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

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 do a pretty good job.
- Can households insure against consumption risk?

Contribution

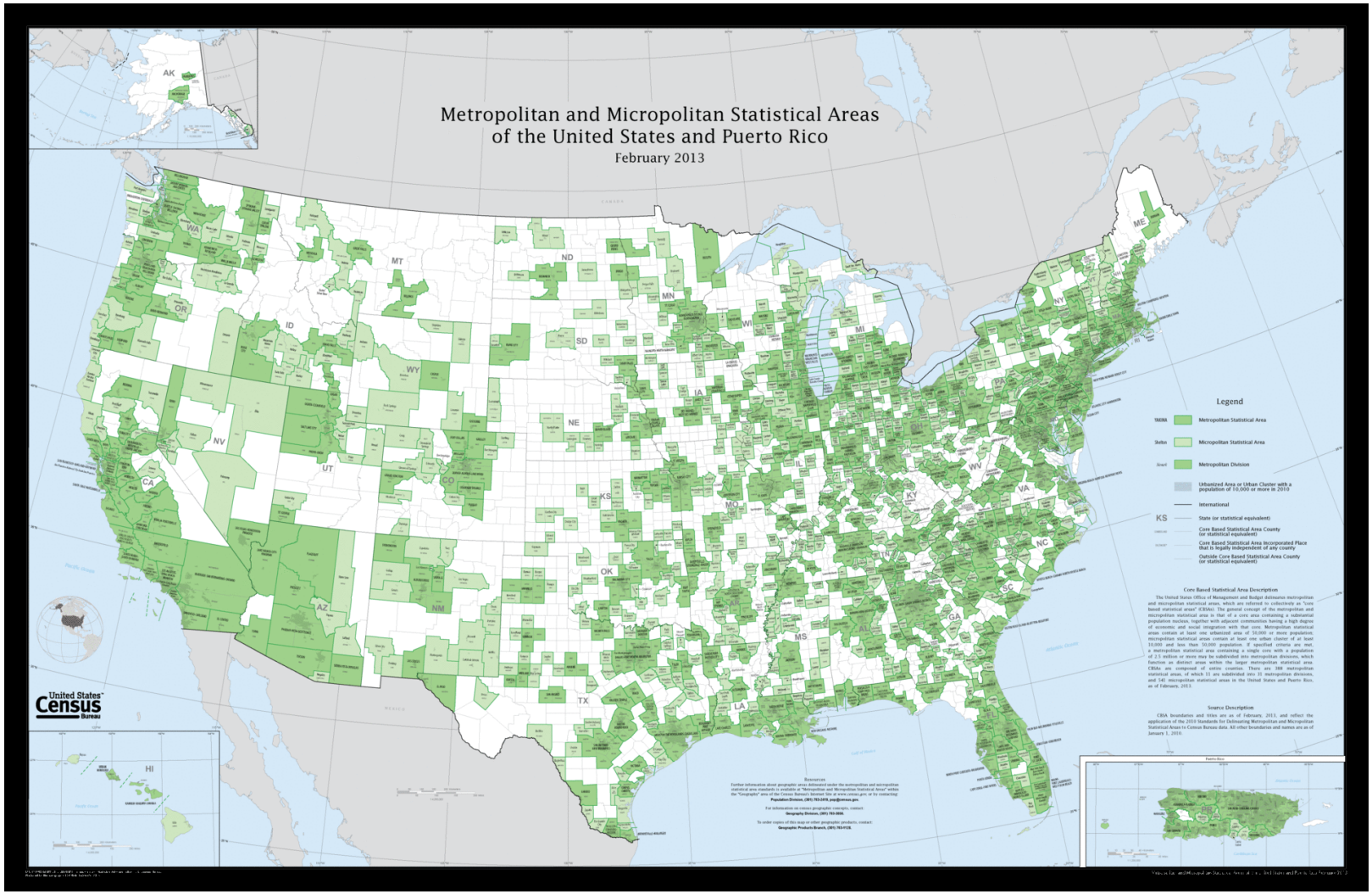
- What were the sources of the Great Recession?
  - Uncertainty about government policy: Bloom (2009), Baker, Bloom, and Davis (2013).
  - Generous unemployment insurance: Mulligan (2012).
  - Firms were credit constrained.
- Policy recommendations are different, depending on the cause.
  - Resolve policy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

Outline

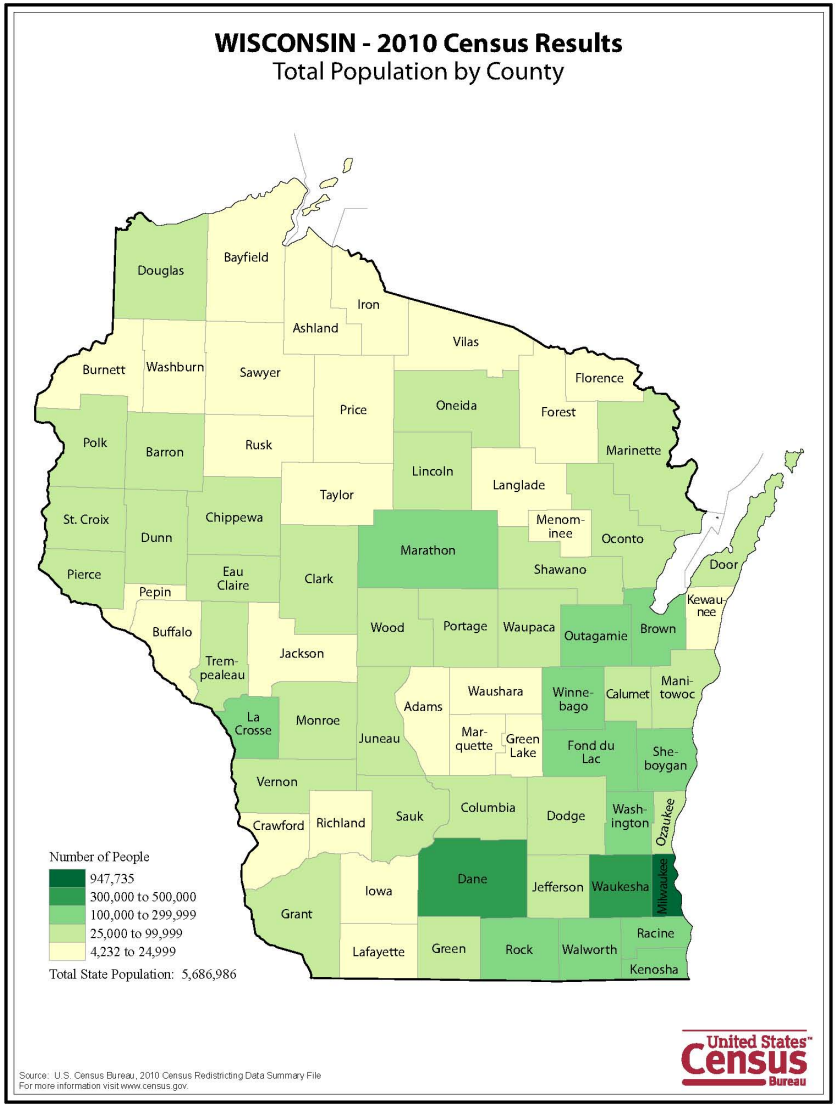
- Data
- Saiz (2010): Housing supply elasticities
- Housing net worth shocks and financial net worth shocks
- The effect of net worth shocks on consumption expenditures

Data

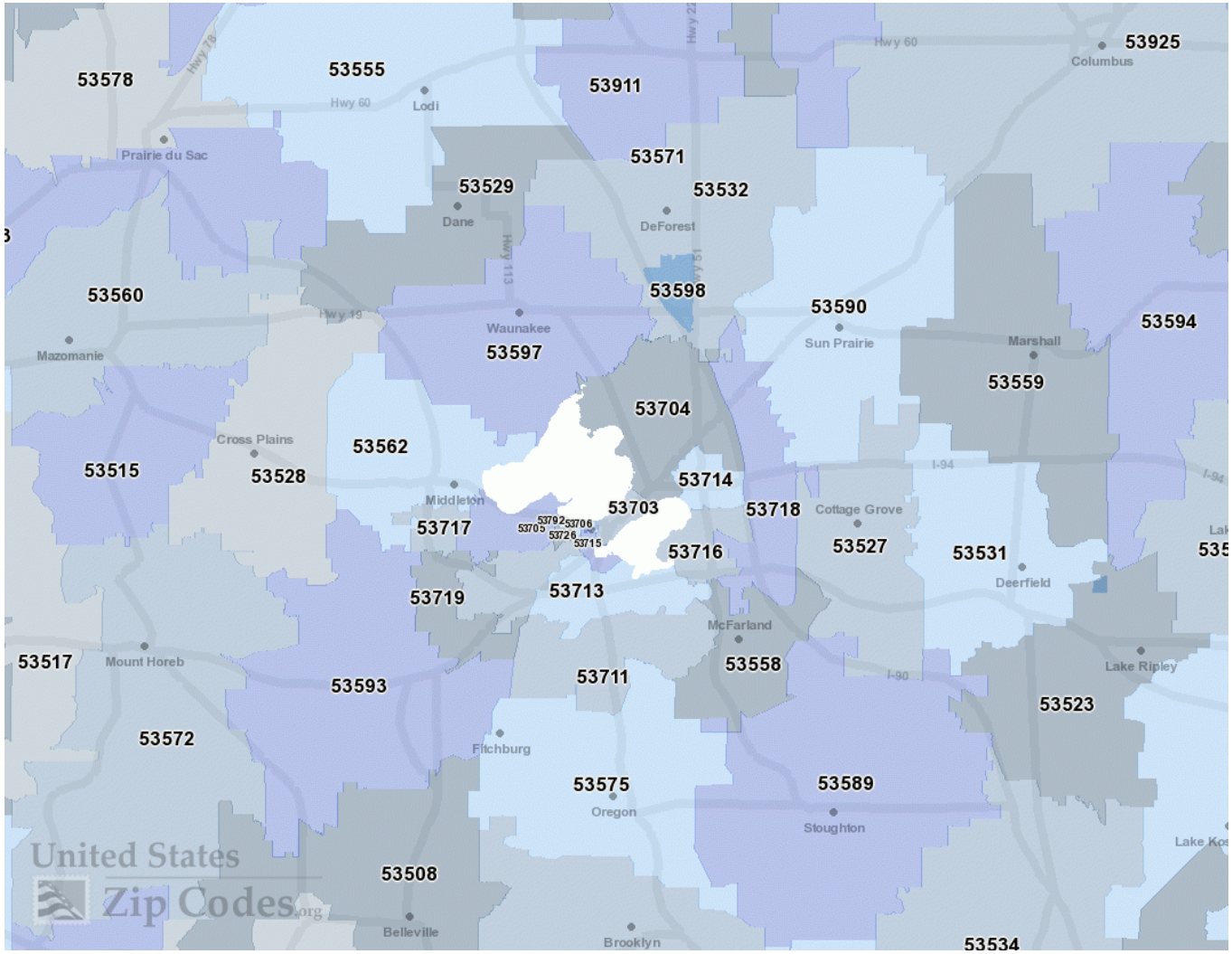
There are 388 Metropolitan Statistical Areas (MSAs), 929 Core Based Statistical Areas (CBSAs)



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 Patterns: 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 $k = \pi \underbrace{\Lambda_k}_{\text{share of avail. land}} \times (\text{Radius}_k)^2$
  - Suppose rental prices, within the region, are linearly decreasing (at rate t) from distance to the city center.
    - Why? Renters trade off rental price vs. commuting costs to the central business district.
    - Mills (1967), Muth(1969)

Saiz (2010)

Housing supply is more inelastic in low Λ_k regions.. Why?

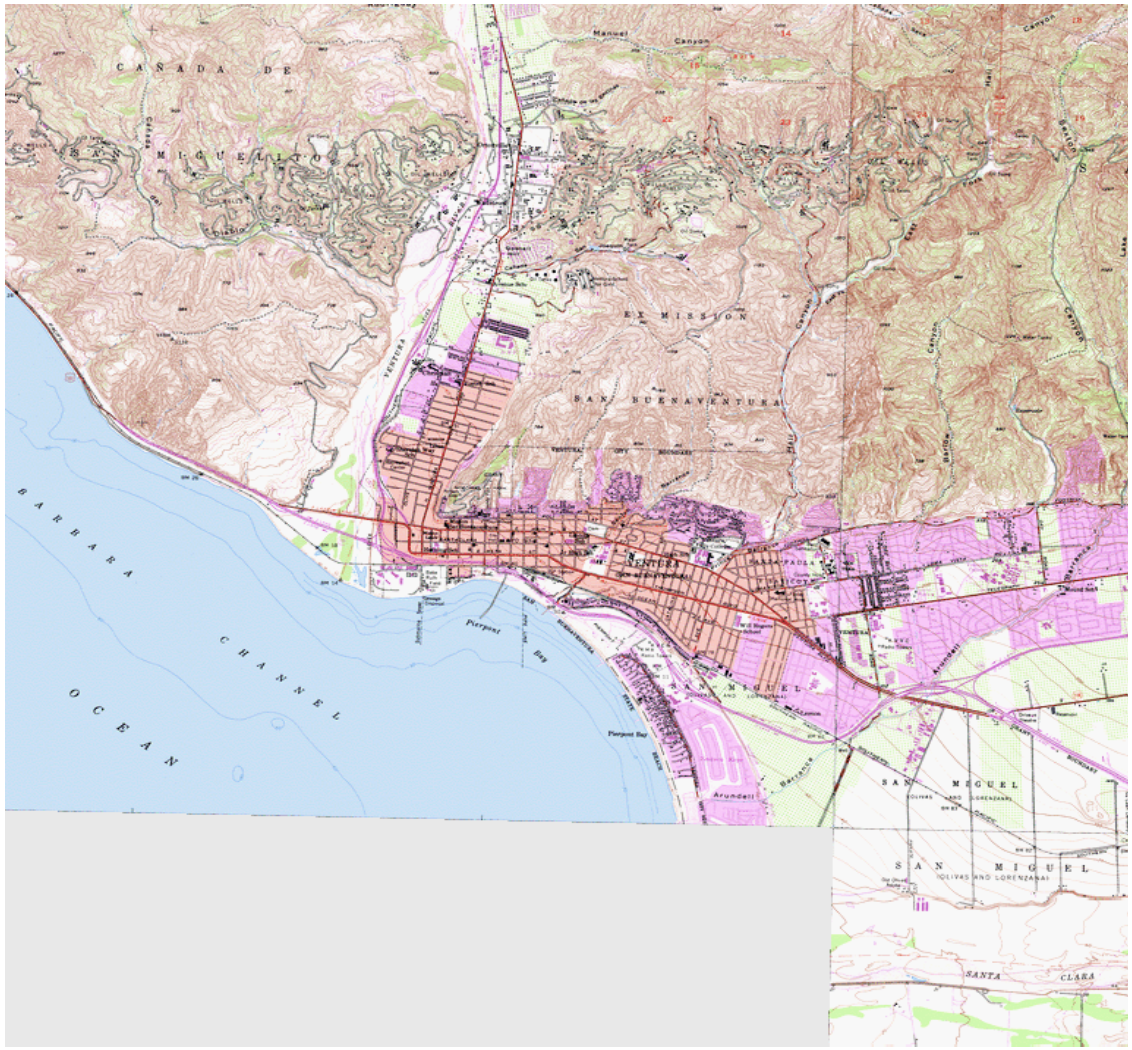
- $H_k \equiv$Stock of housing in city $k = \pi \Lambda_k \left(\text{Radius}_k\right)^2$
- Average real estate price in the city is the sum of construction costs plus land prices at $\frac{2}{3}$ of the way out of the city.
- $P_k^s =$construction costs $+\kappa t \sqrt{\frac{H_k}{\pi \Lambda_k}}$

$$\frac{\partial P_k^s}{\partial H_k} = \frac{1}{2} \kappa t \sqrt{\frac{1}{\pi H_k \Lambda_k}}$$

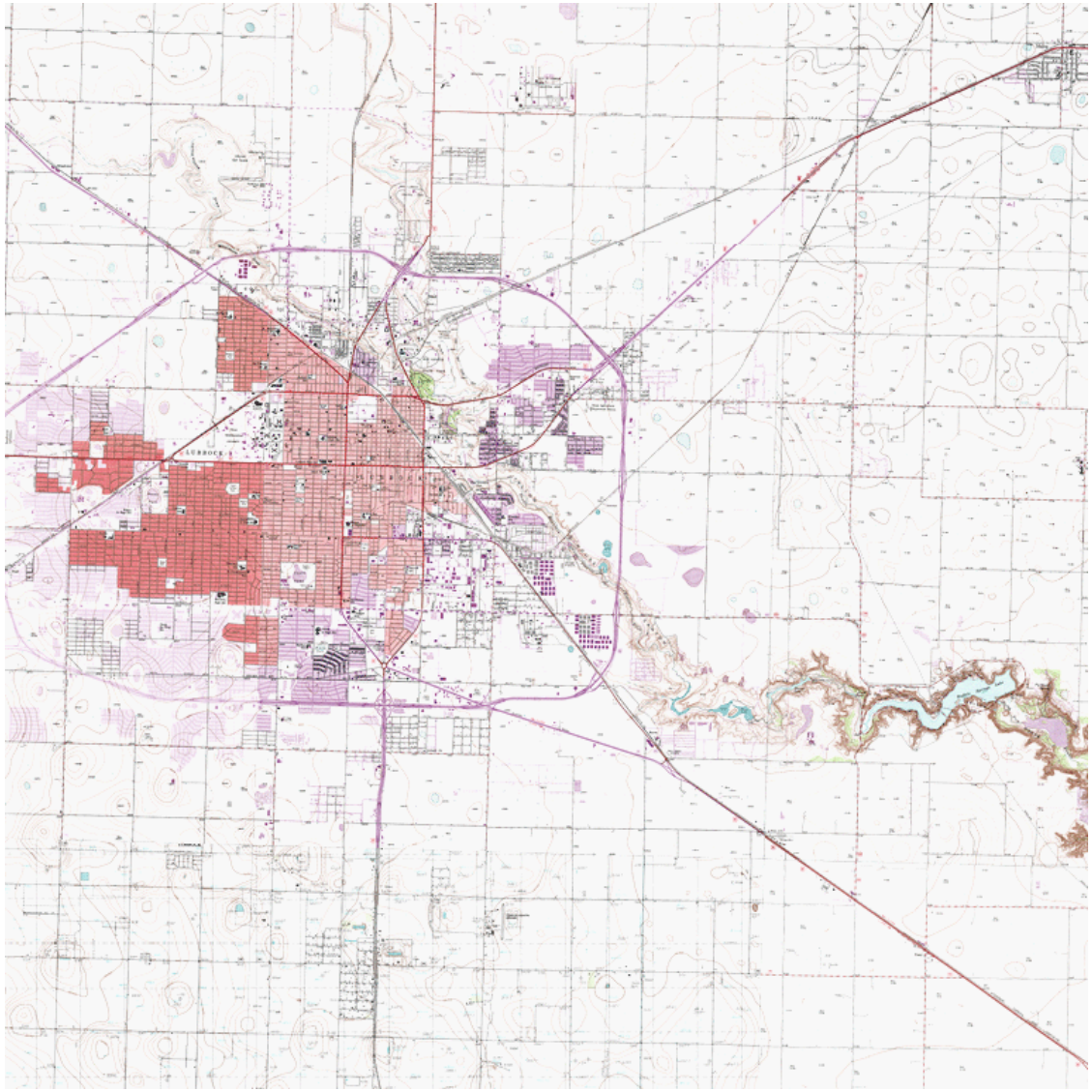
$$\beta^s \equiv \frac{\partial P_k^s}{\partial H_k} \frac{H_k}{P_k^s} = \frac{\frac{1}{2} \kappa t \sqrt{\frac{H_k}{\pi \Lambda_k}}}{CC + \kappa t \sqrt{\frac{H_k}{\pi \Lambda_k}}}$$

- Take the necessary derivatives: $\partial \beta^s / \partial \Lambda_k < 0$

Ventura, CA


CAÑADA DE
SAN MIGUELITO
EX MISSION
SAN BUENAVENTURA
VENTURA
SAN MIGUEL
SAN MIGUEL
SANTA CLARA
BARBARA
CHANNEL
OCEAN

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

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

- $\tilde{P}_k$: 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

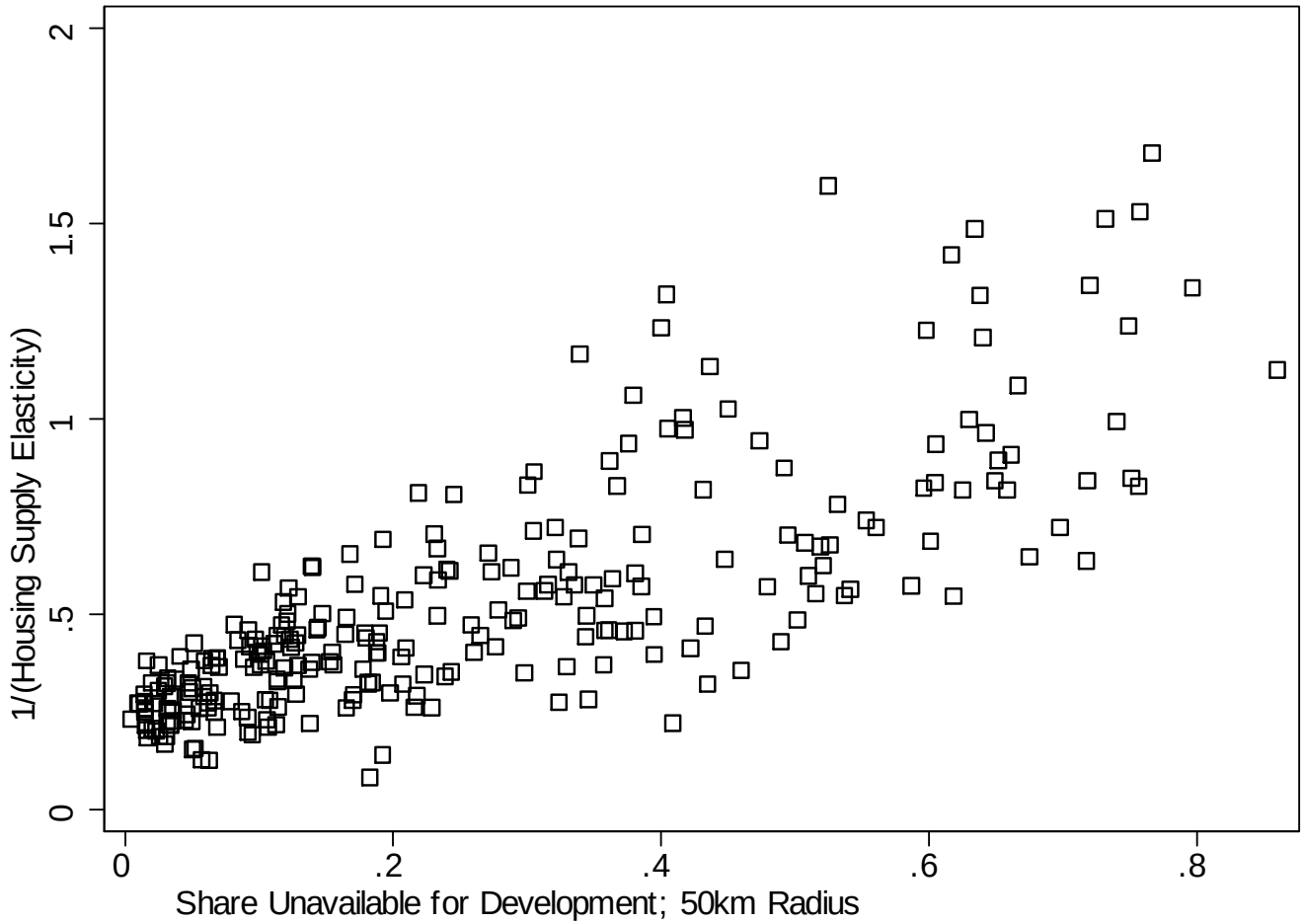
$$\begin{aligned}\Delta \log \tilde{P}_k = \sigma_k \Delta \log CC_k + \beta^s \Delta \log H_k \\ + \beta^{\text{Land}} (\text{Share of unavailable land}) \cdot \Delta \log H_k \\ + \beta^{\text{Regulation}} \log (\text{Regulation index}) \cdot \Delta \log H_k \\ + R^{\text{North}} + R^{\text{South}}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

- $\beta^{\text{Land}} \approx 0.5$
- $\beta^{\text{Regulation}} \approx 0.25$
- 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

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

$$\Delta NW_{'06-'09}^i = \Delta logp_{06-09}^S \cdot \frac{S_{06}^i}{NW_{06}^i} + \Delta logp_{06-09}^B \cdot \frac{B_{06}^i}{NW_{06}^i} + \Delta logp_{06-09}^{H,i} \cdot \frac{H_{06}^i}{NW_{06}^i}$$

- H_{06}^i: 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

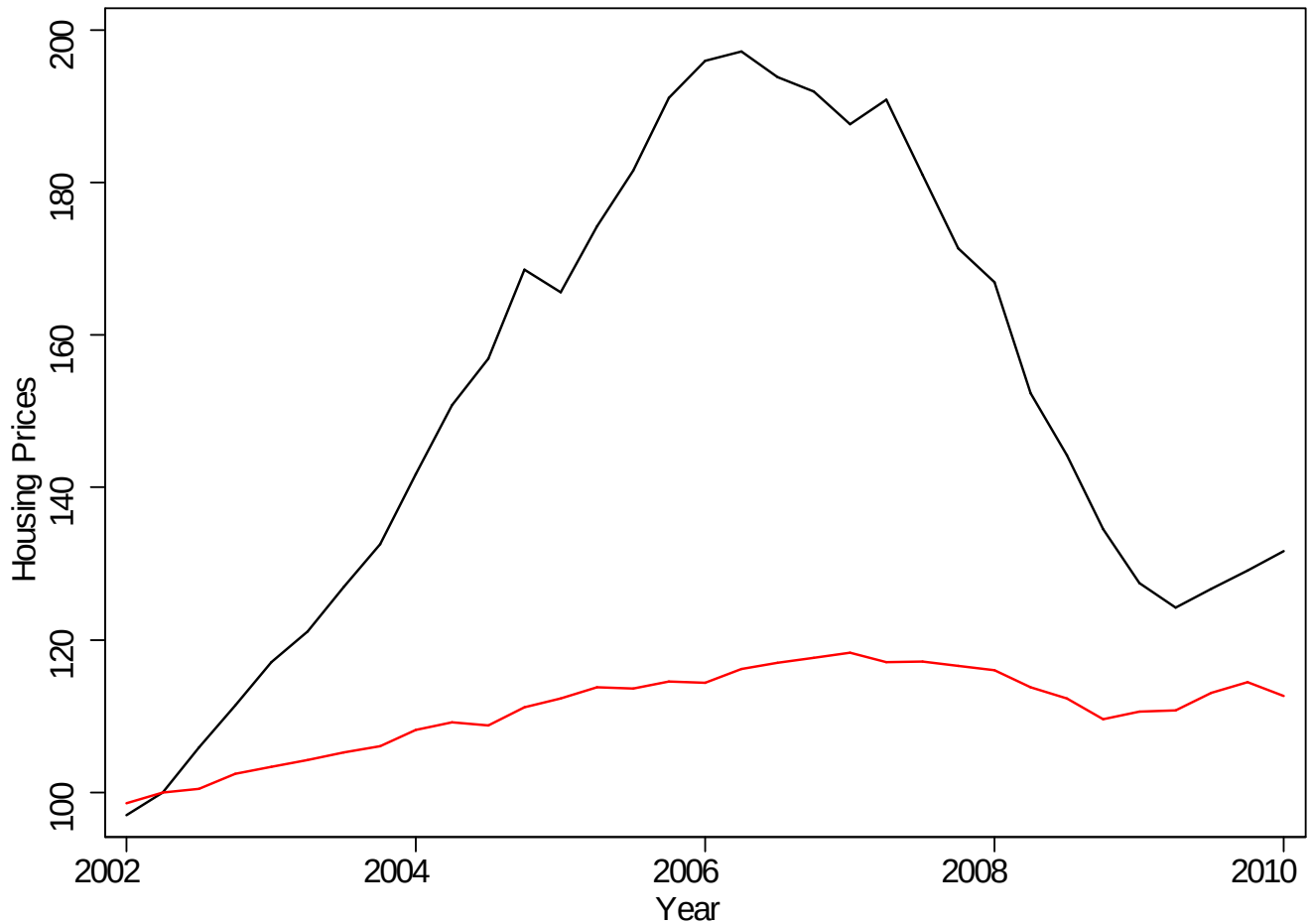
$$NW_t^i = S_t^i + B_t^i + H_t^i - D_t^i$$

$$\Delta NW_{'06-'09}^i = \Delta logp_{06-09}^S \cdot \frac{S_{06}^i}{NW_{06}^i} + \Delta logp_{06-09}^B \cdot \frac{B_{06}^i}{NW_{06}^i} + \Delta logp_{06-09}^{H,i} \cdot \frac{H_{06}^i}{NW_{06}^i}$$

- 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.

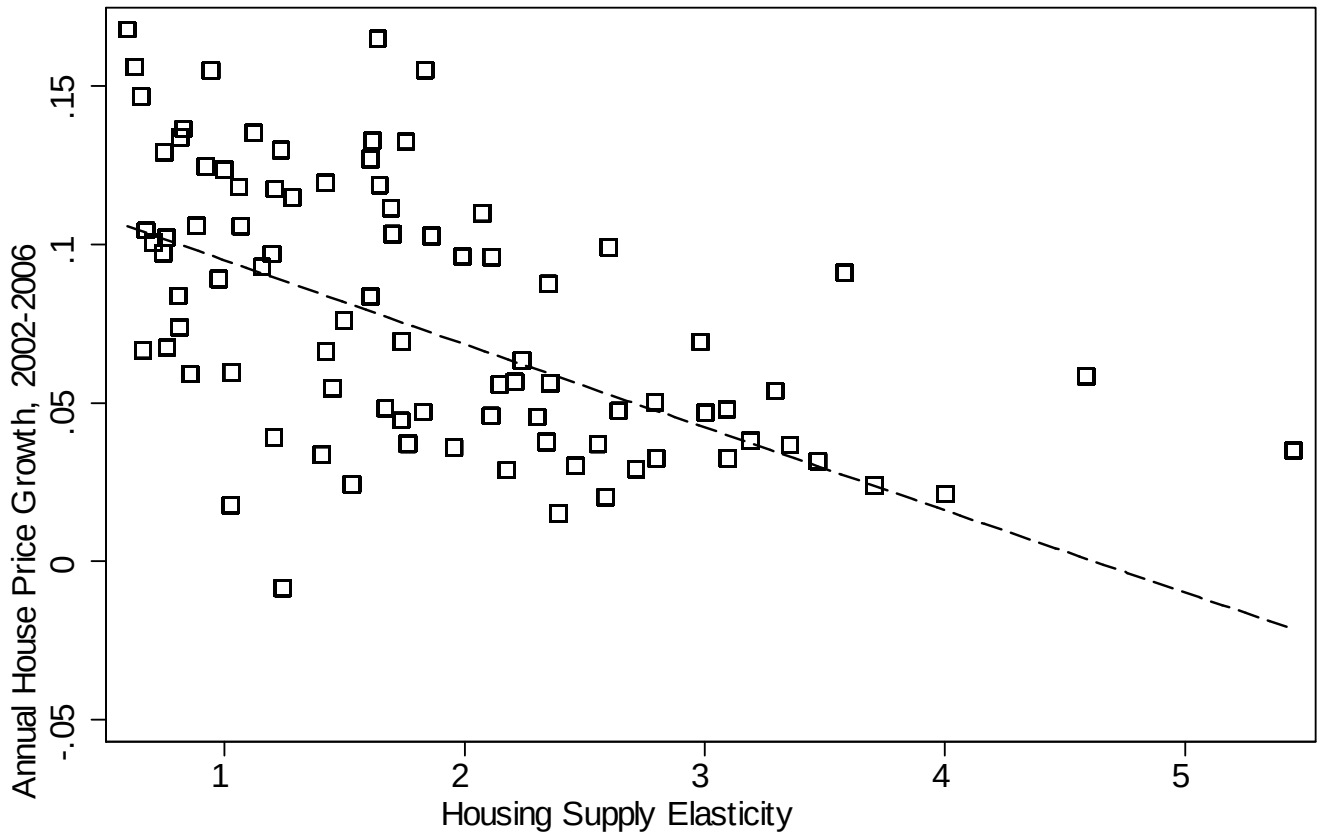
Net Worth Shocks

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



Net Worth Shocks

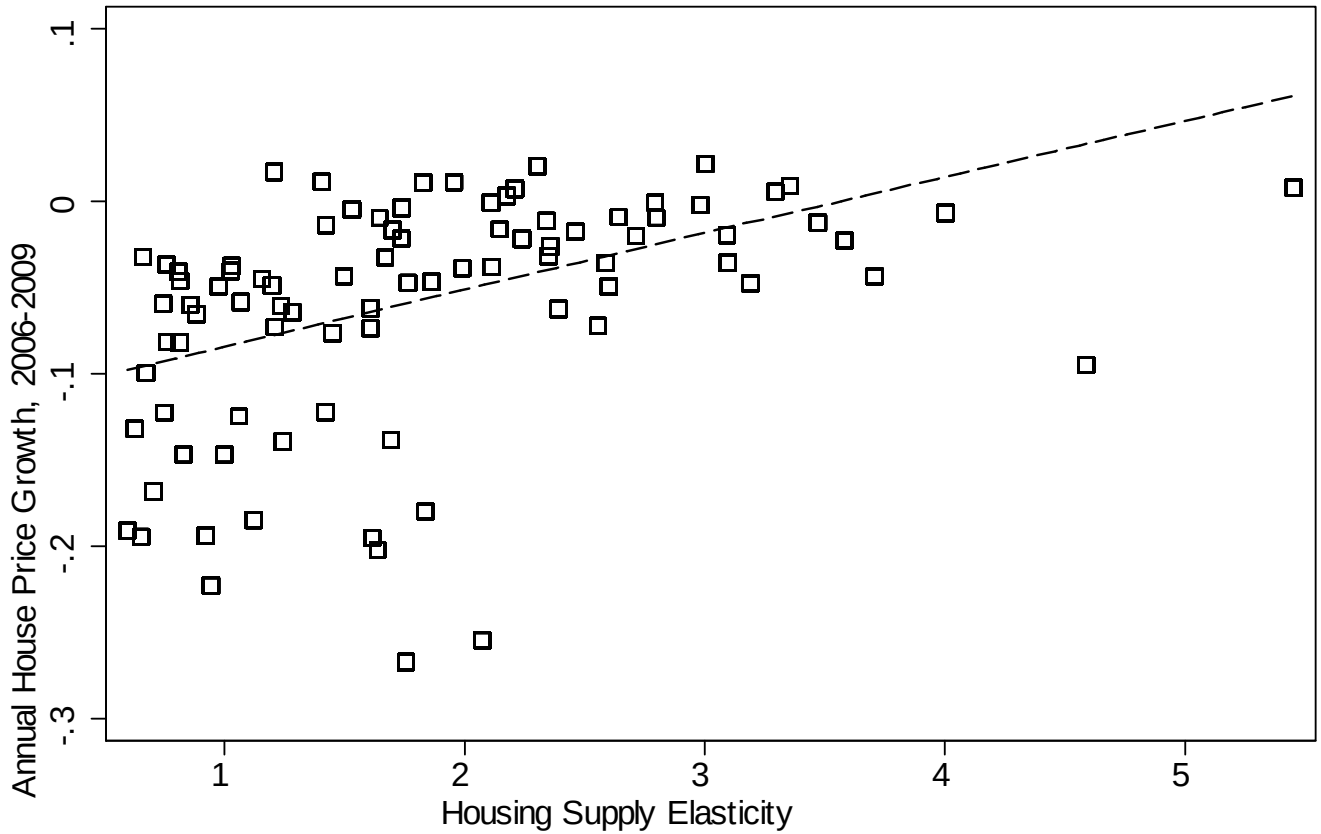
House Prices and Housing Supply Elasticities



Correlation$=-0.51$

Net Worth Shocks

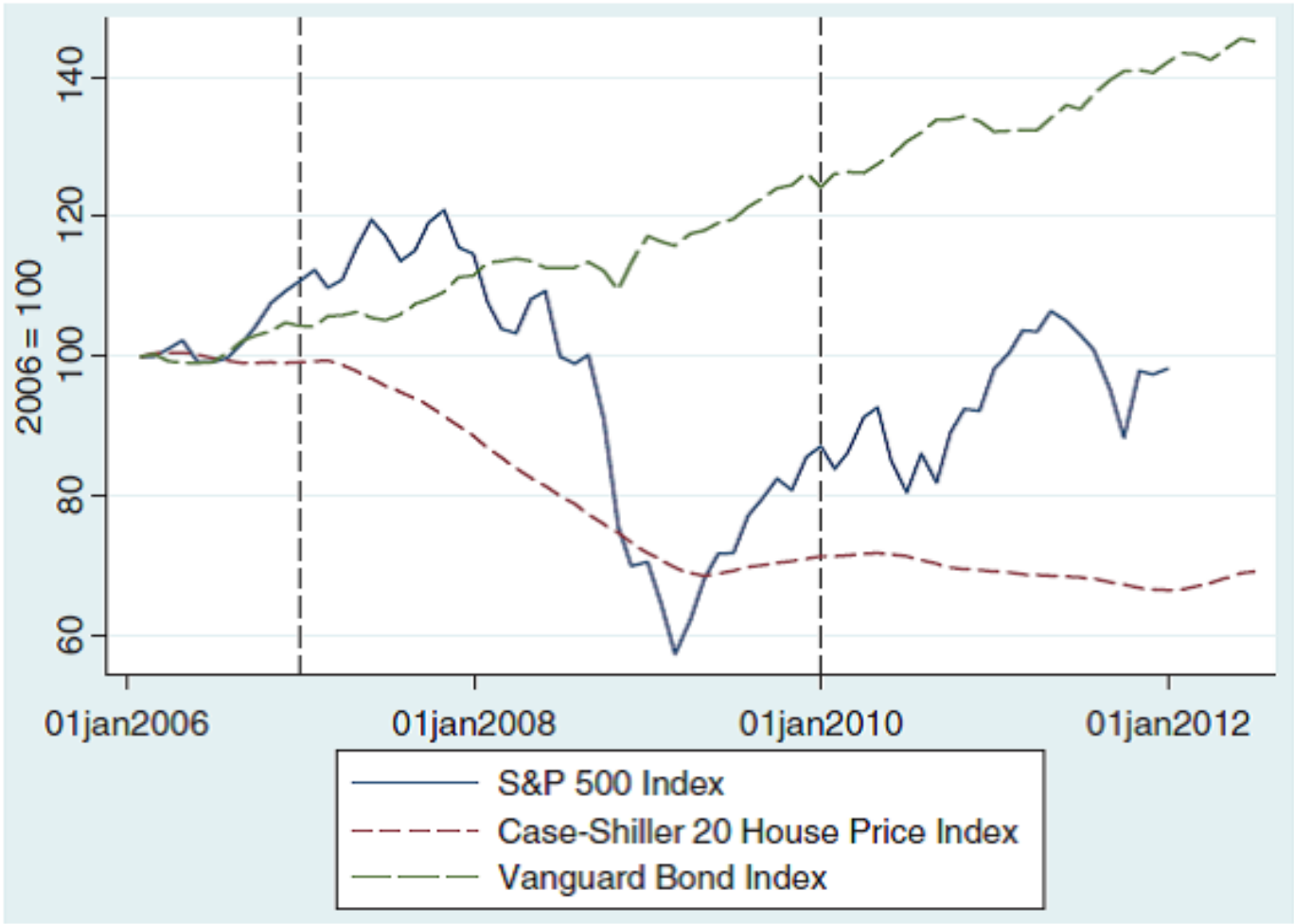
House Prices and Housing Supply Elasticities



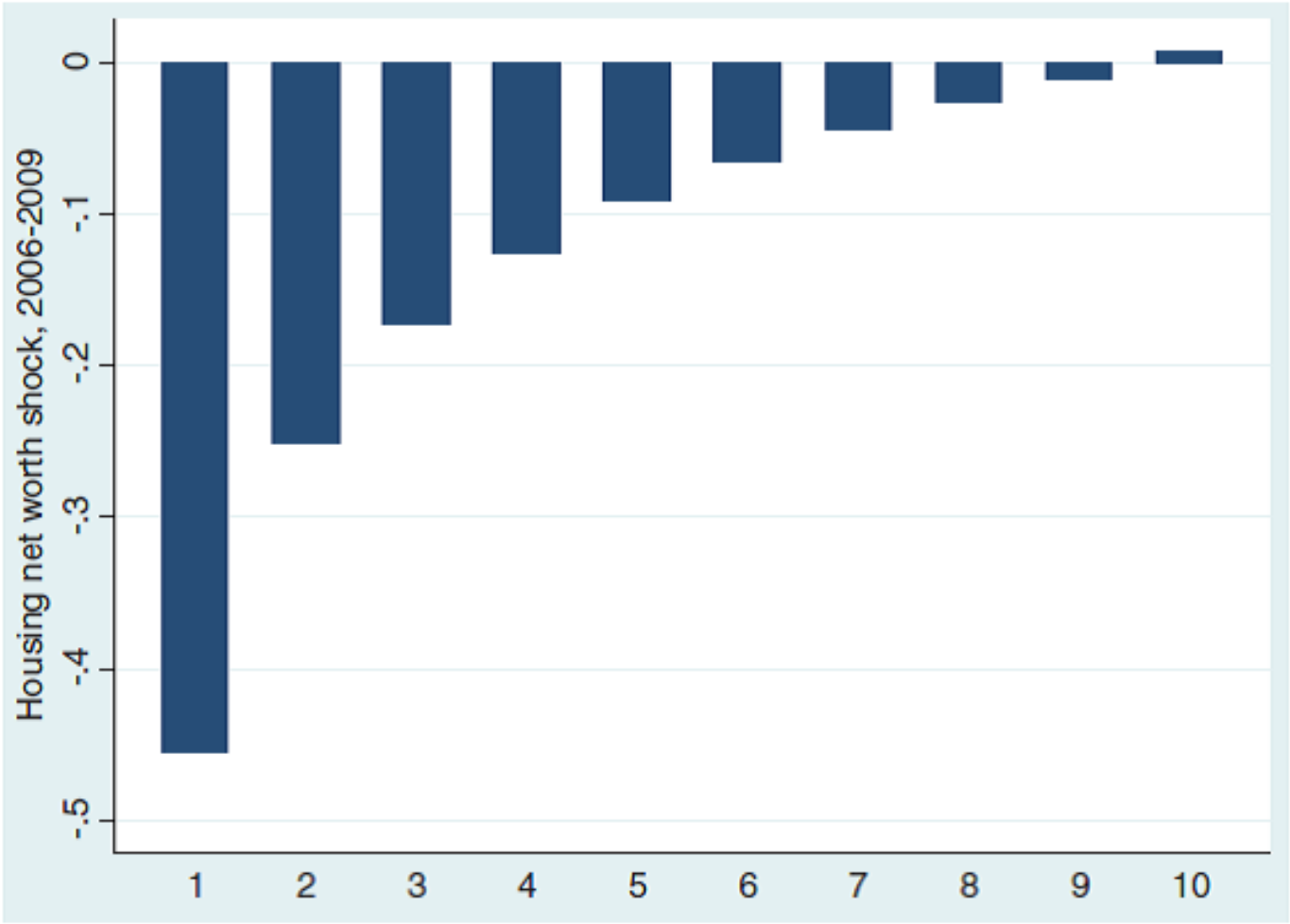
Correlation=0.46

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

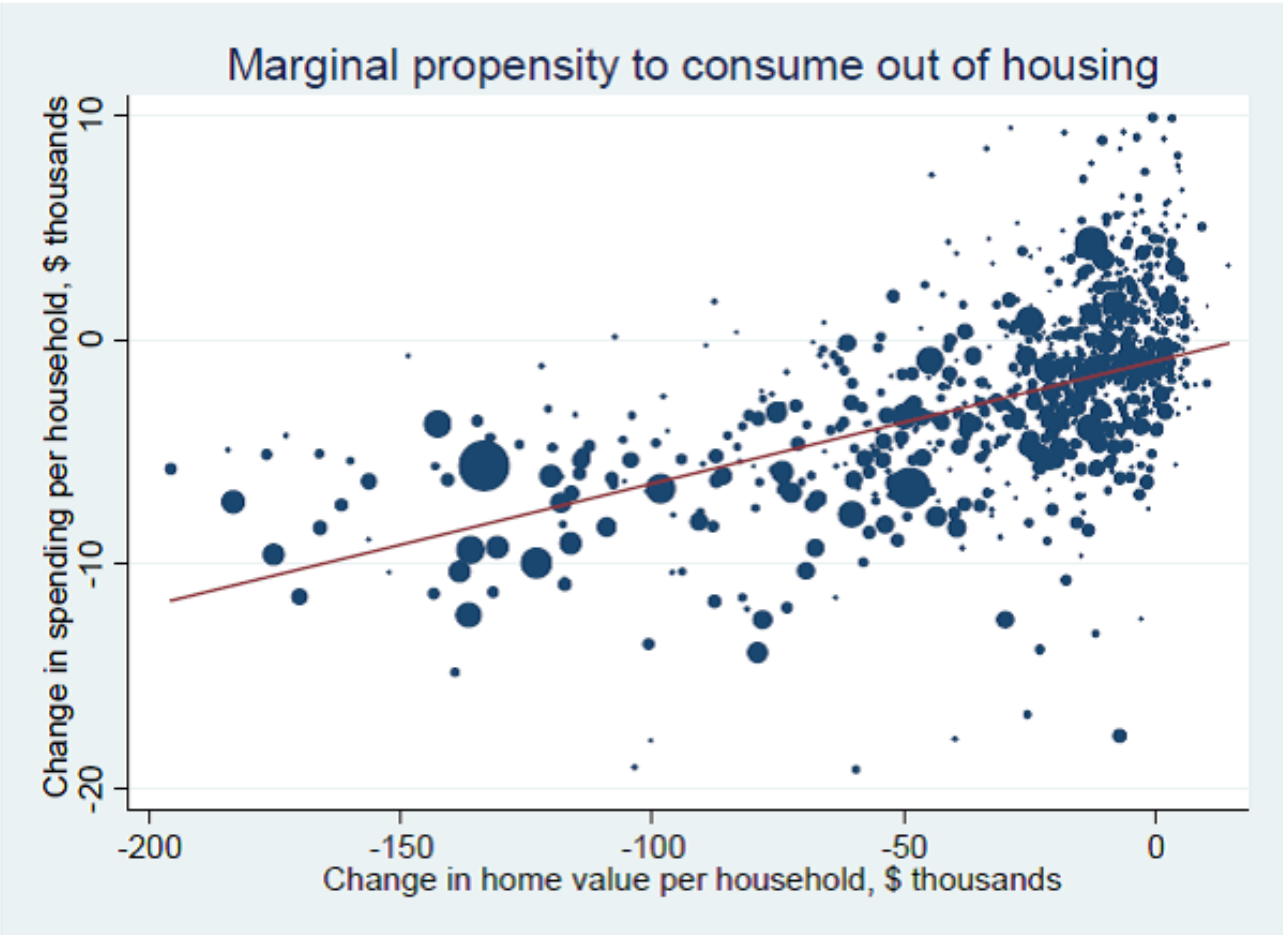
	β	se	R^2
Housing net worth shock, 06-09	0.046**	0.01	0.19
Change in home value, 06-09	27.795**	7.87	0.28
Change in wage growth, (02-06)-(98-02)	-0.002	0.00	0.00
Employment share in construction, (02)	0.002	0.00	0.00
Construction employment growth, (02-06)	0.005	0.01	0.00
Population growth, (02-06)	0.012*	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.

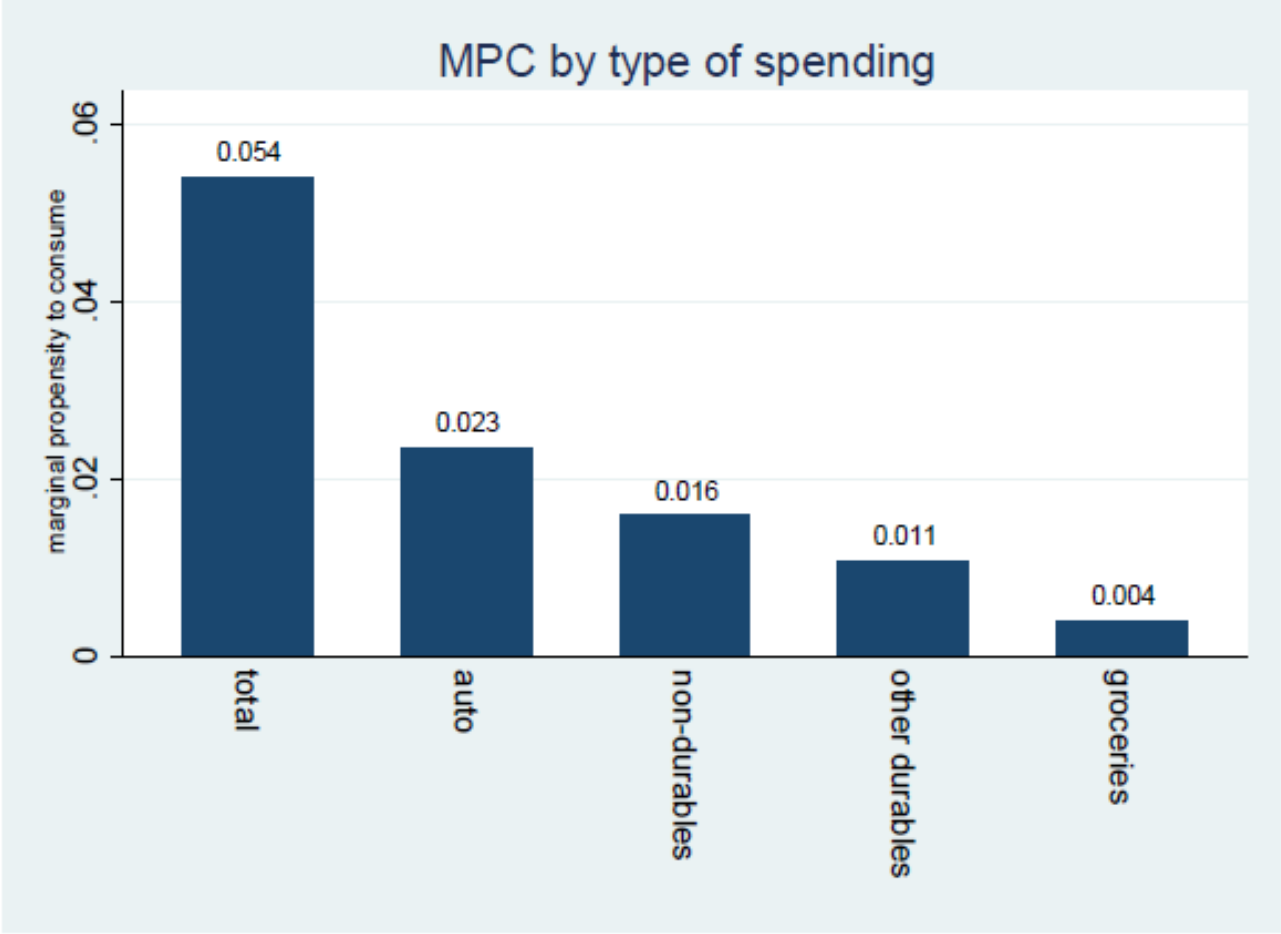
MPC out of household net worth is approximately 6%.

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

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



MPC out of housing wealth is highest for autos.

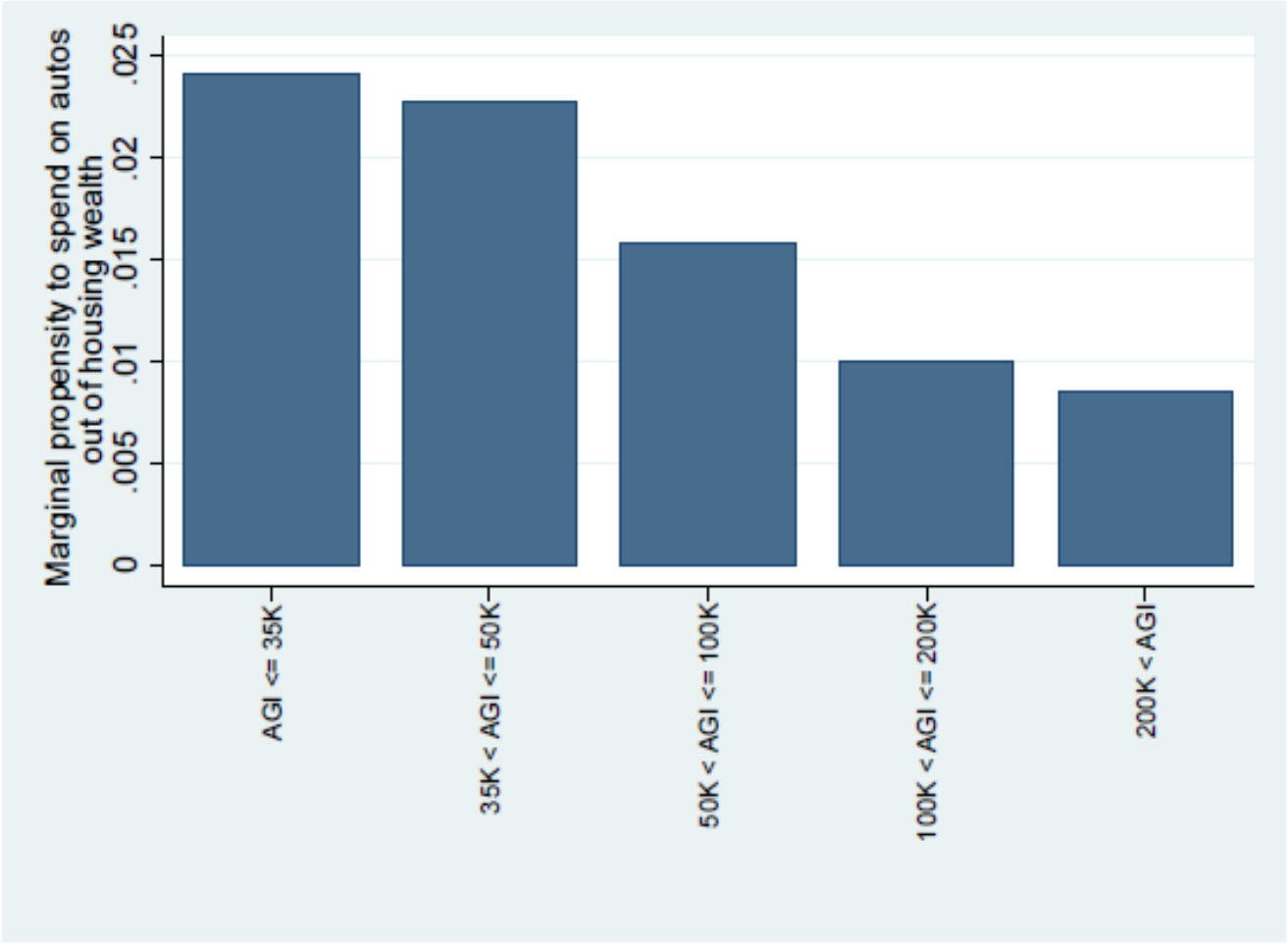


Little power to identify differential MPC using county-level data

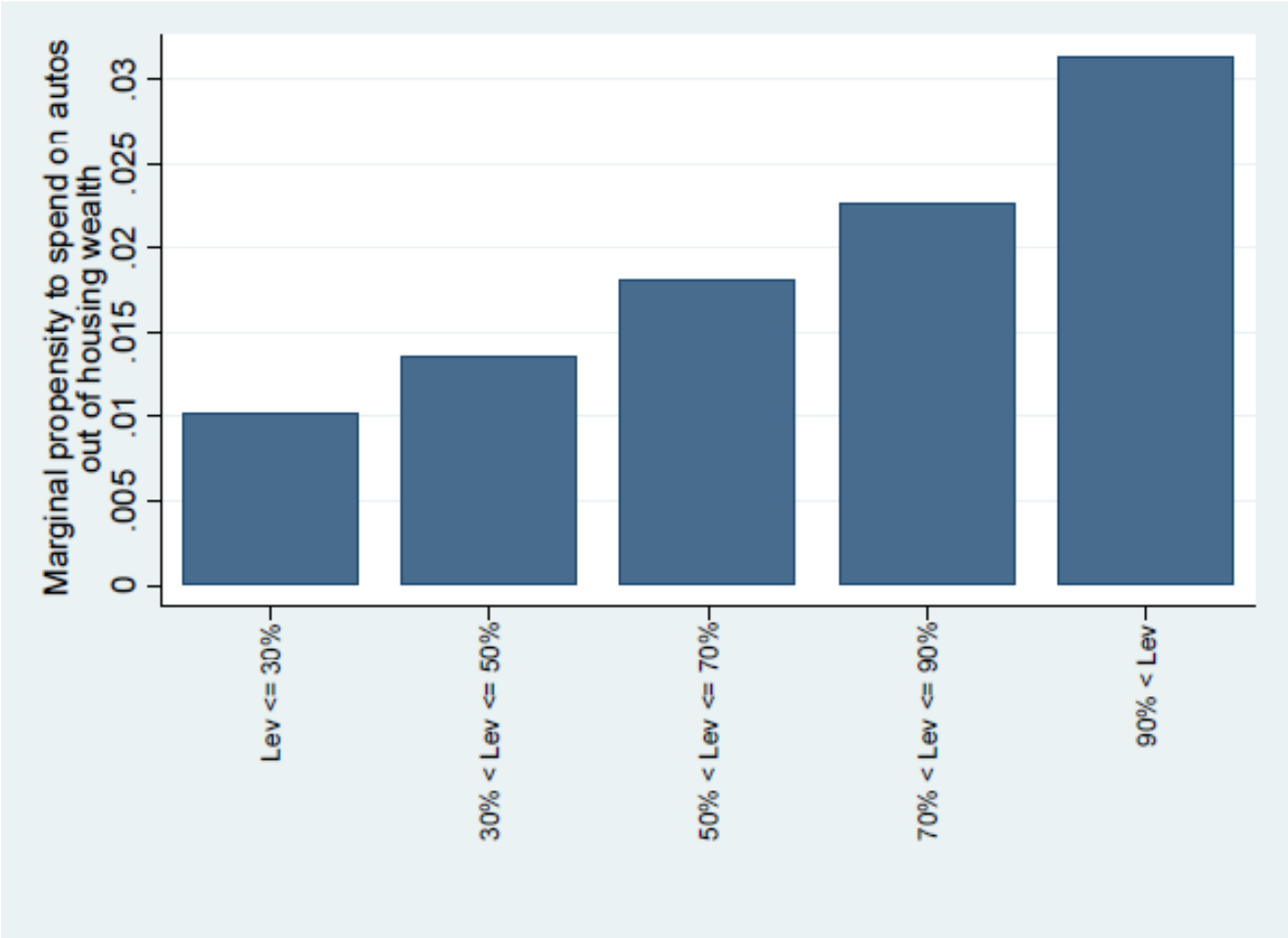
- Within-county standard deviation in net worth is $440,000.
- Between-county standard deviation in net worth is $237,000.

	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

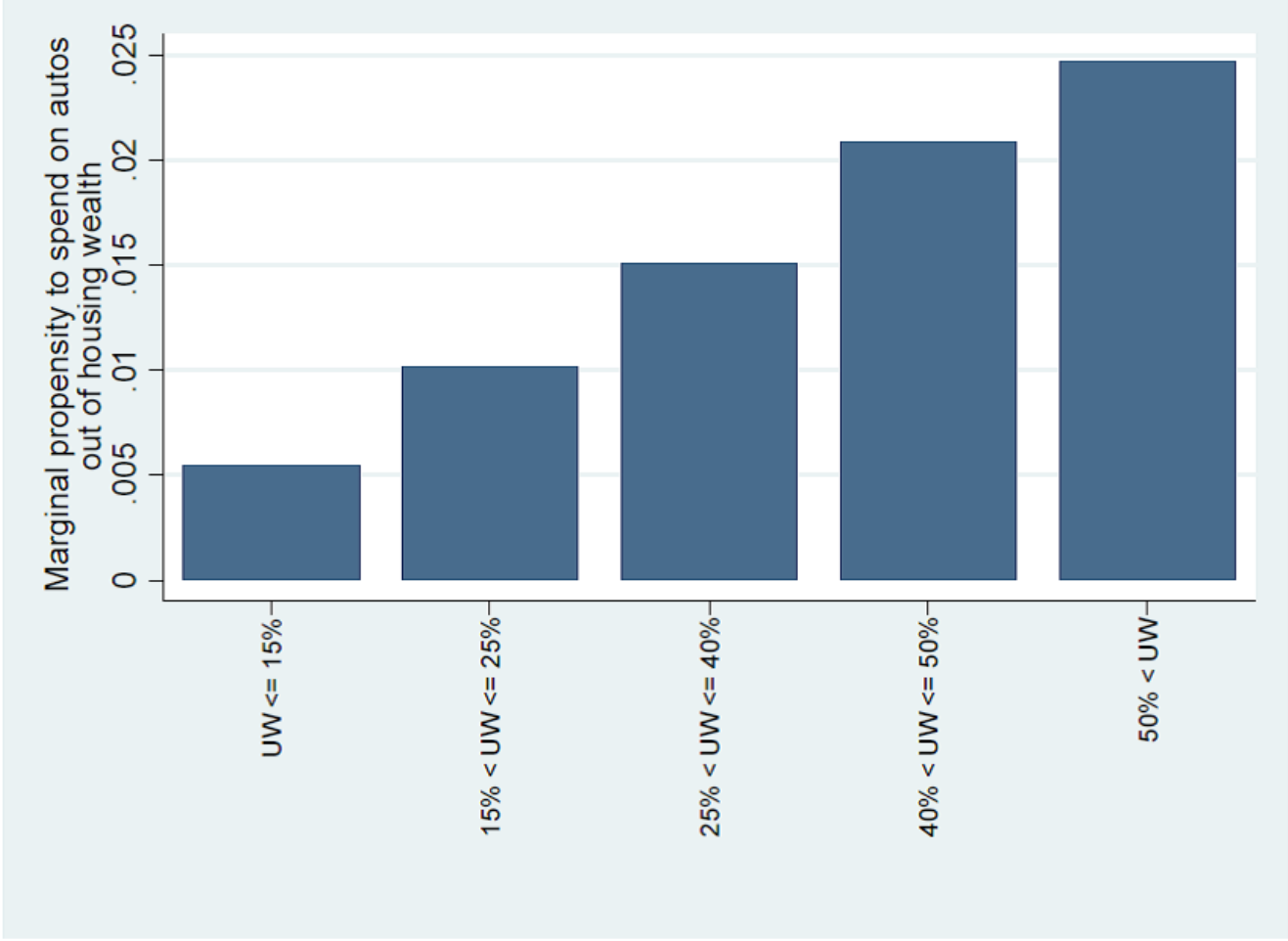
MPC out of housing wealth is highest for low-income zip codes.



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

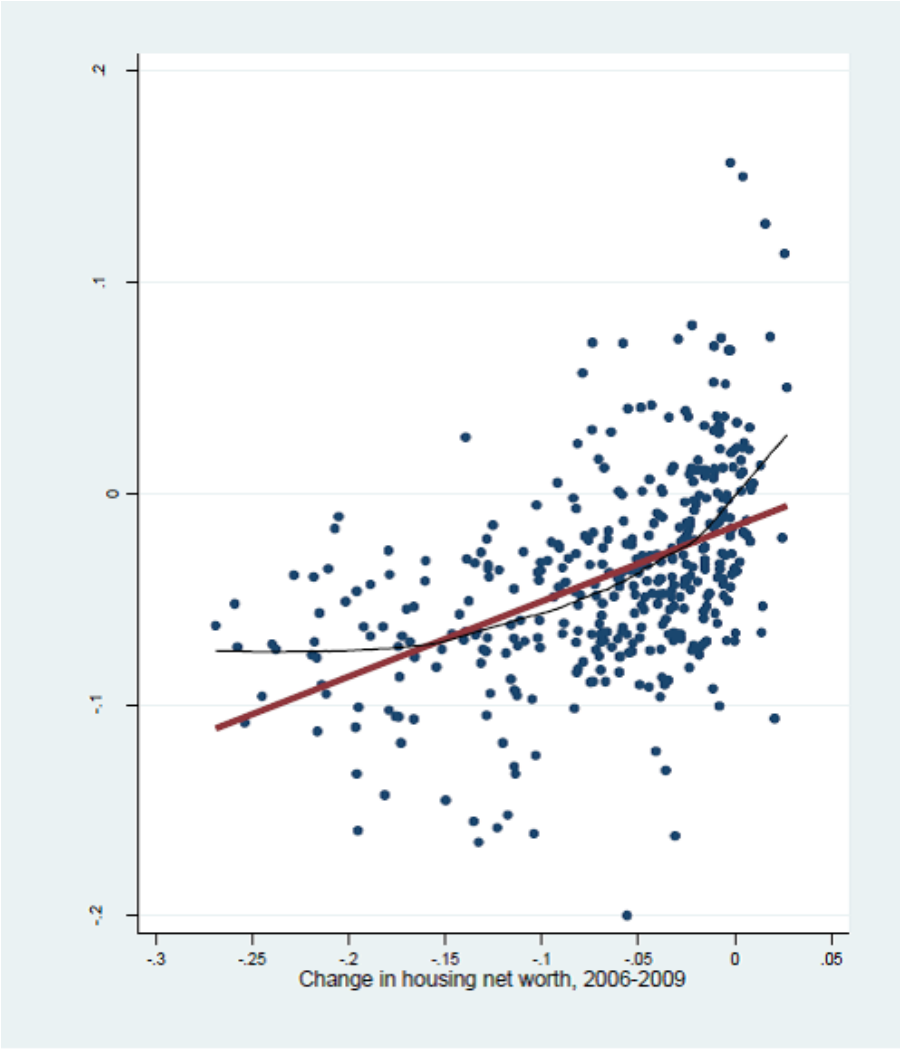
Method 1:

- 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.

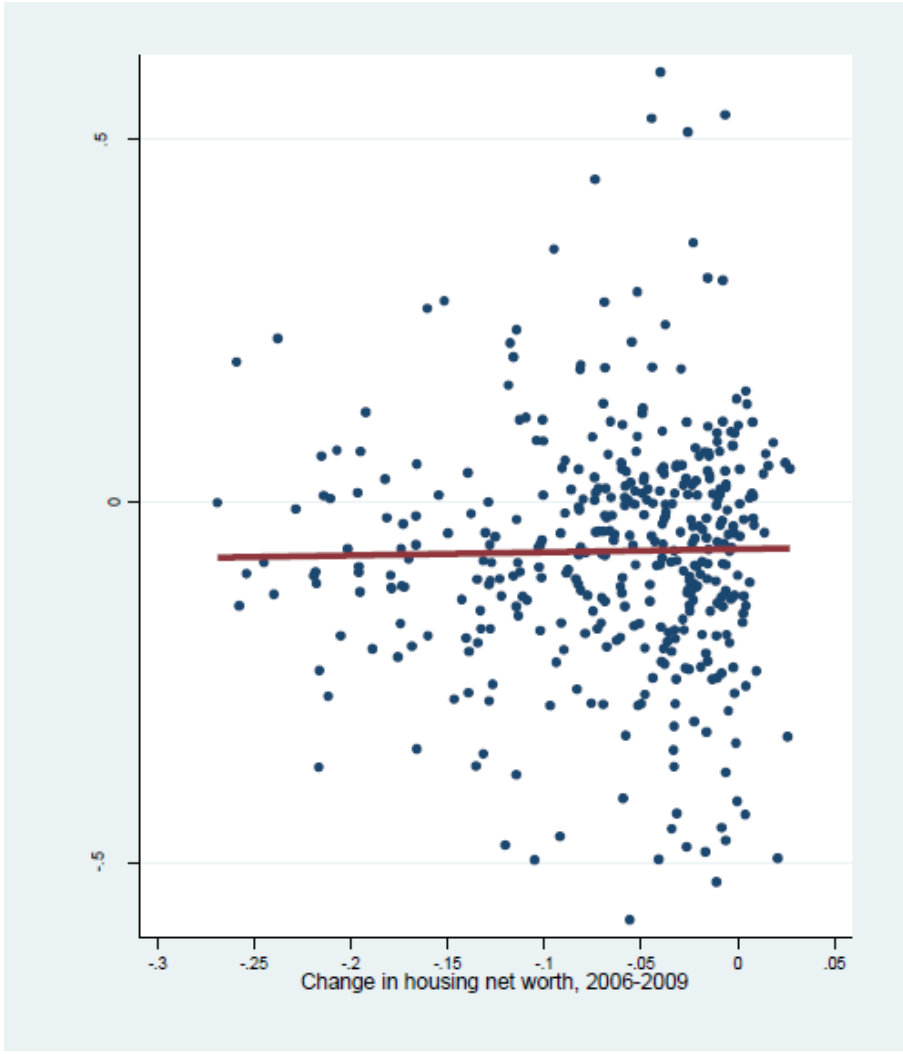
- Most concentrated: Securities and commodities exchanges; pipeline transportation of oil; apparel manufacturing; motion picture industries; agents for artists/athletes.
- Least concentrated: Garden equipment stores; Farm product wholesalers; Gas stations; Mineral mining; General merchandise stores

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

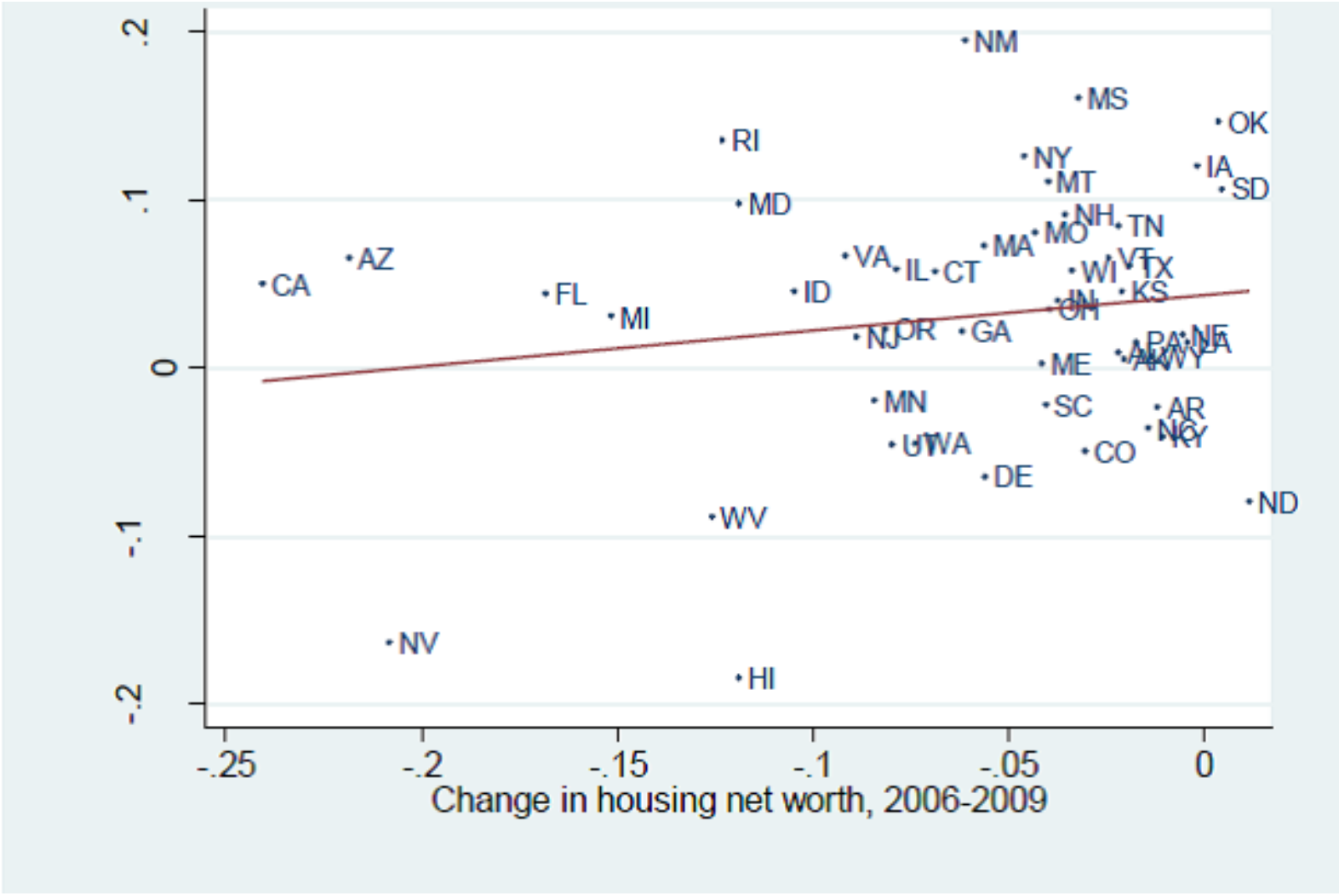
- 90/10 difference in the housing net worth shock = [-0.17, 0.00]
  - Going from the 90th percentile to the 10th percentile of housing net worth shock is associate with a change of approximately 0.31 * 0.17=6 percentage points in non-tradable employment
- 90/10 difference in non-tradable employment growth = 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 Nakamura and Steinsson (2014) "Fiscal Stimulus in a Monetary Union: Evidence from US Regions"

Research Questions and Approach

- What is the short-run government spending multiplier?
  - Big literature tries to measure it, with a variety of answers
  - Potentially depends on how monetary authority reacts to fiscal expansion.
  - Potentially depends on parameterization of consumer preferences
- A common approach: Look at changes in military spending
  - New twist: Use regional variation in reliance on military.
- Does regional variation in government spending help identify the multiplier?
  - Answer: It helps distinguish among relevant preference parameters
  - ... but not so much about the responsiveness of monetary policy.

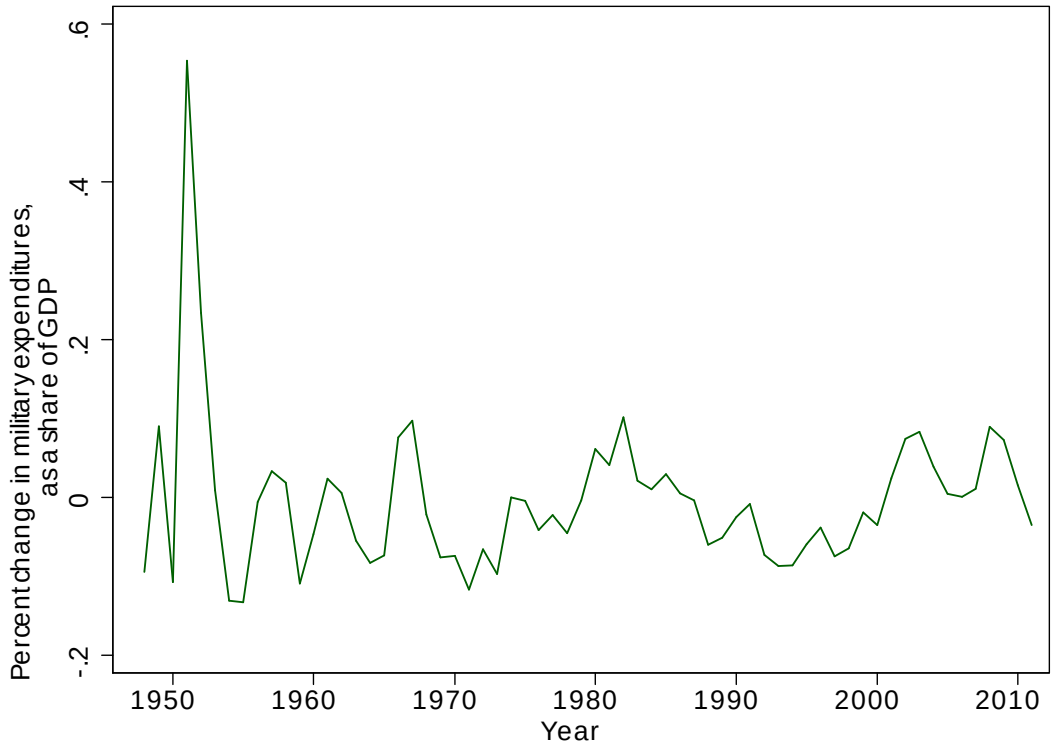
Two multipliers

1. Regional spending helps identify a *relative open economy multiplier*
   - E.g. How much does California's GDP increase vs. Wisconsin b/c military spending increased by more in CA vs. WI?
   - "Open economy" b/c California and Wisconsin share a monetary authority, have a common interest rate.

2. Policy makers (almost exclusively) care more about the *closed economy multiplier.*
   E.g. How much does US GDP increase when federal military spending increases?

Q1: Why might the two multipliers differ? What are the countervailing forces in (2) that are not in (1)?
Q2: Why is it so hard to identify the government spending multiplier?

Not a lot of national variation after the Korean War.



Previous research on government spending multipliers

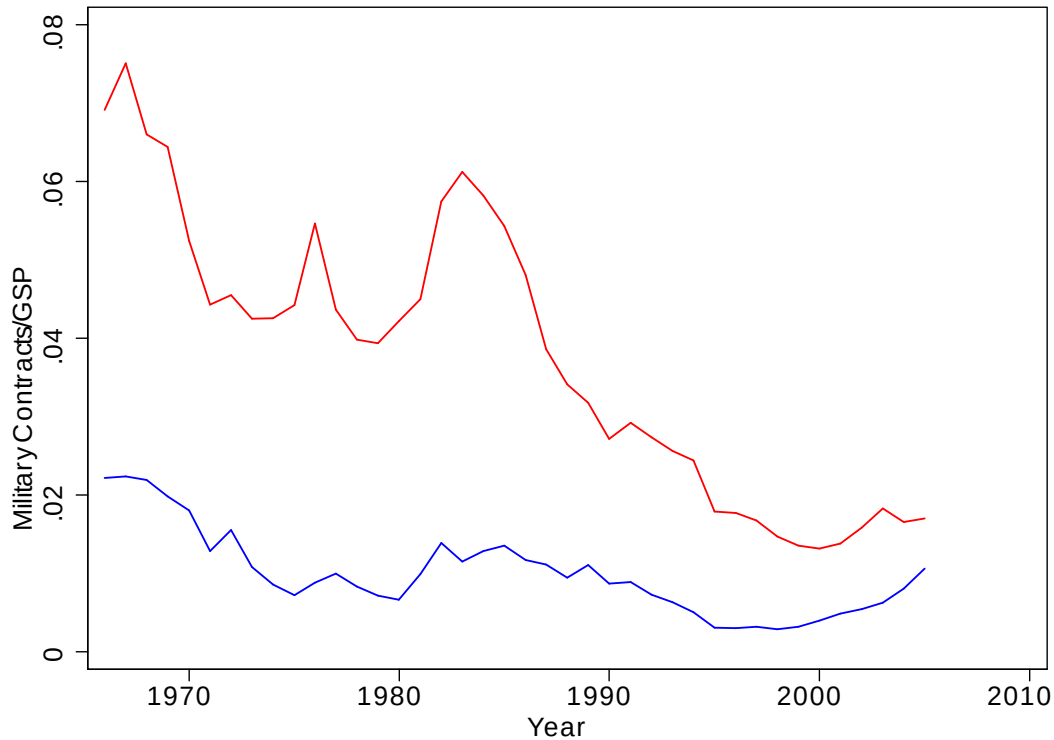
1. Baxter and King (1993): Neoclassical growth model + government sector.
   - Add gov't purchases, capital stock to rep. consumer's utility function, $u = u\left(C_t, N_t, K_t^g, G_t\right)$
   - Add gov't capital stock to aggregate production function: $Y = F\left(K_t, K_t^g, N_t\right)$
   - Analyze $\frac{\Delta Y}{\Delta G}$ for permanent or transitory changes in G.
   - For temporary changes in G, $\frac{\partial Y}{\partial G}$ is small (<1)... Bigger when
     - labor is elastically supplied
     - government expenditure is financed by transfers (as opposed to distortionary taxes)
   - Why is $\frac{\partial Y}{\partial G}$ is small?
     - In response to G being higher$\rightarrow$less private investment$\rightarrow$ less private capital $\rightarrow$ higher (real) interest rates $\rightarrow$ reduce private consumption
2. Eggertson (2010), Christiano, Eichenbaum, Rebelo (2011)

Outline

1. National chance in military spending affect different regions differently $\Rightarrow$ Open economy multiplier is approximately 1.5
2. Model
3. Model + ROEM=1.5 $\Rightarrow$ Large plausible range for closed economy multiplier.

Regions' exposure to military spending differs

- Main Data Source: Department of Defense has a database of military procurement contracts



Methodology

- Measure change in output due to change in government spending

$$\frac{Y_{it} - Y_{it-2}}{Y_{it-2}} = \alpha_i + \gamma_t + \beta \frac{G_{it} - G_{it-2}}{Y_{it-2}} + \varepsilon_{it}$$

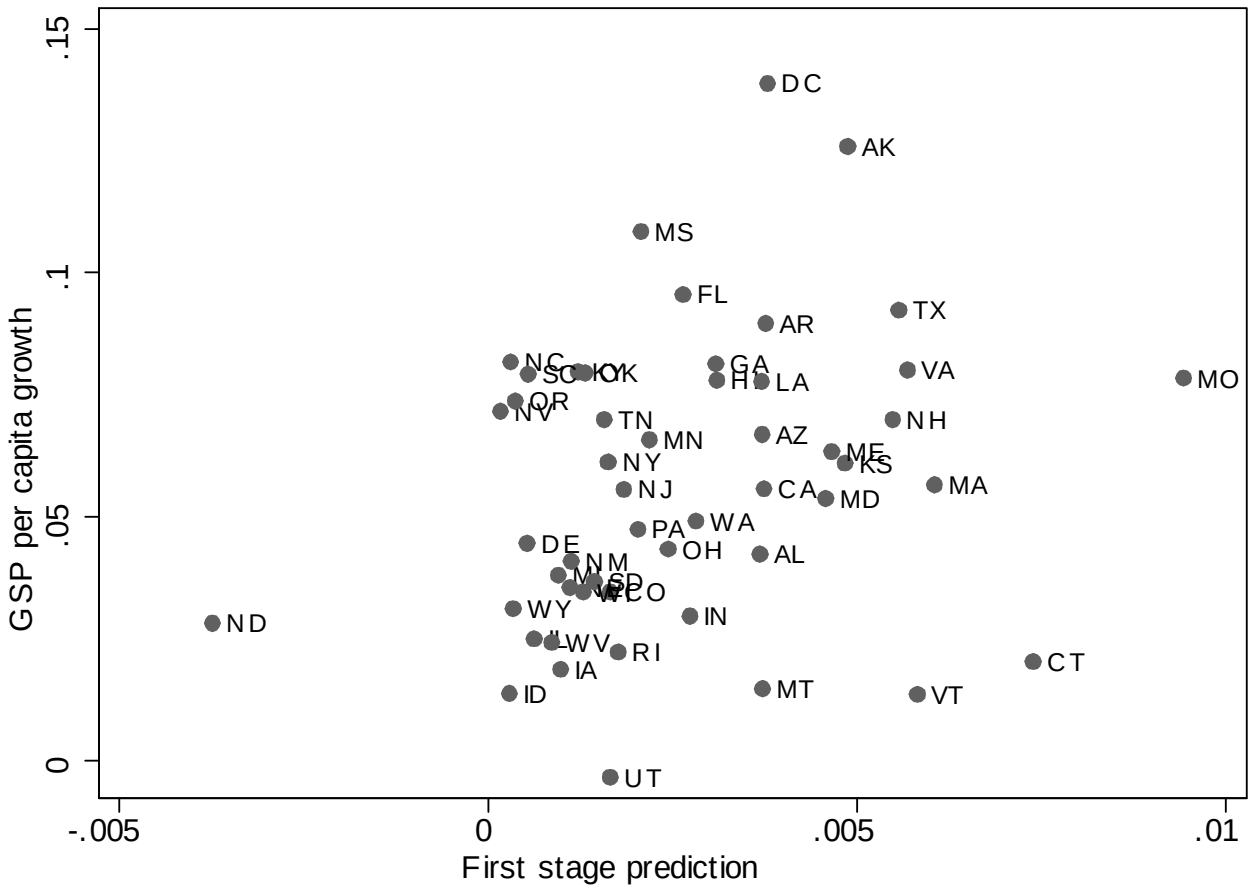
- Issue: Changes in state military spending is politically driven
  - States could lobby for more defense contracts if local conditions are bad
- Instrument $\frac{G_{it} - G_{it-2}}{Y_{it-2}}$ using national changes in military spending

$$\frac{G_{it} - G_{it-2}}{Y_{it-2}} = \eta_0 + \eta_i \cdot \frac{G_t^{\text{agg}} - G_{t-2}^{\text{agg}}}{Y_{t-2}^{\text{agg}}} + \tilde{\varepsilon}_{it}$$

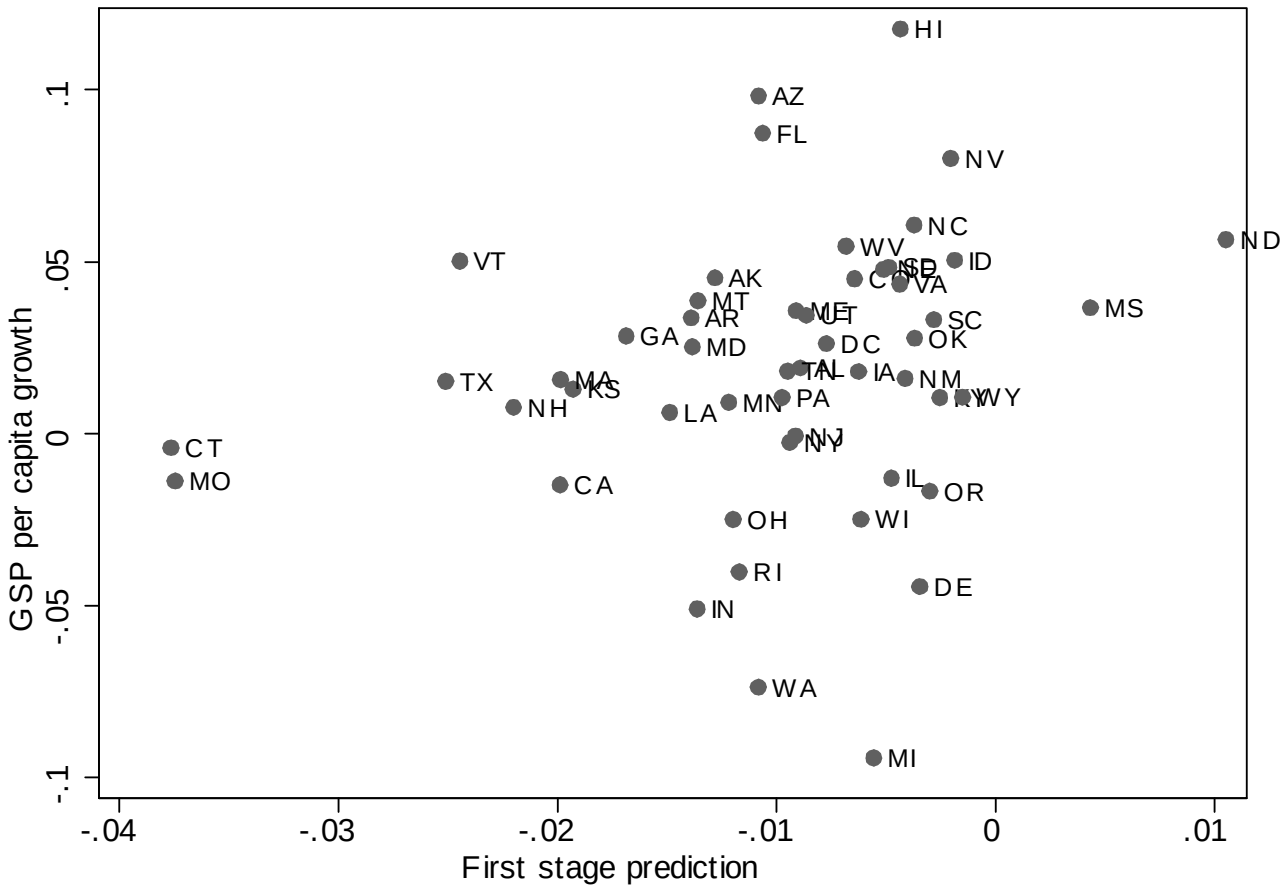
- Weak instrument? F-statistic from this regression is roughly 5.
- Alternative instrument (Bartik)

$$\frac{G_{it} - G_{it-2}}{Y_{it-2}} = \eta_0 + \frac{\overline{(G/Y)}_i}{\overline{(G/Y)}^{\text{agg}}} \cdot \frac{G_t^{\text{agg}} - G_{t-2}^{\text{agg}}}{Y_{t-2}^{\text{agg}}} + \tilde{\varepsilon}_{it}$$

Relationship between First stage estimates and GSP Per Capita Growth



Relationship between First stage estimates and GSP Per Capita Growth



(Open economy) government spending multiplier is approximately 1.4

	Output	Employment	CPI	Population
β	1.43	1.28	0.03	-0.12
(se)	0.36	0.29	0.19	0.07
N	1989	1989	1989	1989

Model Overview

Goal: Compute Open and Closed economy multiplier in a NK model.

- Two regions within the US, home and foreign.
  - Within each region are a continuum of firms over which consumers have CES preferences.
  - Households purchase from firms in the two regions; own a portfolio of all firms.
- Government produces a substitute good
- Monetary authority follows Taylor Rule
  - But what if they followed some other interest rate rule?
- Firms produce using labor, have sticky (Calvo) prices.
  - But what if prices were flexible?

Model: Preferences

- Preferences for consumption and leisure.

$$\mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t u\left(C_t, L_t\left(x\right)\right) \right]$$

- Budget constraint:

$$P_t C_t + \mathbb{E}_t[\underbrace{M_{t,t+1}}_{\text{stoch. discount. factor}} B_{t+1}\left(x\right)] \leq B_t\left(x\right) + \underbrace{\left(1-\tau_t\right)}_{\text{labor tax}} W_t\left(x\right) L_t\left(x\right) + \underbrace{\int_0^1 \Xi_{ht}\left(z\right) dz}_{\text{firm profits}} - \underbrace{T_t}_{\text{lump sum taxes}}$$

- Consumption consists of purchases from the home region and other regions

$$C_t = \left[\phi_H^{\frac{1}{\eta}} C_{Ht}^{\frac{\eta-1}{\eta}} + \phi_F^{\frac{1}{\eta}} C_{Ft}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$$

Model: Preferences

- Each bundle (e.g. C_{Ht}) is a CES composite of purchases from individual firms z

$$C_{Ht} = \left[\int_0^1 c_{ht}(z)^{\frac{\theta-1}{\theta}} dz \right]^{\frac{\theta}{\theta-1}}$$

- Demand curve for each firm will then by

$$\begin{aligned} c_{ht}(z) &= C_{Ht} \left(\frac{p_{ht}(z)}{P_{Ht}} \right)^{-\theta} \\ &= \phi_H C_t \left(\frac{p_{ht}(z)}{P_{Ht}} \right)^{-\theta} \left(\frac{P_{Ht}}{P_t} \right)^{-\eta} \end{aligned}$$

Model: Government

- Government spending in each region, G_{Ht}, follows AR(1) process
  - G_{Ht} is a CES composite of different varieties of the government good, with elasticity of substitution θ.
  - Government imposes labor and lump sum taxes to finance spending.
- Monetary policy follows Taylor Rule
  - Same across both regions

$$\hat{r}_t^n = \rho_r \hat{r}_{t-1}^n + (1-\rho_r) \cdot (\phi_\pi \hat{\pi}^{ag} + \phi_y \hat{y}^{ag} + \phi_g \hat{g}_{ag})$$

  - $\rho_r = 0.8$; $\phi_\pi = 1.5$; $\phi_y = 0.5$, $\phi_g = 0$
  - Also try fixed real (or nominal) rate

Model: Firms

- A firm can sell to i) consumers in the home region, ii) consumers in the foreign region, and the home government.

$$y_{ht}(z) = \left(nC_{Ht} + (1-n)\,C^*_{Ht} + nG_{Ht}\right)\left(\frac{p_{ht}(z)}{P_{Ht}}\right)^{-\theta}$$

- Firms produce using labor. Per period profits are

$$p_{ht}(z)\,y_{ht}(z) - W_t(x)\,L_t(z)^a$$

  - $a = \frac{2}{3}$
  - x is group of firms with common wages; that reset prices at the same time.

- Firms are allowed to re-optimize profits with probability $1-\alpha$.
  - Set price to be markup$\times$expected marginal cost up to the next time at which it can re-set prices.

Calibration and model objects

- Only one driving policies: Government spending, follows AR(1) process taken from data ($\rho_g = 0.933$)
- $n = 0.1$; the home region is about 10% of the national economy
- $\phi_H = 0.7$; about 70% of GSP comes from within the region.

After simulating the model, we care about two model objects

- Closed economy multiplier

$$\frac{Y_t^{agg} - Y_{t-2}^{agg}}{Y_{t-2}^{agg}} = \alpha + \beta \frac{G_t^{agg} - G_{it-2}^{agg}}{Y_{t-2}^{agg}} + \varepsilon_t$$

- Relative open economy multiplier

$$\frac{Y_{Ht} - Y_{Ht-2}}{Y_{Ht-2}} - \frac{Y_{Ft} - Y_{Ft-2}}{Y_{Ft-2}} = \alpha + \beta \left(\frac{G_{Ht} - G_{Ht-2}}{Y_{Ht-2}} - \frac{G_{Ft} - G_{Ft-2}}{Y_{Ft-2}} \right) + \varepsilon_{it}$$

Government Spending Multiplier with Separable Preferences

$$u\left(C_t, L_t\left(x\right)\right) = \frac{C_t^{\frac{\sigma-1}{\sigma}}}{1-\sigma^{-1}} - \frac{L_t\left(x\right)^{1+\nu^{-1}}}{1+\nu^{-1}}$$

	Closed	Open
Sticky Prices $\left(\alpha = \frac{3}{4}\right)$		
Taylor Rule $(\rho_r,\ \phi_\pi,\ \phi_y) = (0.8,\ 1.5,\ 0.5)$	0.20	0.83
$r^{\text{nom}} - \pi$ is constant	1.00	0.83
r^{nom} is constant	∞	0.83
r^{nom} is constant, but $\rho_g = 0.85$	1.70	1.90
Flexible Prices $(\alpha = 0)$	0.39	0.43

Constant nominal interest rates

- In our discussion of Baxter-King:
  - Higher $G \rightarrow$ higher real interest rates, consume less now.
- In our New Keynsian model with constant nominal interest rates
  - Higher $G \rightarrow$ Each of the z firms needs to produce more
  - $\rightarrow$ ... increasing their marginal cost
  - $\rightarrow$ Higher expected inflation for the next period
  - $\rightarrow$ Lower real interest rates
  - $\rightarrow$ Each of the z firms needs produce more
  - etc...

Government Spending Multiplier with Consumption/Leisure as Complements

$$u\left(C_t, L_t\left(x\right)\right) = \frac{1}{1-\sigma^{-1}} \cdot \left[C_t - \frac{L_t\left(x\right)^{1+\nu^{-1}}}{1+\nu^{-1}}\right]^{\frac{\sigma-1}{\sigma}}$$

	Closed	Open
Sticky Prices $\left(\alpha = \frac{3}{4}\right)$		
Taylor Rule $(\rho_r,\ \phi_\pi,\ \phi_y) = (0.8,\ 1.5,\ 0.5)$	0.12	1.42
$r^{\text{nom}} - \pi$ is constant	7.00	1.42
r^{nom} is constant	∞	1.42
r^{nom} is constant, but $\rho_g = 0.85$	8.73	2.04
Flexible Prices $(\alpha = 0)$	0.00	0.30

Summary

- Other Exercises:
  - No state-contingent bonds can be traded across regions. (Not much changes)
  - Include capital investment
- Main results:
  - Relative open economy multiplier > 1 .Similar across many monetary policy rules.
  - Closed economy multiplier varies a lot.
- Lessons relative to Mian and Sufi?