Why Has House Price Dispersion Gone Up?

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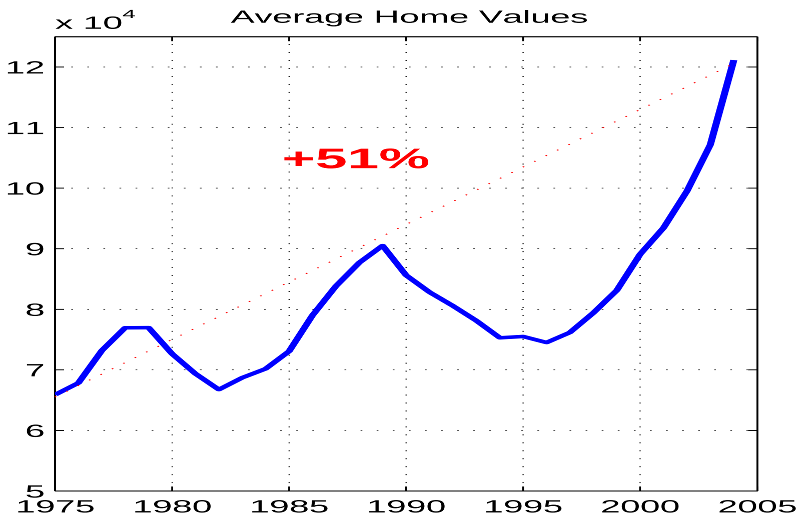
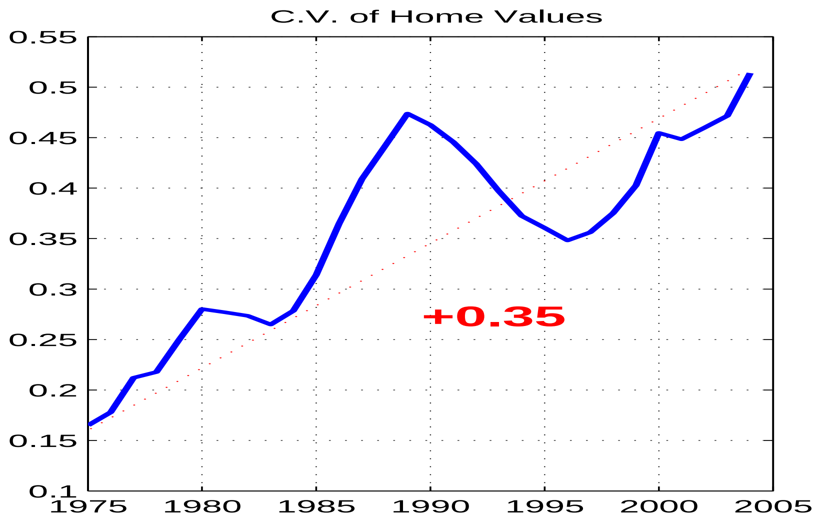
two facts about regional house prices

House price, panel of U.S. metropolitan areas, 1975-2004

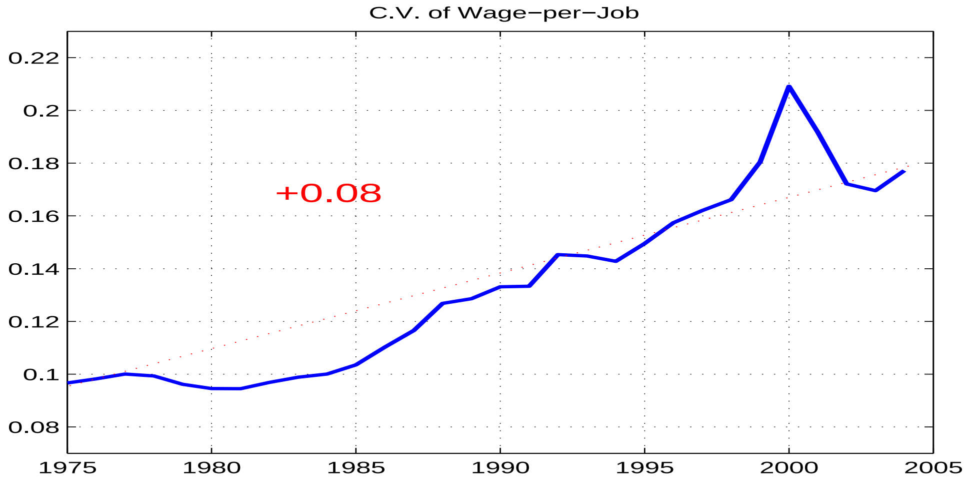




- On the left: increase in cross-sectional average
- On the right: increase in cross-sectional dispersion

two ingredients for an explanation

- Increase in wage dispersion



- Fixed local housing supply

  regulation: evidence from many papers

results

- **Mechanism:** when wage dispersion increases

$\longrightarrow$ households move from low- to high-wage areas

bid prices up in high-wage areas

bid prices down in low-wage areas

$\Rightarrow$ dispersion goes up, and level also goes up!

results

- **Mechanism:** when wage dispersion increases

$\rightarrow$ households move from low- to high-wage areas

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- **Calibration:** matches the two facts

- **Alternative theory:** increase in regulation

  qualitatively: goes in the right direction

  quantitatively: tiny effects

outline

→ Model

→ Calibration

- Scenario 1:
  increase wage dispersion,
  hold regulation fixed at its 1975 level

- Scenario 2:
  increase regulation,
  hold wage dispersion fixed at its 1975 level

→ Welfare effects when both margins are active

setup: islands

Time $t \in \{1, 2, \ldots\}$, $[0, 1]$-continuum of islands

- Competitive firms with linear technology: $n \mapsto A_t n$

  Linear technology and competition: A_t is the wage per job

  $\{A_t\}_{t=1}^{\infty}$ first-order Markov process

  persistent

  i.i.d across islands

- Cross-sectional distribution $g_0(A_0, H_0)$ of initial conditions

  initial wage A_0

  initial housing stock H_0

setup: households

$\rightarrow$ $[0, 1]$-continuum

- Infinitely lived, discount factor $\beta \in (0, 1)$, separable utility

  linear over non-housing consumption goods

  increasing, strictly concave $v(h)$ over housing services

  bounded above, unbounded below

- Supplies one unit of labor inelastically each period

- Perfectly mobile: each period, chooses

  on which island to work

  how much housing to consume in that island

setup: construction

- Aggregate endowment M of construction material

- A representative competitive construction firm

  Buys construction material

  Chooses where to construct

  Linear construction technology (one to one)

  Construction is irreversible, depreciates at rate δ

- Housing supply regulations

  $\Pi_t(A_t)$ permits in each island

equilibrium

Rents, house prices, price of construction material

Housing consumption and location plan

Construction plan

Distribution of households across islands

Distribution of housing stocks across islands

- Optimality
- Feasibility

    Location plan generates distribution of households

    Construction plans generates distribution of housing stock

    Housing market clears in each island

    Construction material market clears

household's problem

- Optimal location

Let $n_t(A^t, H_0)$ be the number of households in island (A^t, H_0)

If $n_t(A^t, H_0) > 0$, then

$$
\begin{aligned}
A_t + \max_h \left\{ v\left(h\right) - \rho_t(A^t, H_0)h \right\} &= U_t \\
&\leq U_t \text{ otherwise}
\end{aligned}
$$

implications of optimal location: monotonicity

- If $n_t(A^t, H_0) > 0$, then

$$A_t + \max_h \left\{ v\left(h\right) - \rho_t(A^t, H_0)h \right\} = U_t$$

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$\Rightarrow \;\; \rho_t(A^t, H_0) = \rho^*(A_t, U_t)$

increasing in A_t, decreasing in U_t

implications of optimal location: monotonicity

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$\Rightarrow \ \rho_t(A^t, H_0) = \rho^*(A_t, U_t)$

increasing in A_t, decreasing in U_t

$\Rightarrow \ h_t(A^t, H_0) = h^*(A_t, U_t)$

decreasing in A_t, increasing in U_t

implication of optimal location: convexity

- If $n_t(A^t, H_0) > 0$, then

$$A_t + \max_h \{v(h) - \rho^*(A_t, U_t)h\} = U_t$$

Take derivative, use envelope condition:

$$1 - \frac{\partial \rho^*}{\partial A} \times h^*(A, U) = 0 \Rightarrow \frac{\partial \rho^*}{\partial A} = \frac{1}{h^*(A, U)}$$

convexity and the level effect of wage dispersion

- increase the dispersion of wage, A, hold U constant

$\Rightarrow$ the cross-sectional average rent $E\left[\rho^*(A,U)\right]$ increases

$\Rightarrow$ the house price level increases in every island

for example, if A_t i.i.d over time

$$\text{house price} = \rho^*(A,U) + \frac{E\left[\rho^*(A',U)\right]}{1-\beta(1-\delta)}$$

implications of optimal location: house prices

- House price

= expected present value of rents
net of depreciation
conditional on island history

$$= p^*(A_t, U_t, U_{t+1}, \ldots),$$

increasing in A_t

decreasing in U_{t+j}

does not depend on local housing supply

construction firm's problem

- Centralized market for construction material

- Linear construction technology, permit constraint $\Pi_t(A_t)$

- Optimality: use up all permits in any islands where

$$p^*(A_t, U_t, U_{t+1}, \ldots) \geq \text{price of material}$$

- House price increasing in $A_t \Rightarrow$ cutoff rule. Let A_t^* such that

$$p^*(A_t^*, U_t, U_{t+1}, \ldots) = \text{price of material}$$

$$\begin{aligned} \text{construction} &= \Pi_t(A_t) \quad \text{if} \quad A_t > A_t^* \\ \text{construction} &= 0 \quad \text{otherwise} \end{aligned}$$

market clearing

- Construction material market,

$$\int_{A_t^*}^{\infty} \Pi_t(A_t) g_t(A_t)\, dA_t = M$$

market clearing

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$$\int_{A_t^*}^{\infty} \Pi_t(A_t) g_t(A_t)\, dA_t = M$$

- Housing market in each island,

$$H_t(A^t, H_0) = (1-\delta) H_{t-1}(A^{t-1}, H_0) + \Pi_t(A_t) \mathbb{I}_{\{A_t > A_t^*\}}$$

$$n_t(U_t, A^t, H_0) h^*(A_t, U_t) = H_t(A^t, H_0)$$

market clearing

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$$n_t(U_t, A^t, H_0) h^*(A_t, U_t) = H_t(A^t, H_0)$$

- Labor market,

$$\int n_t(U_t, A^t, H_0) g_t(A^t, H_0)\, dA^t dH_0 = 1$$

some results

- An efficient procedure for computations
- Existence
- Uniqueness
- Convergence to a steady-state
- Efficiency

calibration exercise

- Pick parameters

  So that the steady-state matches features of 1975 US data

- Change parameters to mimic

  increase in wage dispersion (scenario 1)

  or increase in regulation (scenario 2)

  or both at the same time

- Calculate the transition towards the new steady-state:

  Do we match US data in 2004?

calibration: preference

- Time discount factor $\beta = .95$ (Cooley & Prescott, 1995)

- Utility over housing services $v(h) = \kappa \frac{h^{1-\gamma}}{1-\gamma}$

  κ: match housing expenditure to labor income ratio of 0.12 (Census)

  price elasticity of housing demand $-1/\gamma = -0.5$ (Hanushek & Quigley, 1980)

calibration: wage per job

- Cross-section: $\log(A_t) = a_t \sim \mathcal{N}(\mu_a, \sigma^2_{at})$
- Time series: $a_t = (1-\rho_a)\mu_a + \rho_a a_{t-1} + \sigma_{\varepsilon t}\,\varepsilon_t$
- LLN: $\sigma^2_{at} = \rho^2_a \sigma^2_{at-1} + \sigma^2_{\varepsilon t}$.
- Cross-sectional mean $\mu_a = \log(15) + \log(1.25)$

  average real wage per job is $15,000$ (BEA, REIS)

  average 1.25 jobs per household (Census)

- Persistence: pooled OLS regression, $\rho_a = .99$ (.0008)
- Initial distribution: stationary, pick $\sigma^2_{\varepsilon,0}$ to match CV of A in 1975

calibration: construction

- Depreciation: $\delta = 0.016$ (BEA fixed asset tables)

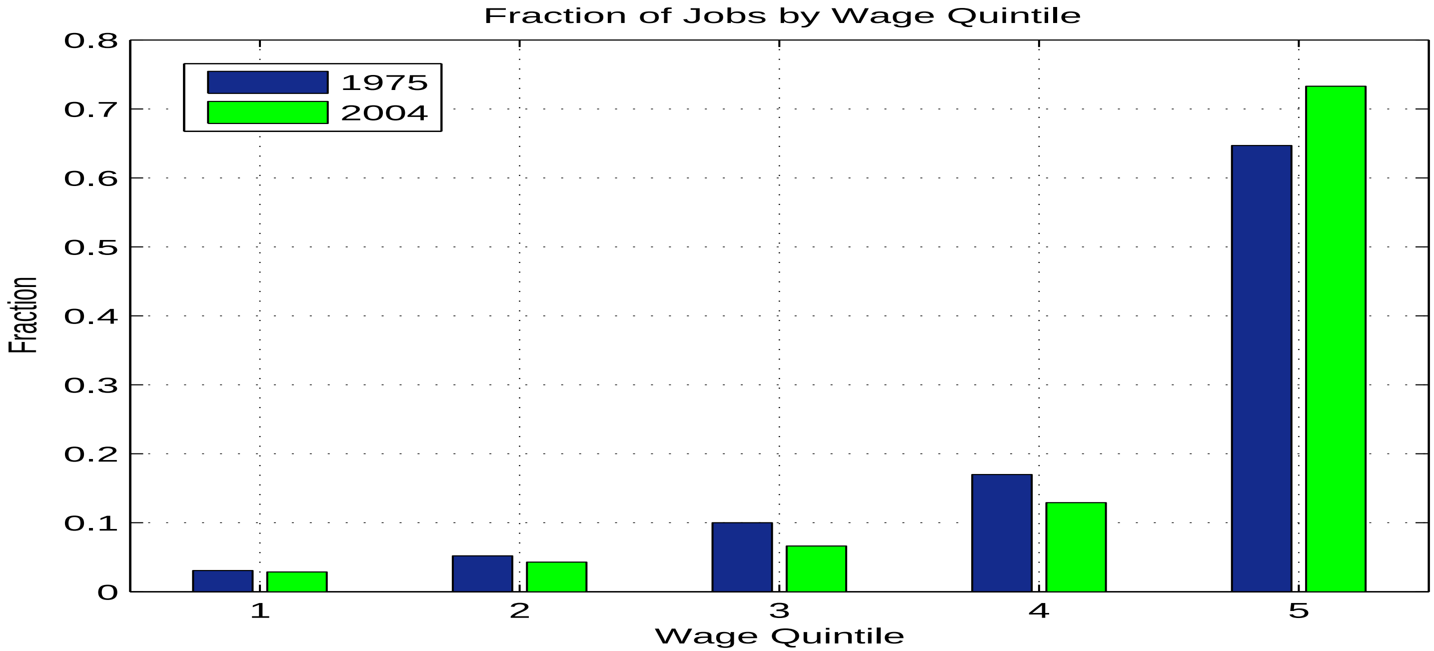
- New construction: $M = 0.03$, because

$$\begin{aligned} M/\delta &= \text{per-capita housing supply} \\ &= \text{average size of a house in the US} \\ &= 1.875 \text{ thousands of square feet (Census)} \end{aligned}$$

- $\Pi(A) = \bar{\Pi}$: match one feature of 1975 data:

  concentration of jobs in high wage regions

calibrating 1975 housing supply regulation



- In 1975: $\Pi(A) = \bar{\Pi}$ governs

  distribution of housing stock across wage quintiles

  distribution of households across wage quintile

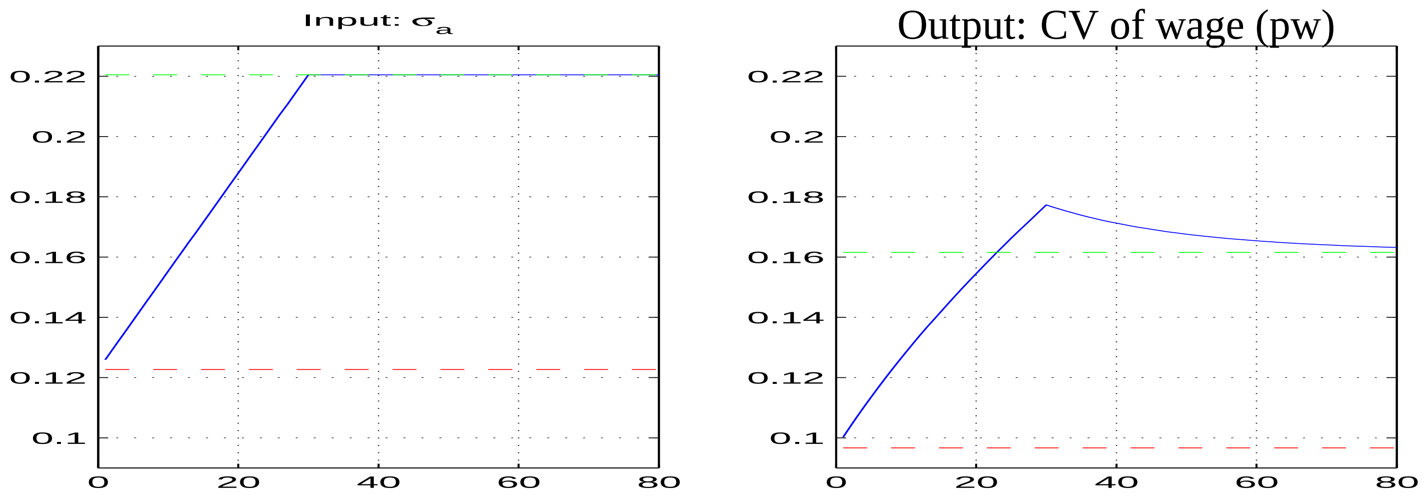
$\Rightarrow$ gets the right number of jobs in highest wage quintile

scenario 1: increase in wage dispersion

- Log wage $a \sim \mathcal{N}(\mu_a, \sigma^2_{a,t})$
- Increase $\sigma_{a,t}$ from 0.127 to 0.220 over 30 periods.

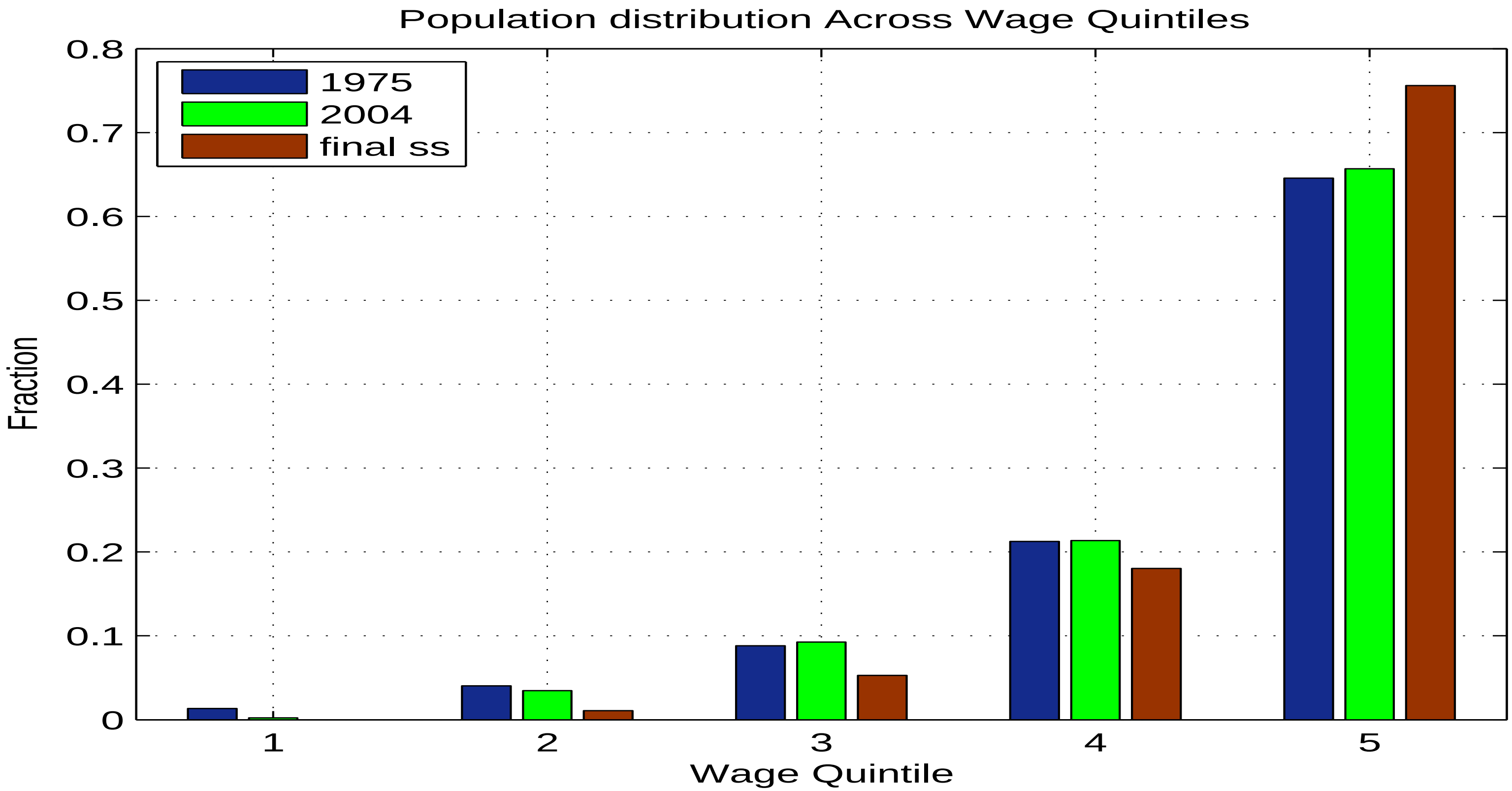
  Through increase in innovation variance σ^2_ε

  Wage variance σ^2_a constant after 2004
- This matches increase in CV of A between 1975 and 2004.



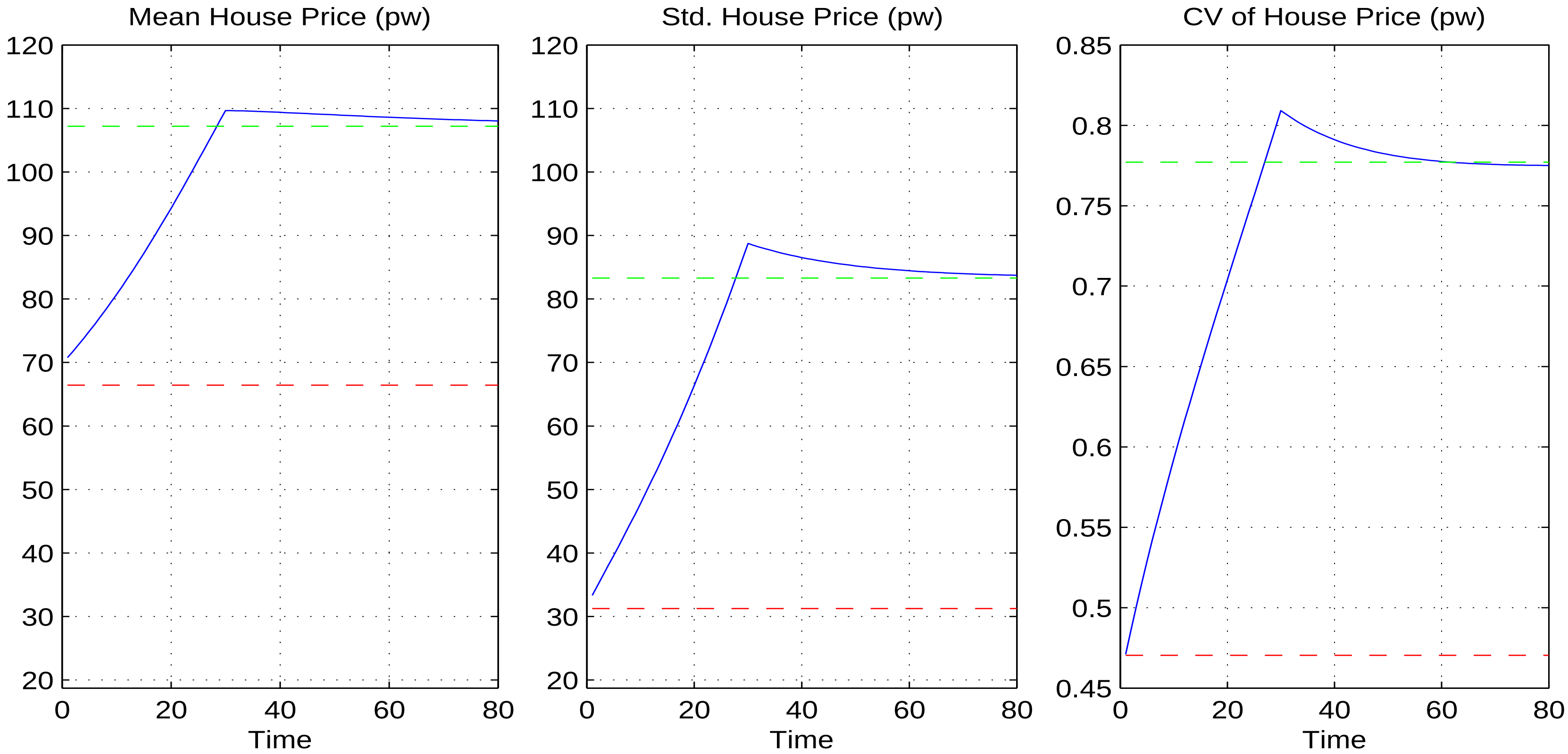
scenario 1: population distribution

- Increase in wage dispersion concentrates households
- Fraction in Q5: +1.1% (in 2004) and +11% in new steady state
- Data: +8.5%



scenario 1:house price dispersion

- Large increase in house prices: 47.9% (50% until 2004)
- Large increase in house price st.deviation: 98% (104%)
- CV increases by 0.35 in 30 years, just as in data

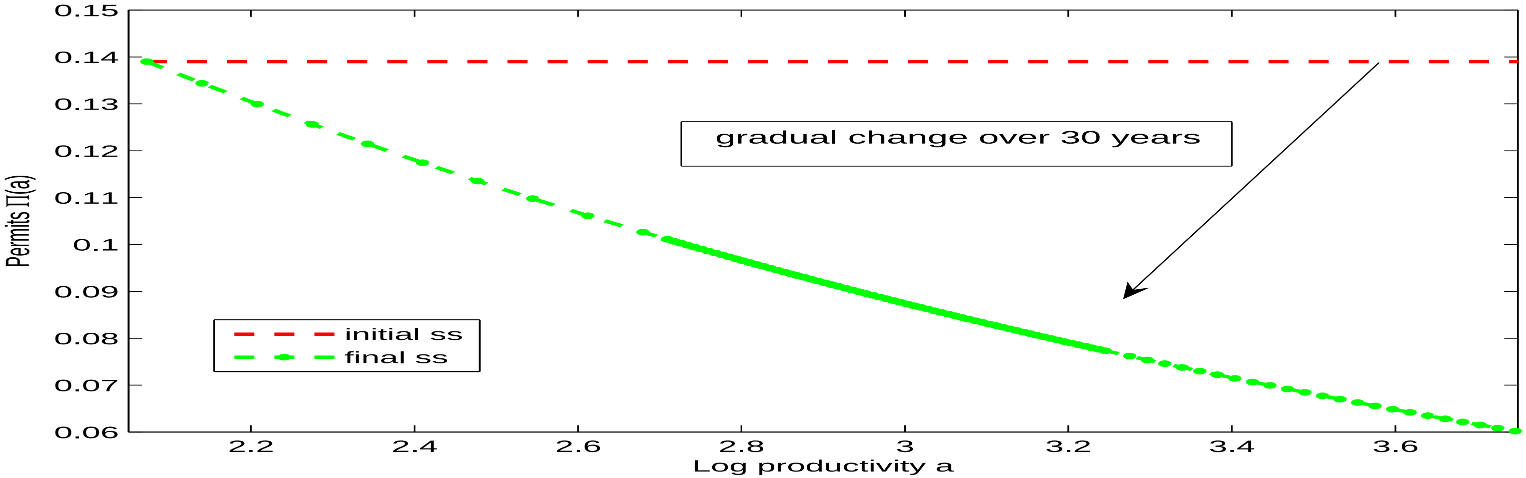


scenario 2: increase in regulation, constant dispersion

- Tighter regulation: $\Pi(A) = \bar{\Pi}\,(A/\underline{A})^{\phi}$
- Gradual decrease in $\phi : 0 \rightarrow -.5$ captures:

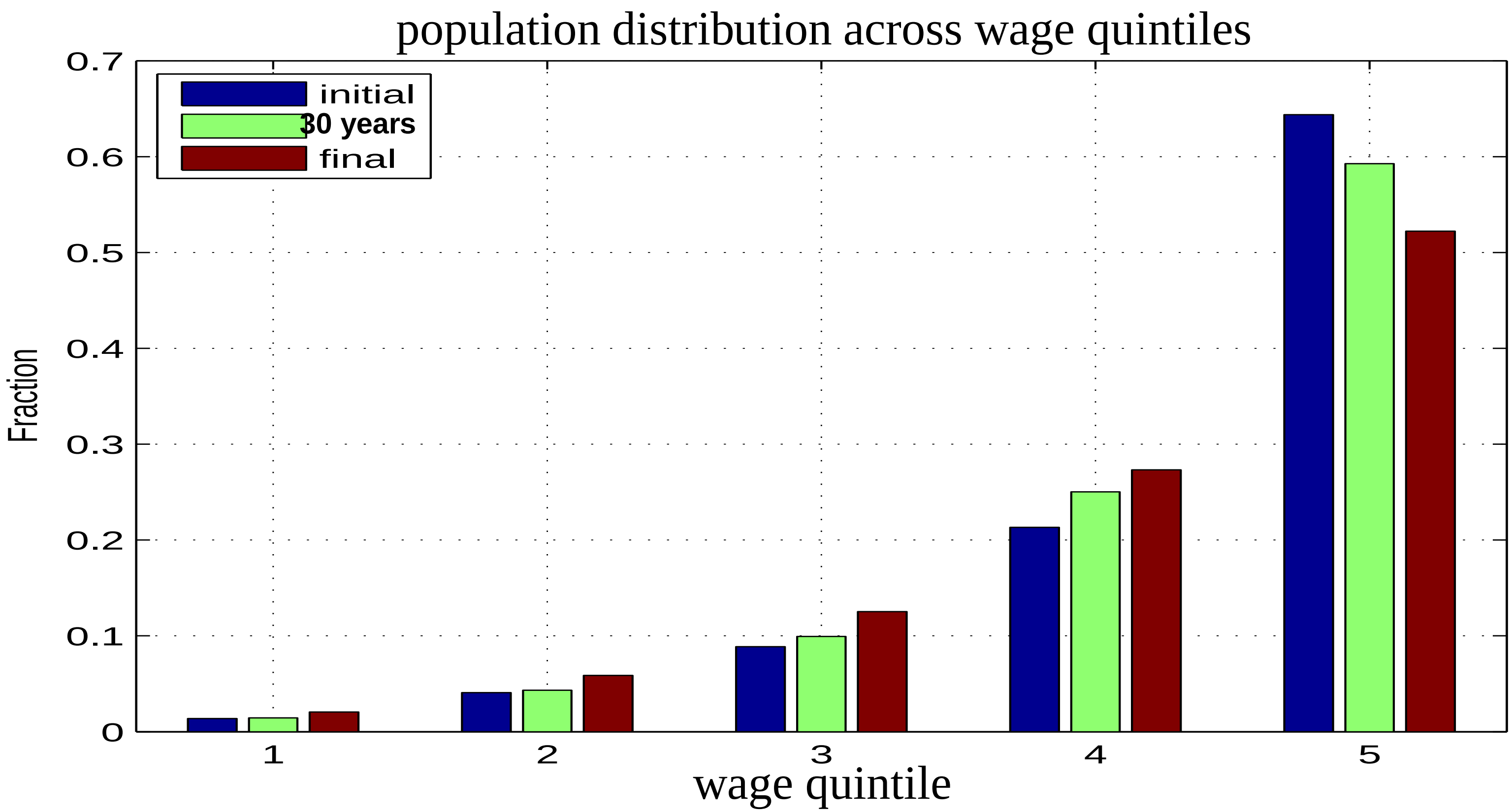
  tighter regulation over time
  tighter regulation in more productive regions

- Transition takes 30 years (1975-2004), $\phi = -.5$ after 2004.



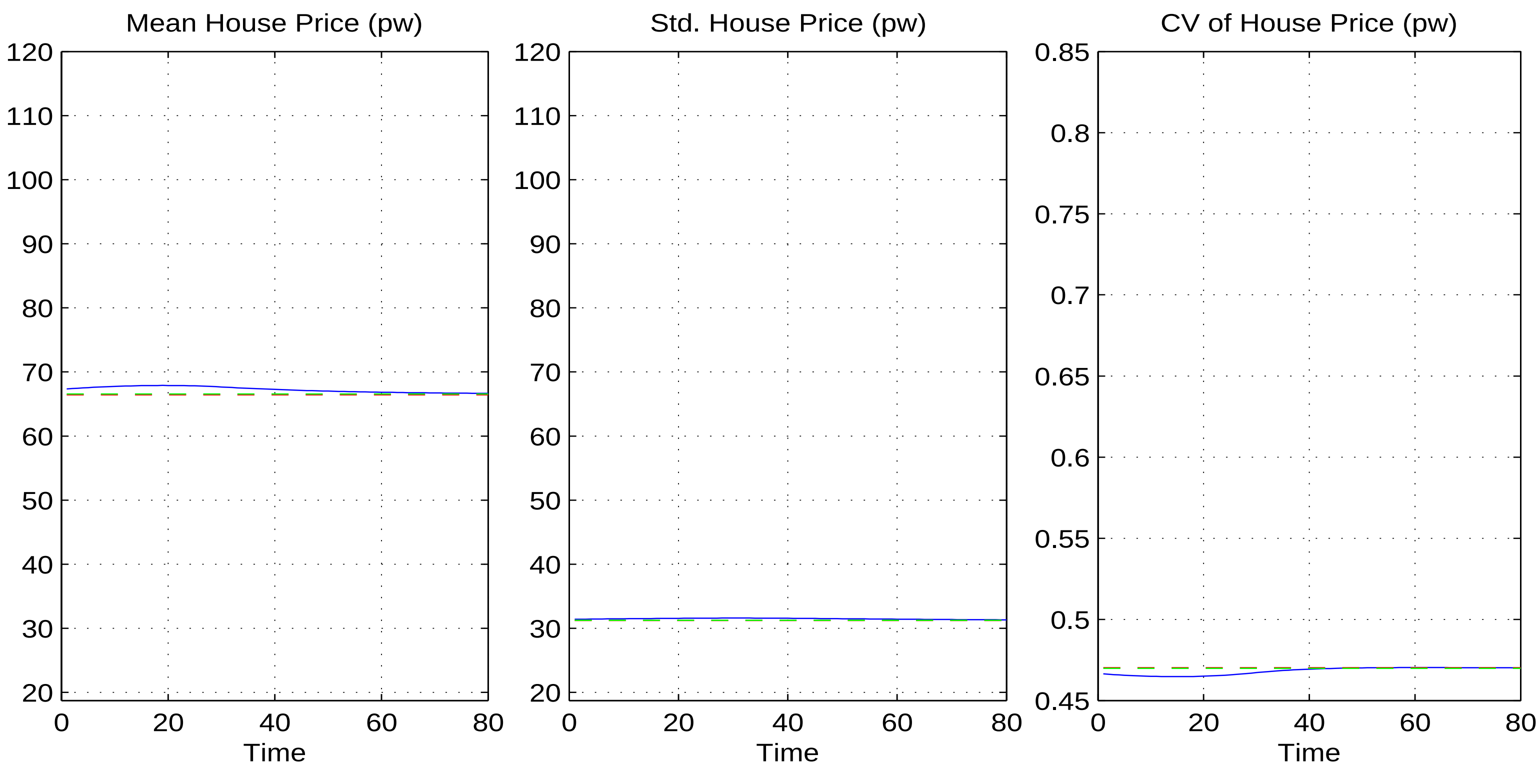
scenario 2: population distribution

- Increase in regulation spreads people out
- Fraction in Q5 decreases by 12.3% (9.7% until 2004)



scenario 2: house price dispersion

- Tiny increase in house prices: .2% (1.9%)
- Tiny increase in house price st.deviation: .1% (1.2%)
- Dispersion level is too low and flat



welfare

- How large are the welfare effects of housing supply regulation?
- Answer: when increasing wage dispersion is taken into account, they are substantial

welfare

- Flow utilitarian welfare

$$w_t = \int n_t(A^t, H_0)\Big(A_t + v\left(h_t\left(A^t, H_0\right)\right)\Big)g_t(A^t, H_0)\, dA^t\, dH_0.$$

w_{2004} is 1.9% lower than if regulation had stayed at 1975 level
w_{st-st} is 5% lower than if regulation had stayed at 1975 level

conclusion: what about

- excessive mobility

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  even though labor is free to move

  migration rates in model are low (high persistence of wage)

  even too low compared to Census data

conclusion: what about

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- reverse causality from home prices to wages

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- excessive mobility
- reverse causality from home prices to wages

    2 types of workers: local industry and local service workers

    local productivity goes up

$\Rightarrow$ house prices go up

$\Rightarrow$ wages of service workers go up to keep them from moving

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- excessive mobility
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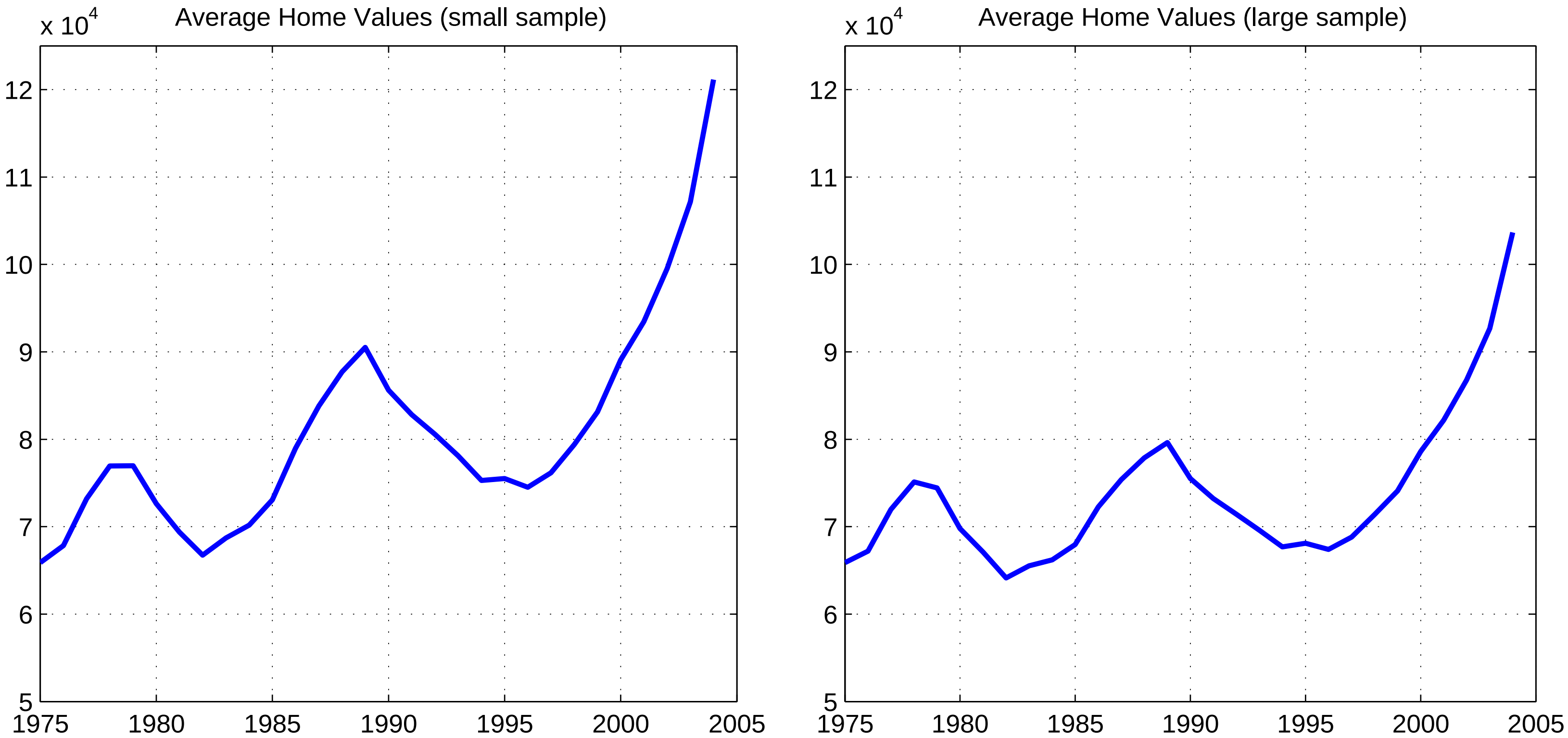
  convexity effect goes through

  richer SDF: asset pricing with durable goods

  e.g. Brunnermeier and Julliard (06), Piazessi, Schneider, and Tuzel (06), Lustig and Van Nieuwerburgh (06), and many others

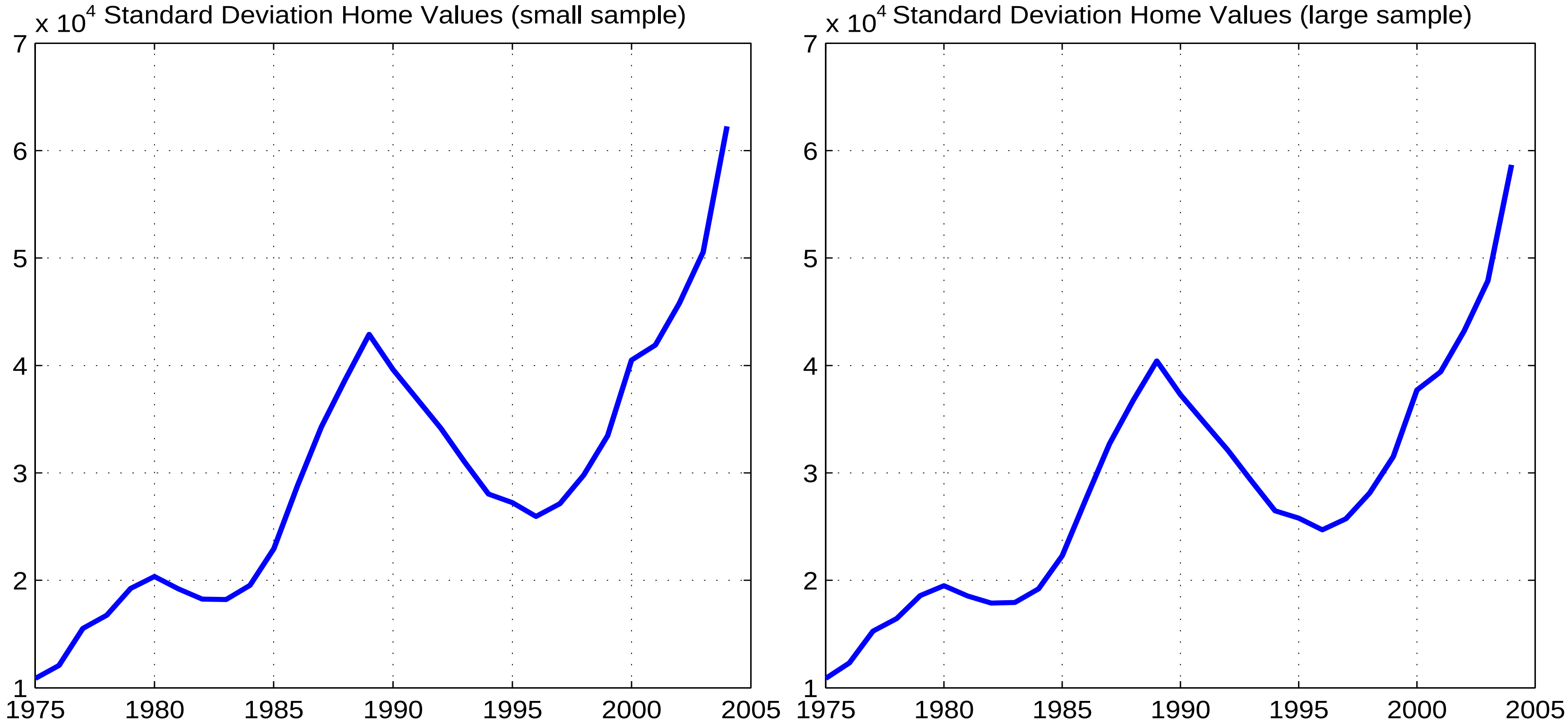
data: mean house price increases

Real house prices went up by 1.46% per year on average



data: standard deviation of house price increases

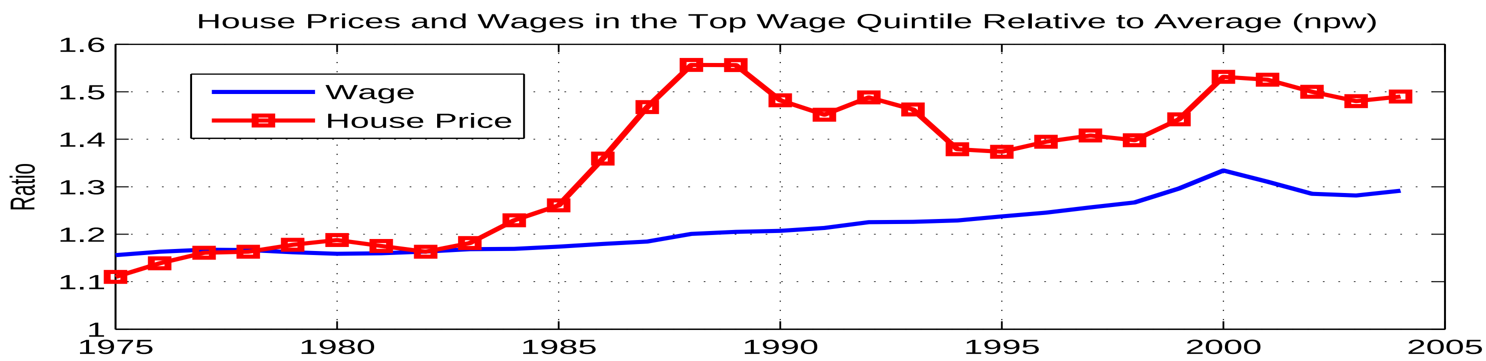
Cross-sectional standard deviation of real house prices increases by factor of 5-6.

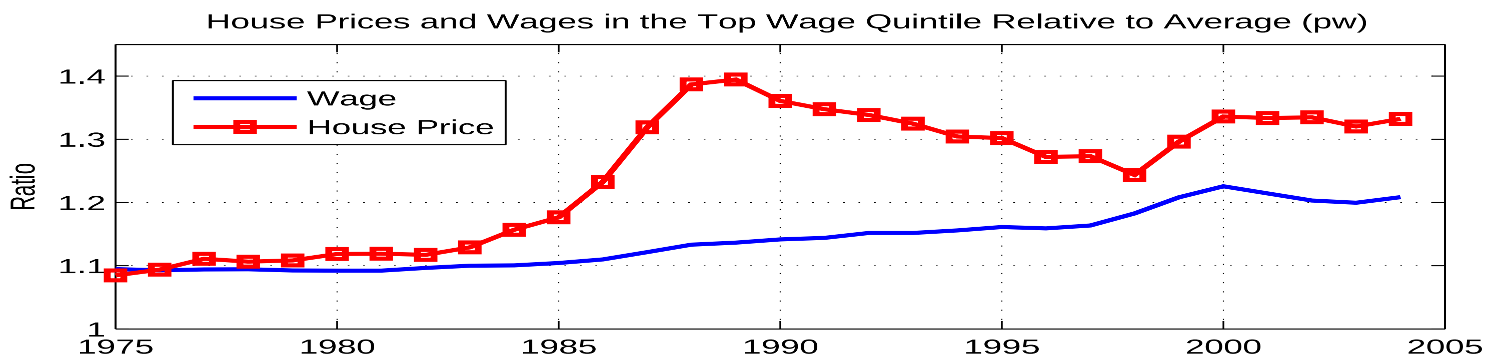


another look at the basic fact

Define wage quintiles in each year and plot $\dfrac{\text{median wage in Q5}}{\text{median wage overall}}$

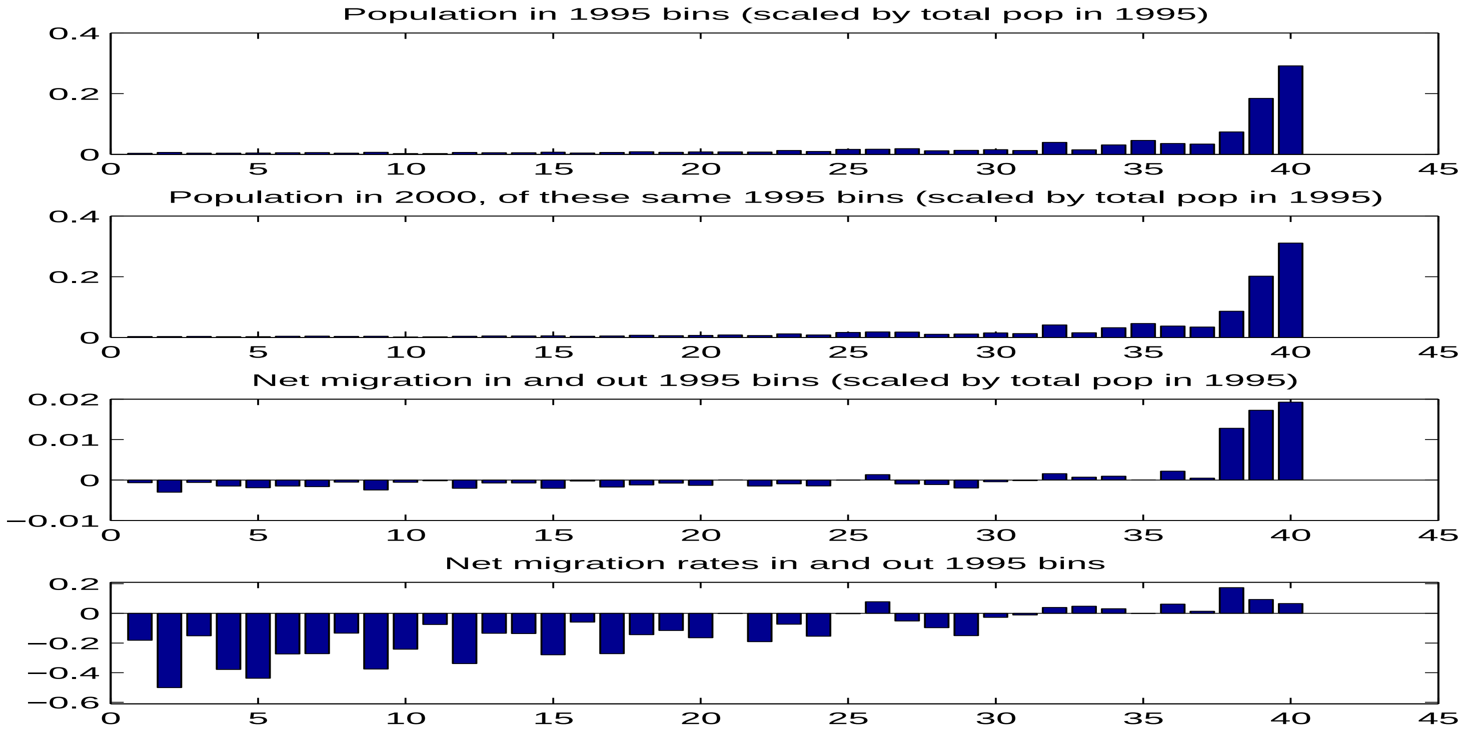
and $\dfrac{\text{median house price in Q5}}{\text{median house price overall}}$





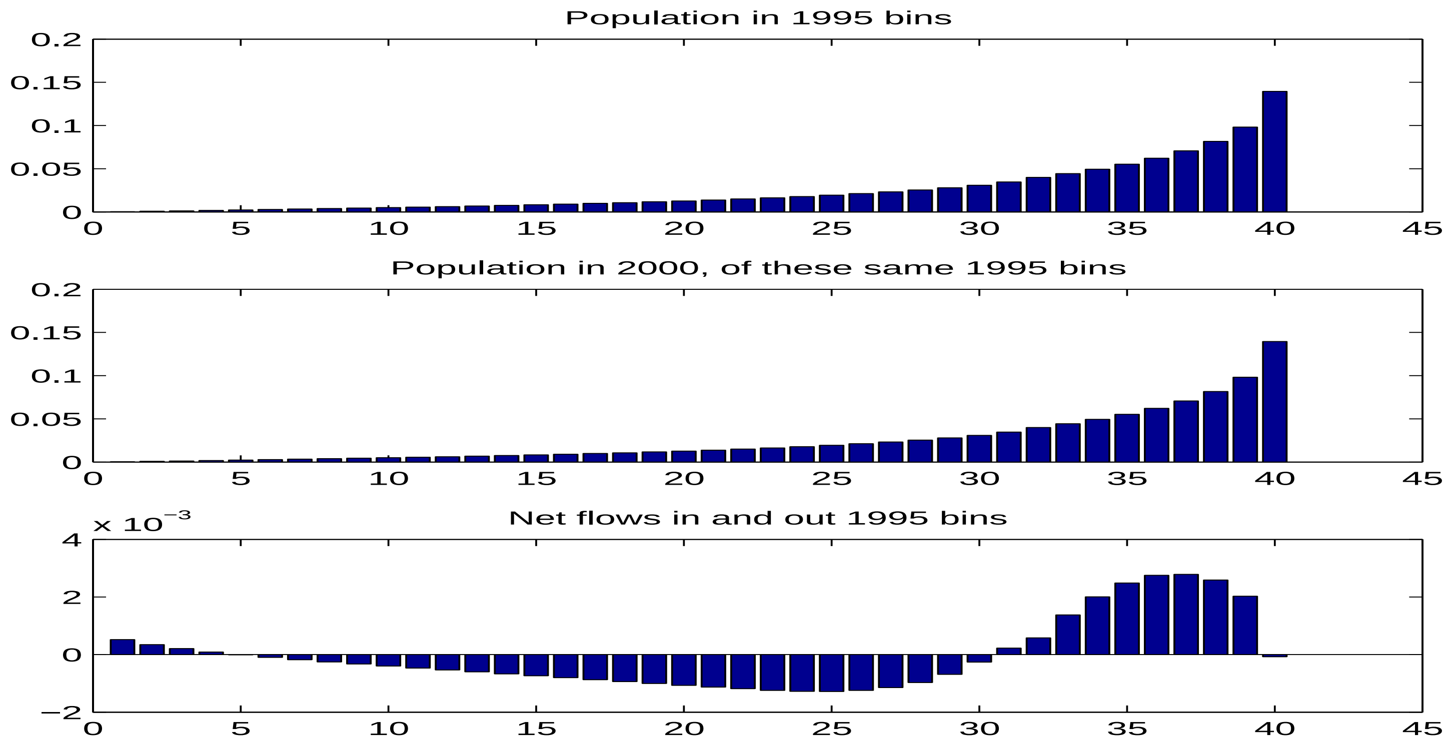
mobility in the data - 40 wage bins in 1995

- Focus on young (25-39), college-educated singles: most likely to move for productive reasons (most similar to agents in our model)
- Census data: in-migration and out-migration between 1995 and 2000



mobility in the model - 40 wage bins in 1995

Most productive areas see large inflows



solving for an equilibrium

- Find the sequence $\{A_t^*\}_{t=1}^{\infty}$ of construction cutoffs using construction material market clearing

- Solve for the distribution of housing stock at each time using

$$H_t(A^t, H_0) = (1-\delta)H_{t-1}(A^{t-1}, H_0) + \Pi_t(A_t)\mathbb{I}_{\{A_t > A_t^*\}}$$

solving for an equilibrium

- Find $\{A_t^*\}_{t=1}^{\infty}$ and solve for $H_t(A^t, H_0)$
- Solve for the distribution $n_t(A^t, H_0)$ of households in three steps

1. indifference condition: $h_t^*(A_t, U_t)$
2. local housing market clearing:
   $n_t(A^t, H_0) = H_t(A^t, H_0)/h_t^*(A_t, U_t)$
3. labor-market clearing:
   $\int H_t(A^t, H_0)/h_t^*(A_t, U_t) g_t(A^t, H_0)\, dA^t dH_0 = 1$

   $\longrightarrow$ one equation in the one unknown U_t

   $\Rightarrow n_t$ increasing in A_t and H_t

some results

- First welfare theorem holds

  the allocation of housing and labor is Pareto optimal (subject to regulatory constraints)

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- Under regularity and stationarity, convergence to a steady-state

  steady-state utility U^* of moving and cutoff A^*

  steady-state price function $p^*(A_t)$

  steady-state distribution of (A_t, H_t) under boundedness conditions
  (otherwise convergence of some moments)

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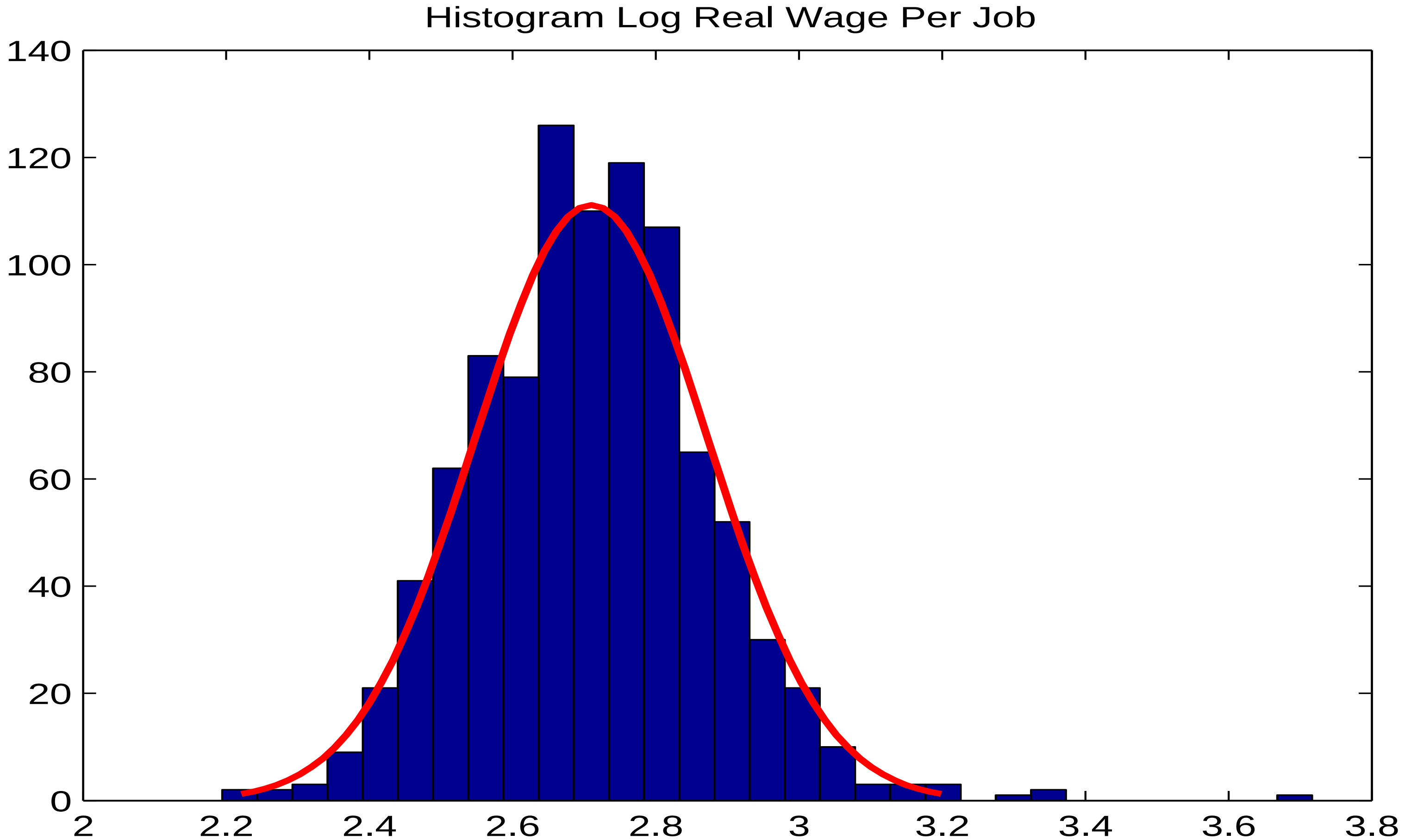
- Approximation: increase in wage dispersion
  $\Rightarrow$ higher average rent and higher CS variation in rent

calibrating initial wage distribution



regulation differs by region

Raven Saks (2005) compiles index of housing supply regulation

based on 6 sources of data

mean 0, standard deviation 1

- Top 10 most regulated: New York (2.2), San Francisco (2.1), Sacramento (1.9), Charleston (1.8), Riverside-San Bernardino (1.7), San Jose (1.65), San Diego (1.6), Santa Barbara (1.5), Seattle (1.5), Gary (1.2)
- Top 5 least regulated: Bloomington (-2.4), Buffalo (-2), Nashville (-1.6), Owensboro (-1.5), Joplin (-1.5)

what is an island?

It's a Core-based Statistical Area = central county or counties containing the core, plus adjacent outlying counties having a high degree of social and economic integration with the central county as measured through commuting.

(OMB definition Dec 2005, based on Census 2000)

Example: New York-Northern New Jersey-Long Island, NY-NJ-PA Metropolitan Statistical Area

Edison, NJ Metropolitan Division: Middlesex County, NJ, Monmouth County, NJ, Ocean County, NJ, Somerset County, NJ

Nassau-Suffolk, NY Metropolitan Division: Nassau County, NY, Suffolk County, NY

New York-White Plains-Wayne, NY-NJ Metropolitan Division: Bergen County, NJ, Hudson County, NJ, Passaic County, NJ, Bronx County, NY, Kings County, NY, New York County, NY, Putnam County, NY, Queens County, NY, Richmond County, NY, Rockland County, NY, Westchester County, NY

Newark-Union, NJ-PA Metropolitan Division: Essex County, NJ, Hunterdon County, NJ, Morris County, NJ, Sussex County, NJ, Union County, NJ, Pike County, PA

- For the 11 CBSAs with metropolitan divisions, we use those.

summary: increasing wage dispersion

- Fix the housing supply regulation ($\log(\bar{\Pi}) = .139$ and $\phi = -.5$)
- Compare final steady state and situation after 30 years in the economy with an increase in dispersion to benchmark economy with no increase

Experiment:	$\sigma_\varepsilon \uparrow, \bar{\sigma}_\varepsilon$		*Benchmark*: $\sigma_\varepsilon \uparrow, \bar{\sigma}_a$		$\rho_a \uparrow$	
Moment	st-st	30 years	st-st	30 years	st-st	30 years
Output	36.41	12.25	13.82	12.26	19.58	4.73
Pop. in Q5	20.13	0.94	8.62	0.97	16.01	-23.24
Mean HP	120.40	56.12	45.32	49.74	52.72	10.42
Std HP	207.10	107.02	96.33	104.10	124.19	56.25
Mean HP/CC	175.45	49.30	65.29	55.30	134.34	22.65
Welfare	5.85	3.12	4.71	3.13	2.71	0.90

summary: tightening housing supply regulation

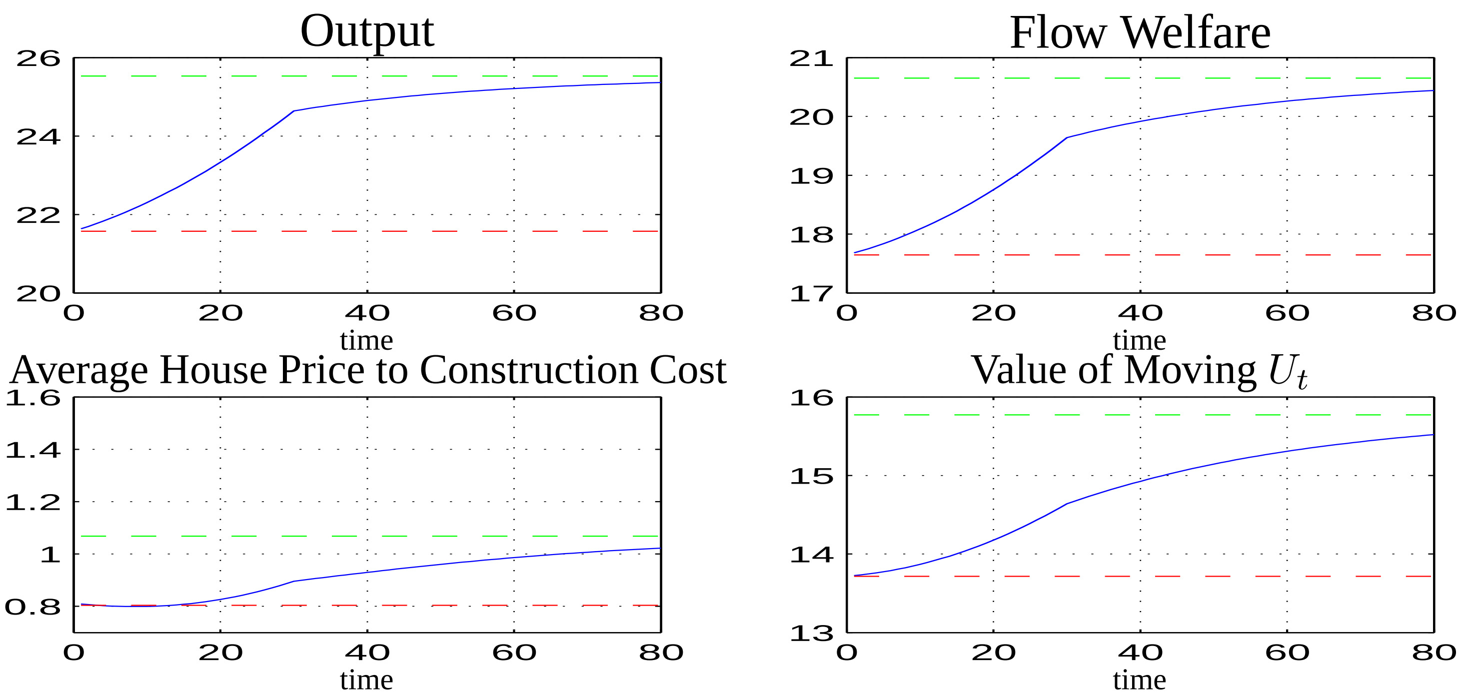
- Fix the increase in wage dispersion
- Scenario C (regulation) minus scenario B (no regulation), both in steady state and after 30 years

Experiment:	$\phi = -.7$		*Benchmark*: $\phi = -.5$		$\phi = -.3$	
Moment	st-st	30 years	st-st	30 year	st-st	30 years
Pop. in Q5	-20.53	-7.20	-14.69	-5.29	-8.65	-3.23
Output	-7.79	-2.62	-5.57	-1.91	-3.33	-1.17
Pop. in Q5	-20.53	-7.20	-14.69	-5.29	-8.65	-3.23
Mean HP	-2.83	2.55	-2.33	1.46	-1.61	0.66
Std HP	-1.83	1.74	-1.61	0.90	-1.15	0.32
Mean HP/CC	33.30	61.45	22.10	41.30	12.54	23.46

- Log difference times 100

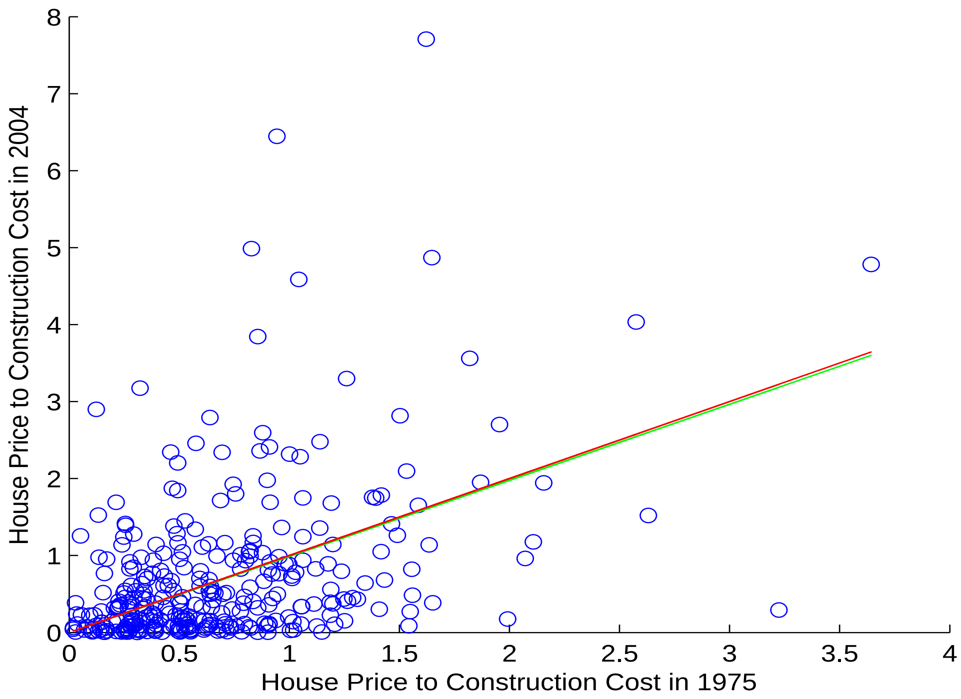
scenario 1: aggregate output

- Output increases 17% between steady-states (13% until period 30)
- Max attainable utility of extra person increases 14% (6.5%) (8.7%)
- Average house price over construction cost increases 28% (11%)



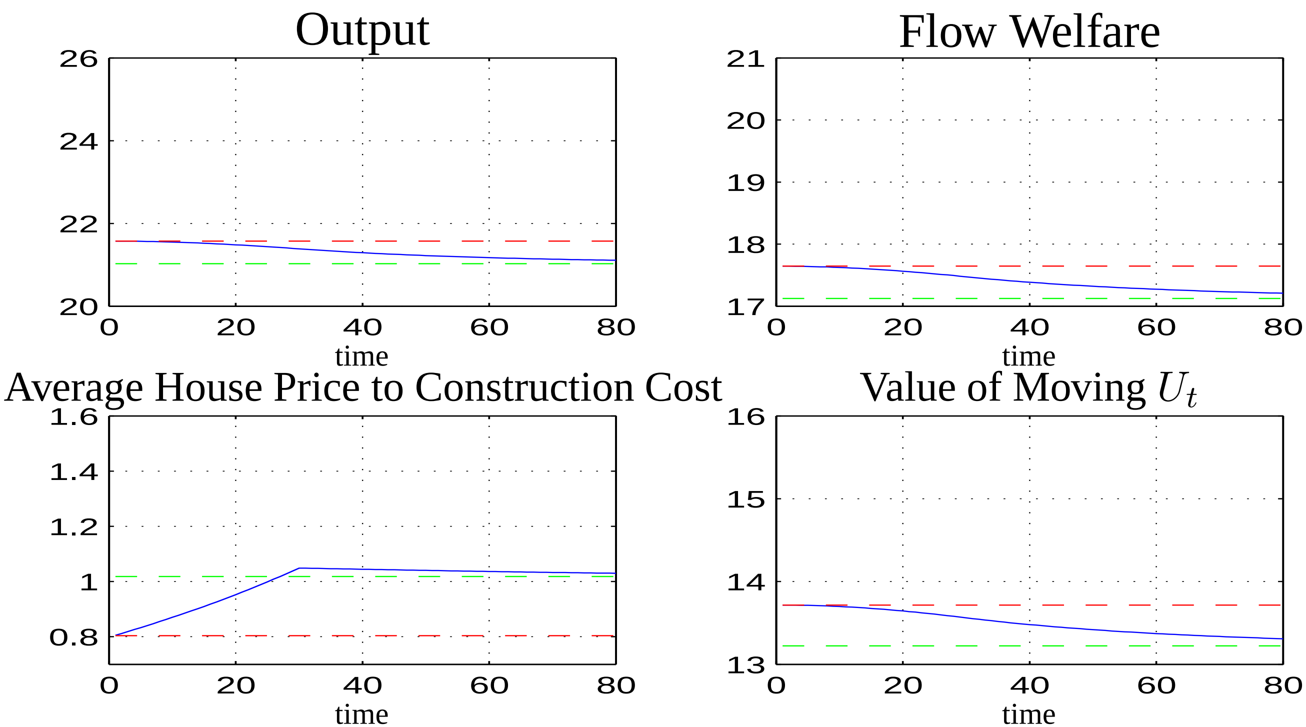
scenario 1: House Price to Construction Cost Ratio

- Mimic GGS exercise
- The ratio, or “regulation share”, constant over time. Slope is 0.99...
- ... but population-weighted average goes up by 35%



scenario 2: aggregate output

- Output falls 2.6% between steady-states (0.9% until period 30)
- Max attainable flow utility U_t decreases 3.7% (1.1%)
- House price over construction cost increases 24% (27%)



scenario 2: house price to construction cost ratio

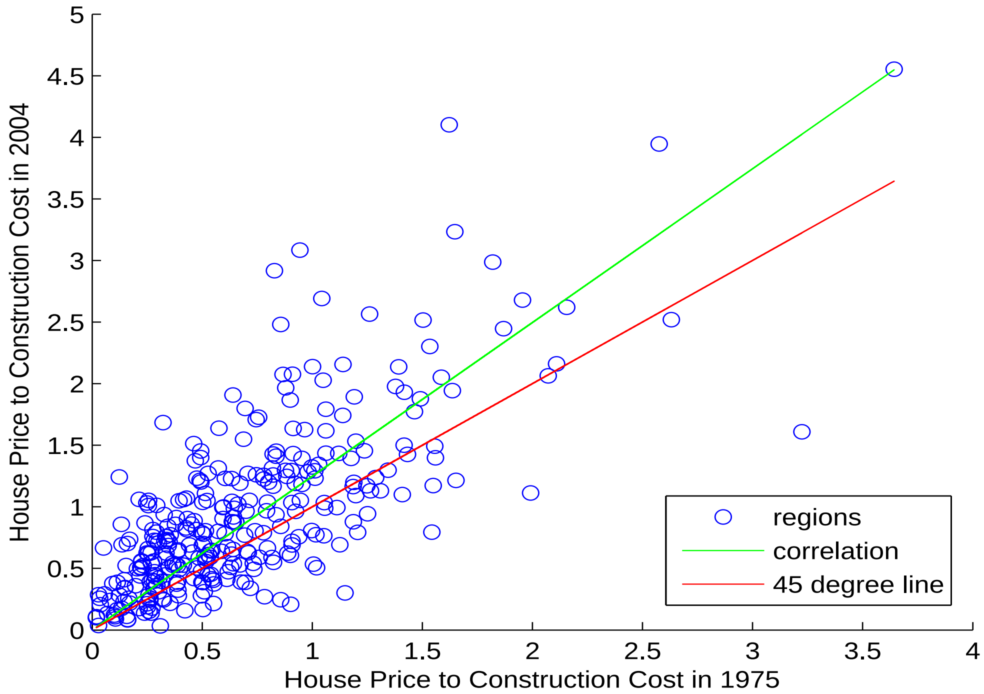
- Mimic GGS exercise

  Draw 322 regions from 1975 stationary distribution

  Follow them until 2004

  Plot 2004 ratio against 1975 ratio

- The ratio, or "regulation share", increases over time. Slope is 1.25.



scenario 3: increasing regulation and dispersion

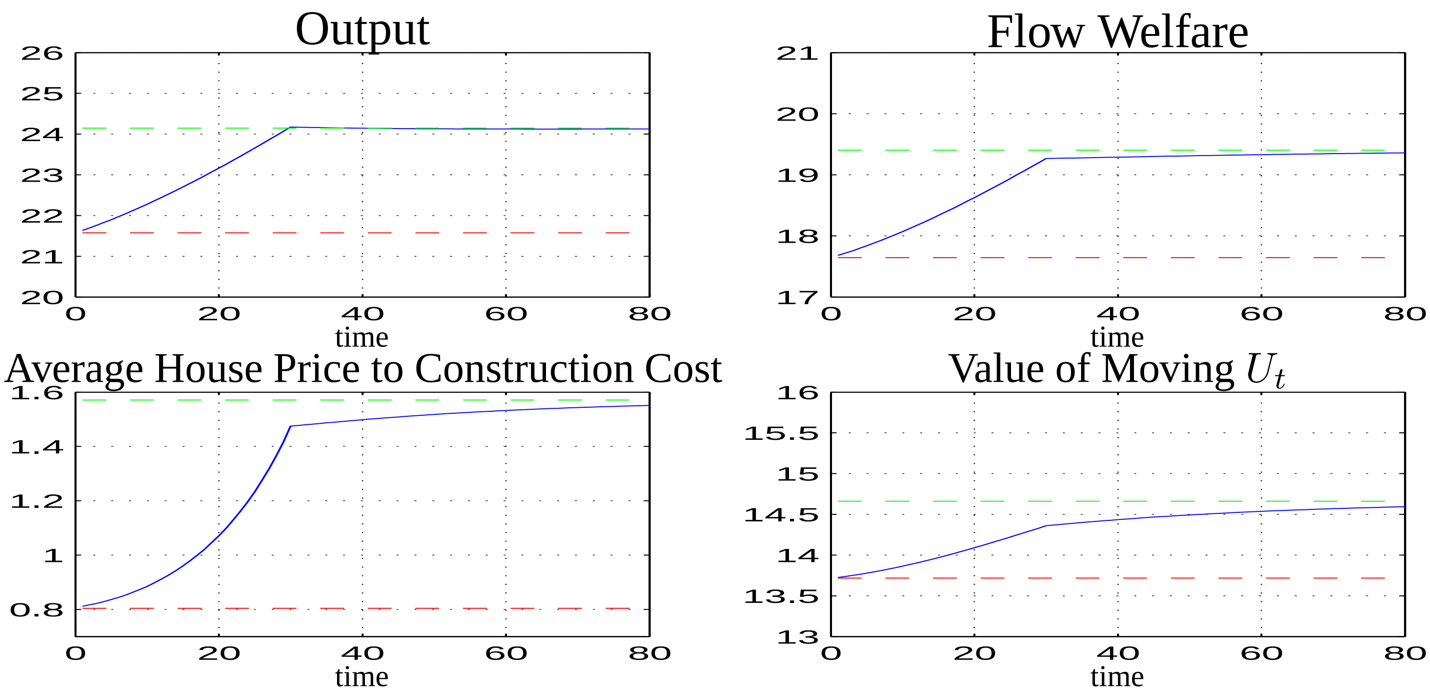
Two forces work in **o**pposite directions for:

- Population in Q5: -3.6% (-4.2%)

- House price: Large increase in house prices: 46% (52%) and in the standard deviation: 96% (105%) $\Rightarrow$ C.V. increases by 0.35 in 30 years.

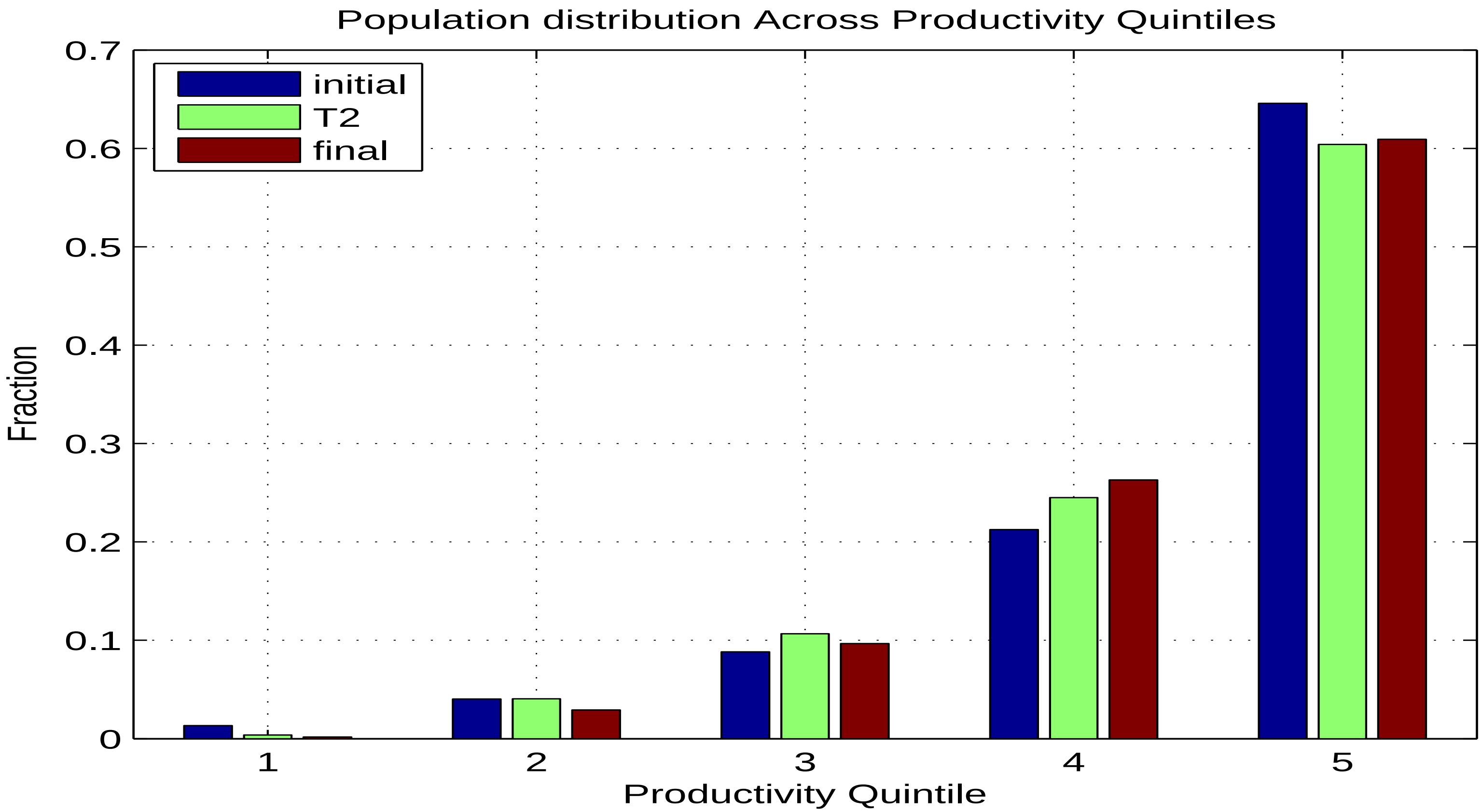
Scenario 3: output

- Output increases 11% between steady-states (11% until period 30)
- Max attainable utility increases 6.7% (4.6%)
- Average price over construction cost increases 67% (61%)



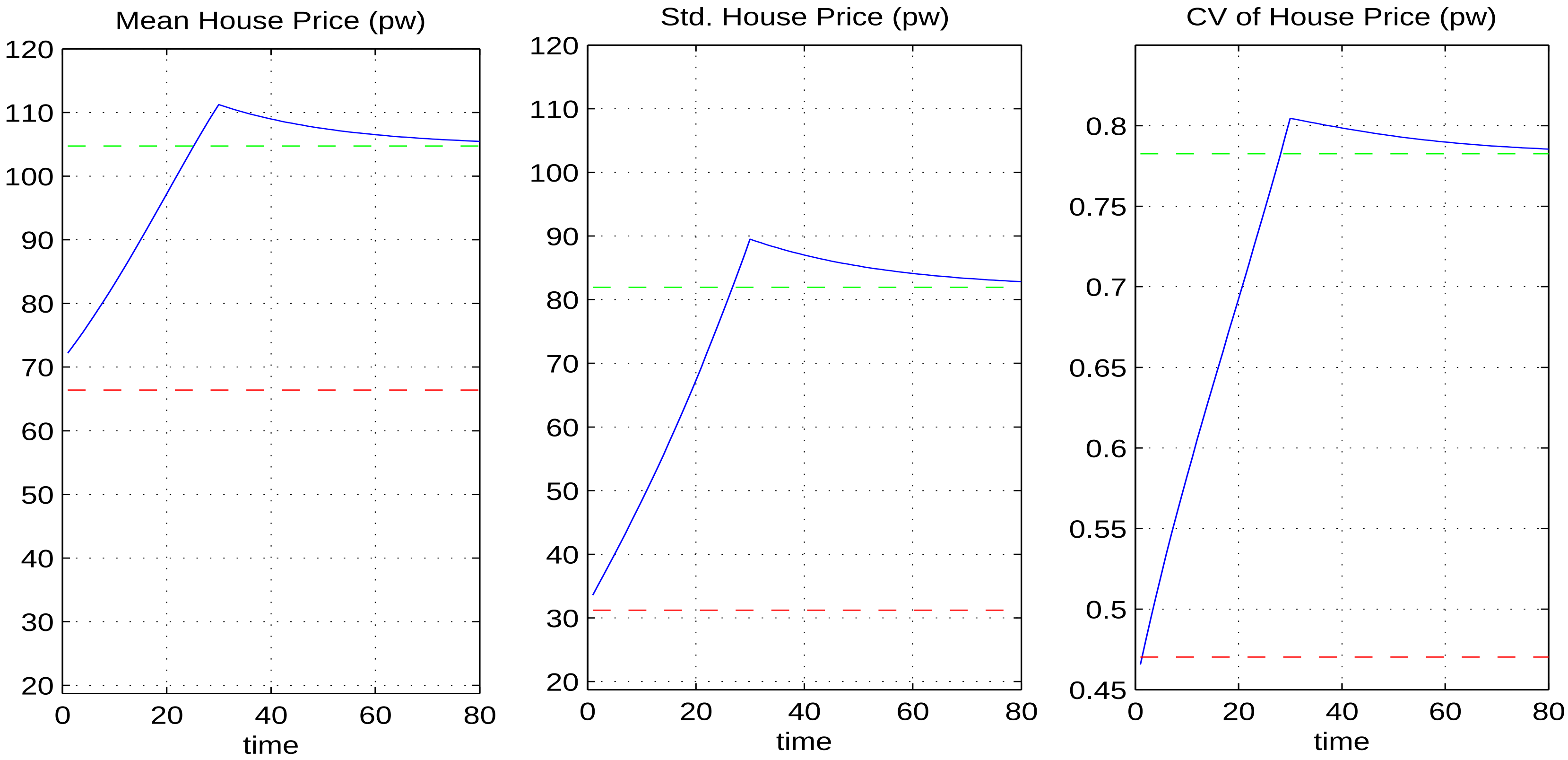
Scenario 3: population distribution

- Two forces work in opposite direction.
- Net effect on fraction in Q5: -3.6% (-4.2%)



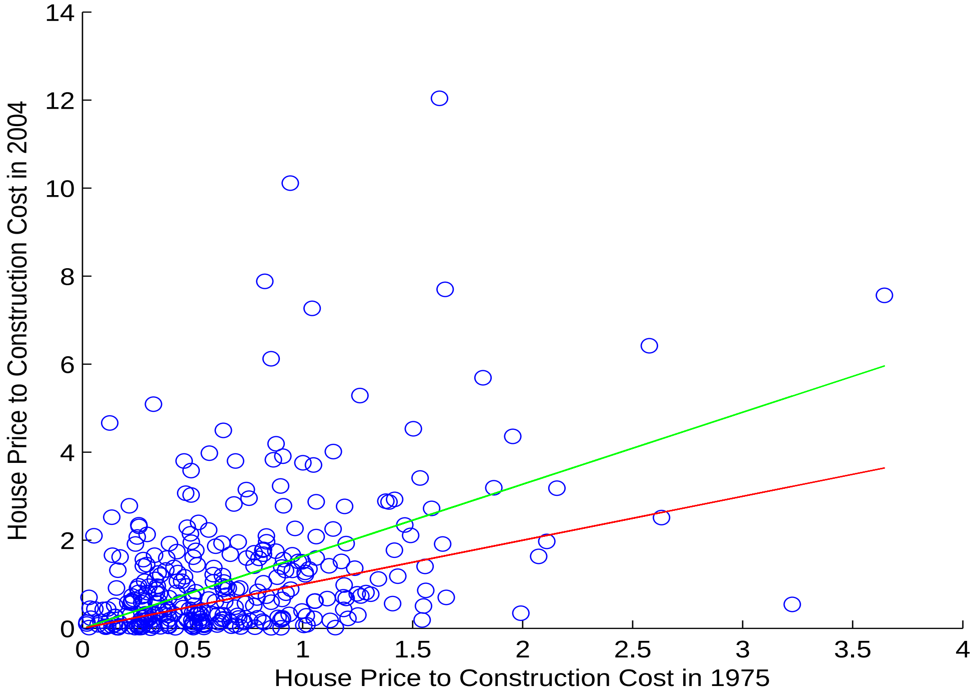
Scenario 3: house price dispersion

- Large increase in house prices: 46% (52%)
- Large increase in house price st.deviation: 96% (105%)
- Dispersion level increases by 0.35 in 30 years!



Scenario 3: house price to construction cost ratio

- Mimic GGS exercise
- The ratio, or “regulation share”, increases over time. Slope is 1.64.
- Pop-weighted average HP/CC increases by 77% (77%)



welfare table

- PV welfare comparison: $\sum_{t=1975}^{2004/st-st} \beta^{t-1} w_t$

Experiment:	$\phi = -.7$		*Benchmark*: $\phi = -.5$		$\phi = -.3$	
	st-st	30 years	st-st	30 years	st-st	30 years
$\sigma_\varepsilon \uparrow$, $\bar{\sigma}_\varepsilon$	-1.52	-0.22	-1.03	-0.08	-0.56	-0.02
Benchmark: $\sigma_\varepsilon \uparrow$, $\bar{\sigma}_a$	-1.49	-0.48	-1.06	-0.33	-0.64	-0.19
$\rho_a \uparrow$	-1.74	-0.41	-1.24	-0.27	-0.75	-0.15

conclusions and extensions

- Increase in wage dispersion

  induces reallocation towards more productive regions

  can quantitatively account for rise in house price dispersion and level

  captures that this rise is situated in the non-structure component

- While baseline level of regulation is important, *increase in regulation* is not sufficient to explain house price changes

- Extensions

  Congestion externalities: optimal taxation/regulation

  Heterogeneity within the region

  House pricing with more realistic SDF

household's problem

$$\text{Island}\,(A^t, H_0) \quad : \quad u_t(A^t, H_0) = A_t + \max_h \left\{ v\,(h) - \rho_t(A^t, H_0) h \right\}$$

$$\text{Best island} \quad : \quad U_t = \max_{(A^t, H_0)} u_t(A^t, H_0)$$

household's problem

$$\text{Island } (A^t, H_0) \quad : \quad u_t(A^t, H_0) = A_t + \max_h \left\{ v(h) - \rho_t(A^t, H_0) h \right\}$$

$$\text{Best island} \quad : \quad U_t = \max_{(A^t, H_0)} u_t(A^t, H_0)$$

$\Rightarrow$ Optimal location:

Let $n_t(A^t, H_0)$ be the number of households in island (A^t, H_0)

$$\text{if} \quad n_t(A^t, H_0) > 0 \quad \text{then} \quad u_t(A^t, H_0) = U_t$$

$$\text{if} \quad n_t(A^t, H_0) = 0 \quad \text{then} \quad u_t(A^t, H_0) \leq U_t$$