\Delta B^{H}_{jt} x_j^{\text{Land Unavail.}}$, $\Delta B^{L}_{jt} x_j^{\text{Regulation}}$, $\Delta B^{L}_{jt} x_j^{\text{Land Unavail.}}$
  - What do the housing supply elasticities identify?

- Step 2: Search over ρ, γ_L, γ_H to minimize $\mathbb{E}\left[\Delta\tilde{\varepsilon}^{H}_{jt} Z_{jt}\right]$; similar set of moments for low-skilled workers.

Estimation of the housing supply moments

- From before, the residual change in construction costs is a function of observables, plus the parameters to estimate (γ_j)

$$\Delta r_{jt} - \Delta \log \iota_t + \gamma_j \Delta \log \{H_{jt} + L_{jt}\} = \Delta \log CC_{jt}$$

where, again

$$\gamma_j = \gamma + \gamma^{\text{Use Regulation}} \exp\left\{x_j^{\text{Regulation}}\right\} + \gamma^{\text{Land Unavail}} \exp\left\{x_j^{\text{Land}}\right\}$$

- Need an instrument for change in housing supply (equivalent to population, $H_{jt} + L_{jt}$) unrelated to construction costs.
- Use $Z_t \equiv$Bartik instruments and interactions with Saiz variables. Minimize $\mathbb{E}[\Delta \log (CC_{jt}) Z_{jt}]$

Estimation of the labor supply moments

Recall, labor supply equations:

$$\sum_{i \in \mathcal{H}_t} \frac{\exp\left\{\delta^z_{jt} + \beta^{st} z_i x^{st}_{ij} + \beta^{div} z_i x^{div}_{ij}\right\}}{\sum_{j'} \exp\left\{\delta^z_{j't} + \beta^{st} z_i x^{st}_{i'j} + \beta^{div} z_i x^{div}_{ij'}\right\}}, \text{ where}$$

$$V_{ijt} = \delta^z_{jt} + \beta^{st} z_i x^{st}_{ij} + \beta^{div} z_i x^{div}_{ij} + \varepsilon_{ijt}$$

- Step 1: Estimate δ^z_{jt} for each city at each point in time by comparing populations of different worker types in different cities.
- Step 2: Estimate the components of

$$\Delta\delta^z_{jt} \equiv \beta^w z_i \Delta w^i_{jt} - \beta^r z_i \Delta r_{jt} + \beta^{col} z_i \Delta \log \frac{H_{jt}}{L_{jt}} + \underbrace{\beta^A z_i \Delta x^A_{jt}}_{\equiv \Delta\xi^z_{jt}}$$

Use $Z_t \equiv$Bartik instruments and interactions with Saiz variables. Minimize $\mathbb{E}\left[\xi^z_{jt} Z_{jt}\right]$

Parameter estimates

- No-spillover model: $\gamma_L = \gamma_H = \beta^{\text{col}} = 0$
- Labor supply

	College		Non-college	
Non-black, natives	Full	No-Spillovers	Full	No-Spillovers
Wage (β^{w})	1.77	2.23	3.76	4.17
Rent (β^{r})	-1.11	-0.10	-2.56	-2.16
Impl. Local Exp. Share$=\frac{-\beta^{\text{r}}}{\beta^{\text{w}}-\beta^{\text{r}}}$	0.63	0.05	0.68	0.52
College Emp. Amenity (β^{col})	2.07	-	0.83	-

- Housing supply: $\gamma = 0.032$; $\gamma^{\text{Use Regulation}} = 0.076$; $\gamma^{\text{Land Unavail.}} = 0.025$
- Labor demand: $\rho = 0.474$; $\gamma^{H} = 0.448$; $\gamma^{L} = -0.013$

High- and low-amenity MSAs

$$U_A^z = \delta_{jt}^z - \left(\beta^w zw_{jt}^{\text{edu}} + \beta^r zr_{jt}\right)$$

College		Non-college	
High Amenity	Low Amenity	High Amenity	Low Amenity
Los Angeles	Flint, MI	Los Angeles	Flint, MI
Washington DC	Youngstown, OH	Phoenix	Youngstown, OH
San Francisco	Allentown, PA	Denver	Toledo, OH
Boston	Syracuse, NY	Seattle	Syracuse, NY
Denver	Harrisburg, PA	Boston	Buffalo, NY

Welfare calculations

- Change in welfare due to wages=

$$\frac{\log\left[\frac{\sum_j \exp\left\{\beta^w z_i w^{edu}_{j,'00}+\ldots.\right\}}{\sum_j \exp\left\{\beta^w z_i w^{edu}_{j,'80}+\ldots.\right\}}\right]}{\beta^w z_i}$$

- Change in welfare due to wages + rent=

$$\frac{\log\left[\frac{\sum_j \exp\left\{\beta^w z_i w^{edu}_{j,'00}+\beta^r z_i r^{edu}_{j,'00}\ldots.\right\}}{\sum_j \exp\left\{\beta^w z_i w^{edu}_{j,'80}+\beta^r z_i r^{edu}_{j,'80}\ldots.\right\}}\right]}{\beta^w z_i}$$

- Change in welfare due to wages + rent+endogenous amenities=

$$\frac{\log\left[\frac{\sum_j \exp\left\{\beta^w z_i w^{edu}_{j,'00}+\beta^r z_i r^{edu}_{j,'00}+\ldots\beta^{col} z_i \log\frac{H_{j00}}{L_{j00}}.+\ldots\right\}}{\sum_j \exp\left\{\beta^w z_i w^{edu}_{j,'80}+\beta^r z_i r^{edu}_{j,'80}+\beta^{col} z_i \log\frac{H_{j80}}{L_{j80}}+\ldots.\right\}}\right]}{\beta^w z_i}$$

Welfare calculations

Wellbeing gap betw. college and non-college from:	Wages	Wage+ Rent	Wage+ Rent+ Re-sorting	Wage+Rent +Amenities +Re-sorting
1980	0.383	0.383	0.383	0.383
1990	0.539	0.521	0.576	0.722
2000	0.599	0.572	0.638	0.901
Change: '80-'00	0.216	0.189	0.255	0.518