

Course in Heterogeneity and Fluctuations

III: Financial Frictions, Asset Prices, and the Great Recession

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Based on joint work with Zhen Huo

We have had a Great Recession

FACTS ON THE LAST RECESSION: OUTPUT, UNEMP, CONS, INV

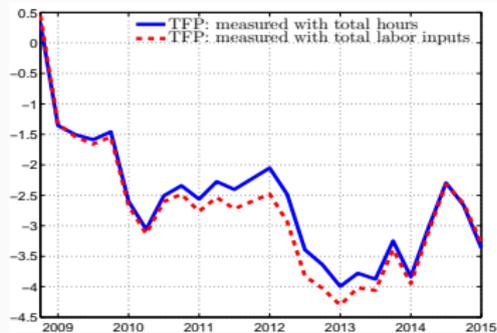
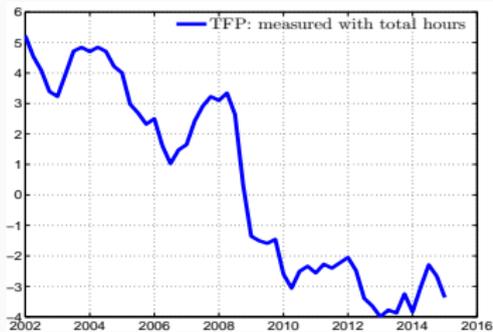


Note: Except for unemployment, figures show percentage deviation from a linear trend.

FACTS ON THE LAST RECESSION: WEALTH, MORTG, HOUSES, PR H



FACTS ON THE LAST RECESSION: PRODUCTIVITY AND LABOR QUALITY



CULPRIT: FINANCIAL SHOCKS?





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- Financing difficulties contribute to cut spending both of firms and households.
- Most of the action occurs via a demand reduction.
- Yet models have a hard time to deliver this.





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 - Production with Savings
 - A lot of wealth
 - Heterogeneity so that the financial frictions are not imposed

FINDINGS: THE ANSWER IS YES, PROVIDED THERE ARE (FROM +TO





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5. Some labor market frictions that limit wage adjustments.



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1 Model

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- Households have assets a . These assets can be allocated to (frictionless) houses and/or to financial assets with a collateral constraint. The poor will have some housing wealth and a mortgage, the rich houses and shares of the economy's mutual fund.





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- Perfect competition and frictionless markets for tradables.





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- Wages are exogenous (set to some aggregate target).





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- Positive financial assets ($b > 0$) are shares of a mutual fund.
 - Its return, r , is determined ex-post (it matters when we hit the economy with shocks). Possible capital gains and loses.

$$R(b) = \begin{cases} 1 + r, & \text{if } b \geq 0 \\ 1, & \text{if } b < 0. \end{cases}$$



$$V(\epsilon, e, a) = \max_{c_N, i, c_T, I_N, h, d} u(c_A, h, d) +$$

$$\beta \sum_{\epsilon', e', \theta'} \Pi_{\theta, \theta'}^\theta \Pi_{e'|e, \epsilon}^w \Pi_{\epsilon, \epsilon'} V[\epsilon', e', a'(b, h)] \quad \text{s.t.}$$



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- The firm has to make sure that it can satisfy the demand at all locations.



$$\Omega^N(k, n) = \max_{\substack{i, v, p_i \\ \ell_1, \ell_2}} \Psi^f[Q^g] p_i \int c(p_i, \epsilon, e, a) dx - w\ell - i - \kappa v$$

$$+ \sum_{\theta'} \Pi_{\theta, \theta'}^{\theta} \frac{\Omega^N(k', n')}{1 + r^*} \quad \text{s.t.}$$

$$\ell_2 \geq \Psi^f[Q^g] \int f^\ell[c(p_i, x), k, \ell_1] \frac{d(x, S)}{D} \quad \text{DC}$$

$$\ell_1 + \ell_2 = n\bar{e} \quad \text{SL}$$

$$k' = (1 - \delta_k)k + i - \phi^N(k, i) \quad \text{LMK}$$

$$n' = [1 - \bar{\delta}_n]n + v \quad \text{LML}$$



- Its output is used for exports, investment, and (part of) consumption.
- Decreasing returns.

$$\Omega^T(k, n) = \max_{i, v} F^T(k, \ell) - w\ell - i - \kappa v - \phi^{T, n}(n', n) + \sum_{\theta'} \Pi_{\theta, \theta'}^{\theta} \frac{\Omega^T(k', n')}{1 + r^*} \quad \text{s.t.}$$

$$k' = (1 - \delta_k)k + i - \phi^{T, k}(k, i)$$

$$\ell = n\bar{\epsilon}$$

$$n' = [1 - \bar{\delta}_n]n + v$$



- Financial wealth in the economy is

$$L_+ = \int_{b>0} b(\epsilon, e, a) dx$$

- Mortgages in the economy are

$$L_- = \int_{b<0} -b(\epsilon, e, a) dx$$

- Net foreign asset position of the country (the mutual fund owns all firms)

$$B = L_+ - \left(\Omega^N - \pi^N + \Omega^T - \pi^T + \frac{1}{1+r^*} L_- \right)$$

- The realized rate of return is

$$1+r = \frac{\Omega^N + \Omega^T + (1+r^*)B + L_-}{L_+}$$



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- We have to take care of wages dynamics. They are determined via the following formula ?

$$\log w - \log \bar{w} = \varepsilon_w (\log Y - \log \bar{Y})$$

- Solving the transition implies solving for sequences for home prices, wages, nontradable prices.



An equilibrium is a set of decision rules and values for households, firms' values and decision rules, and a set aggregate variables of aggregate states, such that:

- Households' and firms' policy functions and value functions solve the corresponding program problems.
- Aggregate searching consistence

$$D = \int d(\epsilon, e, a) dx,$$

- Nontradable prices satisfies

$$p = p_i(K_N, N_N) dx,$$

- Housing market clears

$$\int h(\epsilon, e, a) dx = H.$$



- Average separation probability and labor force quality

$$\bar{\delta}_n = \frac{\sum_{\epsilon} \delta_n(\epsilon) n(\epsilon)}{N}, \quad \bar{\epsilon} = \frac{\sum_{\epsilon} \epsilon n(\epsilon)}{N}$$

- Rate of return to the mutual fund satisfies

$$1 + r = \frac{\Omega^N + \Omega^T + (1 + r^*)B + \int_{b < 0} b(x)}{\int_{b > 0} b(x)}$$

2 Calibration

Mapping the Model to Data



- Preferences

$$u(c_A, h, d) = \frac{1}{1 - \sigma_c} \left(c_A - \xi_d \frac{d^{1+\gamma}}{1 + \gamma} \right)^{1 - \sigma_c} + v(h)$$

- where there is an Armington aggregator for consumption

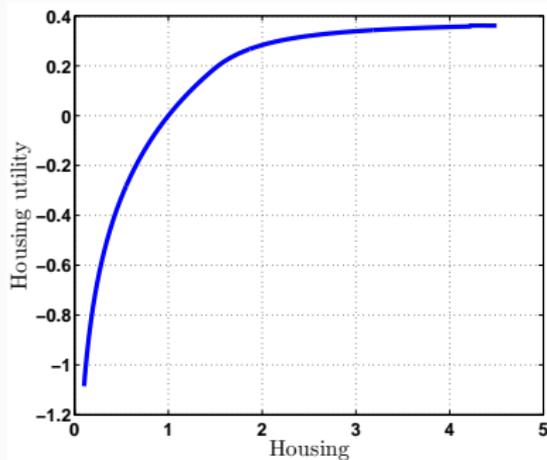
$$c_A = \left[\omega (c_N I_N^\rho)^{\frac{\eta-1}{\eta}} + (1 - \omega) c_T^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$$

- and houses are inferior goods as a proxy for segmentation of housing markets

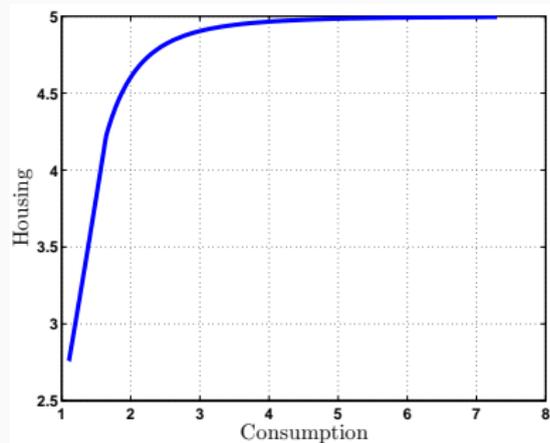
$$v(h) = \begin{cases} \xi_h \log(h), & \text{if } h < \hat{h}_1 \\ \frac{\xi_h}{1 - \sigma_h} h^{1 - \sigma_h}, & \text{if } \hat{h}_1 \leq h \leq \hat{h}_2. \\ \xi_h \sqrt{\bar{h} - h}, & \text{if } h > \hat{h}_2. \end{cases}$$



Housing utility function



Engel Curve: consumption vs housing





- Production function

$$F^N(k, l_1, l_2) = z_N k^{\alpha_0} l_1^{\alpha_1} l_2^{\alpha_2}, \quad F^T(k, l) = z_T k^{\theta_0} l^{\theta_1}$$

- Capital adjustment cost in the nontradable goods sector

$$\phi^N(i, k) = \frac{\psi}{2} \left(\frac{i}{k} - \delta_k \right)^2 k$$

- Capital and employment adjustment cost in the tradable goods sector

$$\phi^{T,k}(i, k) = \frac{\psi}{2} \left(\frac{i}{k} - \delta_k \right)^2 k, \quad \phi^{T,n}(n', n) = \frac{\psi}{2} \left(\frac{n'}{n} - 1 \right)^2 n$$

- Matching technology

$$M(D, T) = \nu D^\mu T^{1-\mu}$$



Parameter	Value
Risk aversion for consumption, σ_c	2.0
Satiation level for housing, \bar{h}	5.0
Curvature of shopping, γ	1.5
Elasticity of substitution bw tradables and nontradables, η	0.80
Price markup, ρ	1.1
Loan to value ratio, λ	0.80
Interest rate for international bonds, r^*	4%

Note: model period is half a quarter

ENDOGENOUSLY DETERMINED PARAMETERS: AGGREGATE



Target	Value	Parameter	Value
Wealth to output ratio	4.00	β	0.97
Housing value to output ratio	1.70	ξ_h	0.54
Debt to output ratio	0.40	ϵ_4	37.41
Fraction of housing held by bottom 70%	0.25	\hat{h}_1	1.48
Fraction of housing held by bottom 80%	0.39	\hat{h}_2	4.22
Fraction of housing held by bottom 90%	0.58	σ_h	2.92
Share of tradables	0.30	ω	0.98
Occupancy Rate	0.81	ν	0.81
Capital to output ratio	2.00	δ_k	0.01
Labor Share in nontradables	0.64	α_0	0.27
$\alpha_1 = \alpha_2$	—	α_1	0.36
Labor Share in tradables	0.66	θ_1	0.66
Vacancy cost to output ratio	0.02	κ	0.42
Home production to lowest earning ratio	0.50	\bar{w}	0.07

Units Parameters

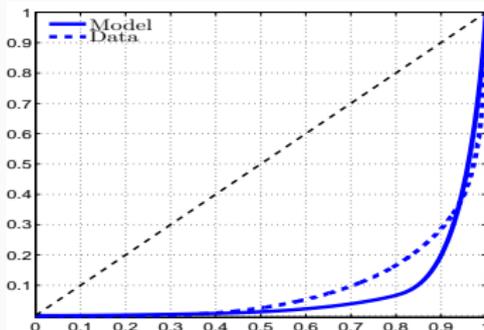
Output	1	z_N	0.93
Relative price of nontradables	1	z_T	0.48



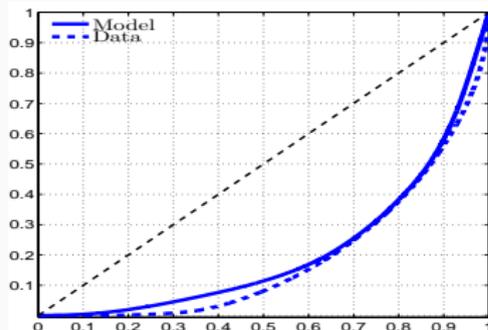
Target	Value	Parameter	Value
Job duration for type 1	1.5 year	δ_n^1	0.083
Job duration for type 3	5 year	δ_n^3	0.025
Job duration for type 4	5 year	δ_n^4	0.025
Unemployment rate	6%	δ_n^2	0.048
Wealth Gini index	0.82	$\Pi_{1,4}^\epsilon$	0.0007
Earnings Gini index	0.64	$\Pi_{4,1}^\epsilon$	0.0058
Earning autocorrelation	0.91	$\Pi_{1,1}^\epsilon$	0.9656
Earning stdev	0.20	$\Pi_{2,2}^\epsilon$	0.9770



Network

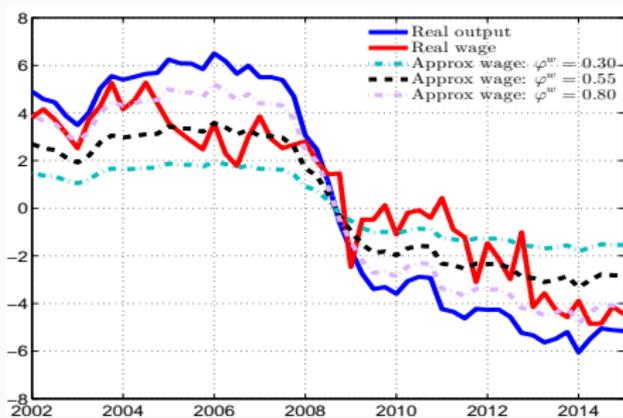


Housing





- Real wage rule: $\log \frac{w_t}{P_t} - \log \frac{\bar{w}}{\bar{P}} = \varphi^w (\log Y_t^* - \log \bar{Y})$
- Choose $\varphi^w = 0.55$: match correlation between real output and real wage
- Consistent with the movement during the Great Recession





Summary of Dynamic Parameters

Parameter	Value	Target
Adjustment cost, ψ	1.60	Decrease in investment: 30%
DRS in tradables, θ_0	0.21	Increase in tradable sector: 4%
Goods market matching elasticity in, μ	0.80	Decrease in TFP: 1.5%
Wage elasticity, φ_w	0.55	Ratio of wage to output change: 0.55



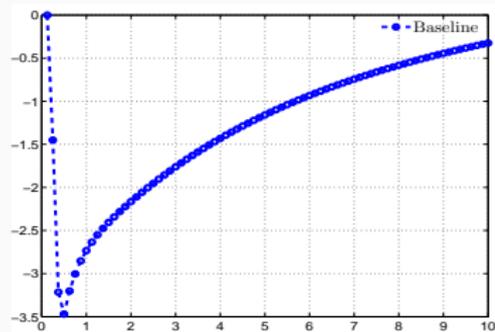
1. Baseline
 - Over three months the down payment changes from 20% to 40%
 - The borrowing interest rate's surcharge goes from zero to 0.5%
2. Decomposition: with only down payment or interest rate change
3. Role of asset price: constant housing price
4. Role of frictions: wage elasticity, matching frictions and adj costs
5. Allowing default: a larger drop of housing price
6. Credit cycle



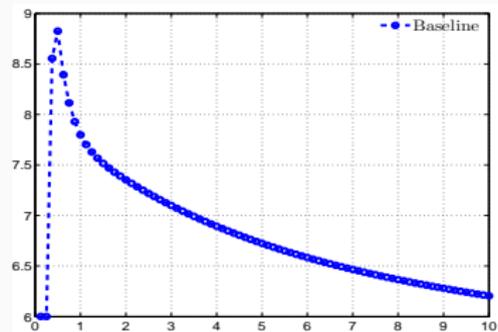
- Typically like in all $\beta - \delta - \alpha - \gamma$ type models, in the long run output and wealth end up being higher.

- But in our economies the transition is associated to a recession.

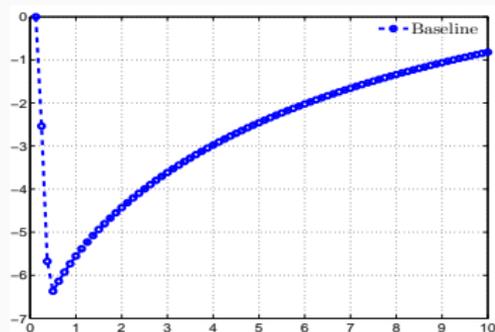
EXPERIMENT 1: BASELINE



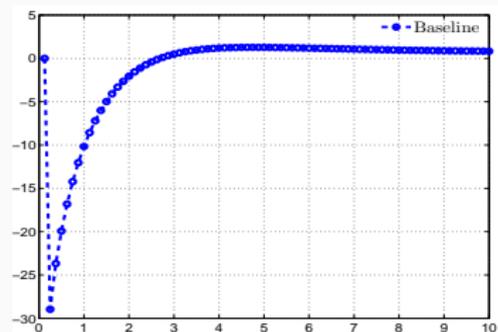
Real output



Unemployment

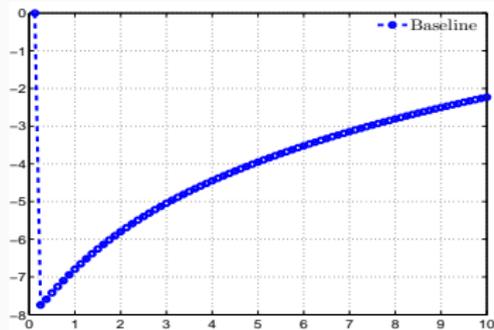


Consumption

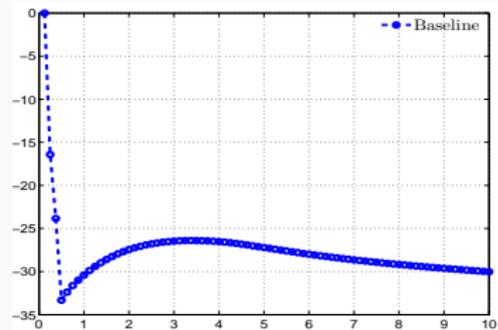


Investment

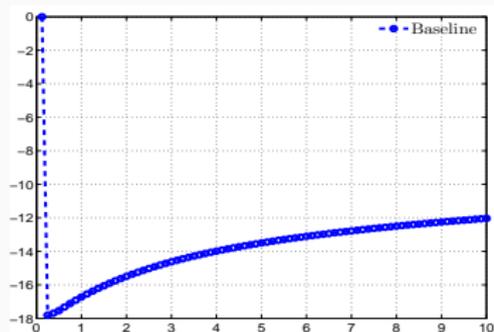
EXPERIMENT 1: BASELINE



Wealth

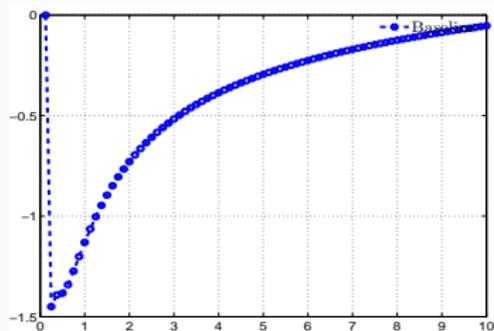


Debt

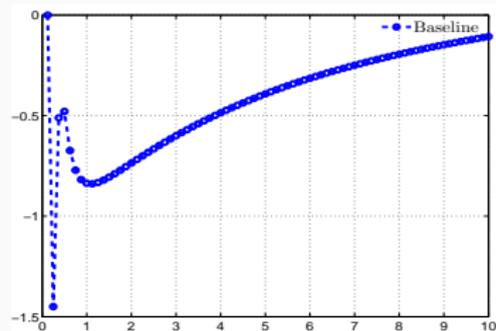


Housing price

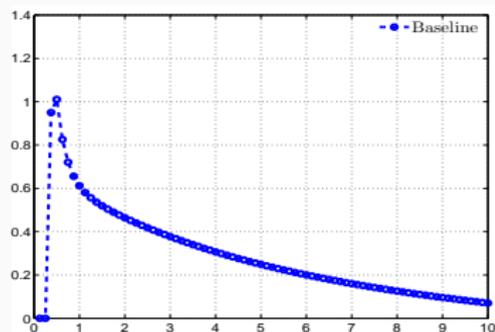
EXPERIMENT 1: BASELINE



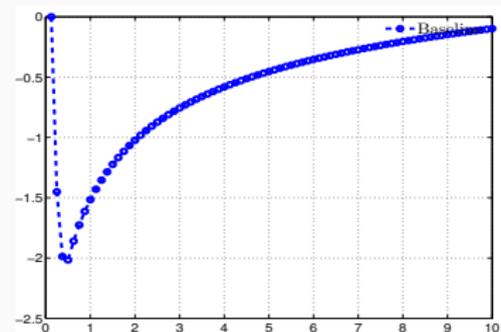
TFP with total hours



Labor Productivity

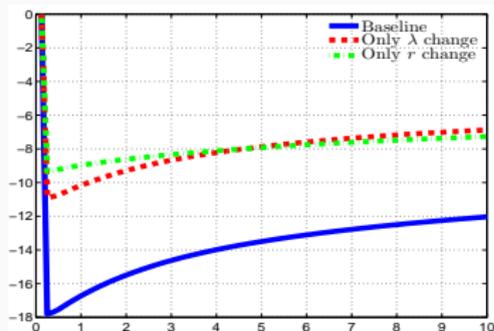
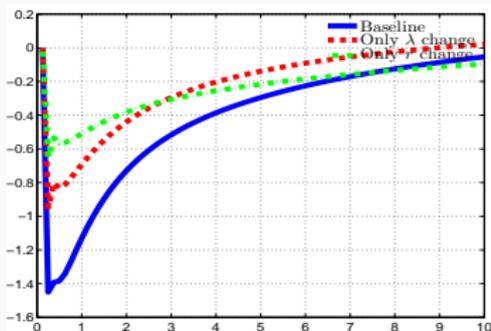
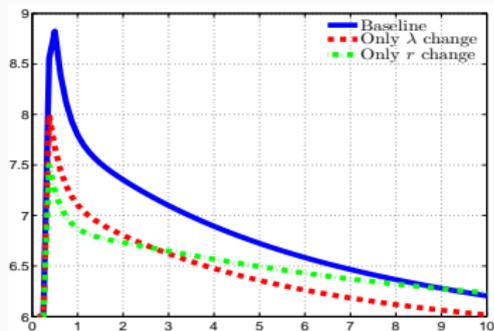
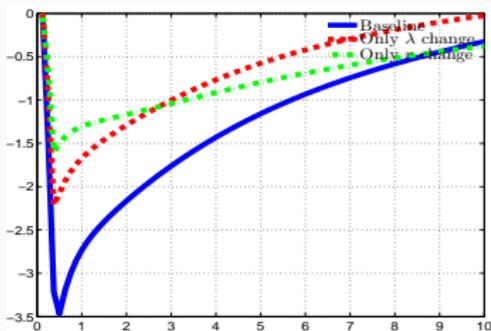


Labor quality

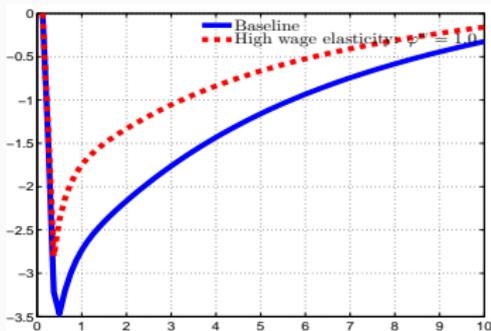


TFP with total labor inputs

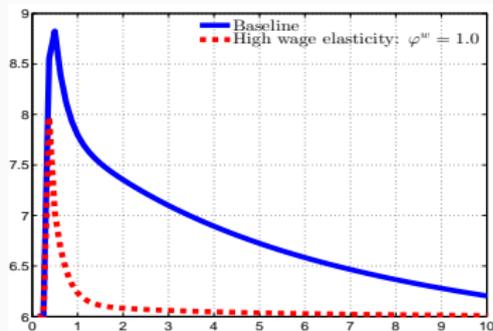
EXPERIMENT 2 : ONLY λ OR r CHANGE



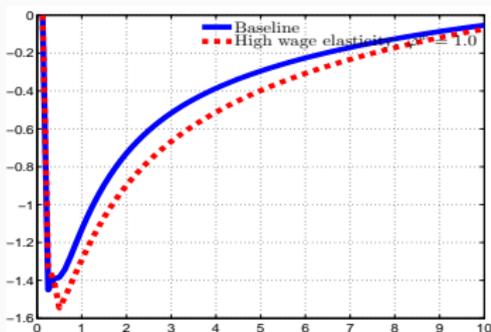
EXPERIMENT 4.1: WAGE ELASTICITY



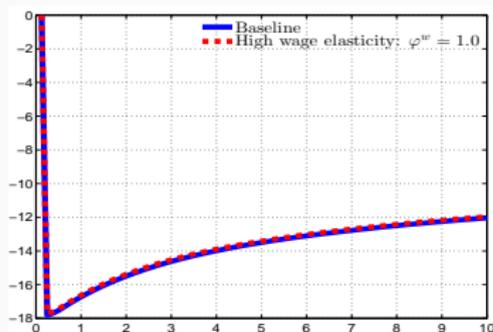
Real output



Unemployment rate

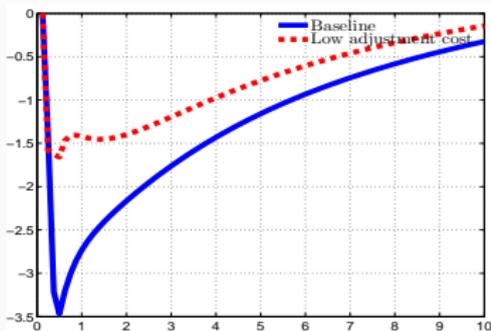


TFP

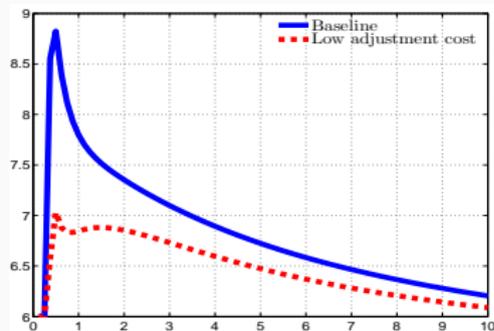


Housing price

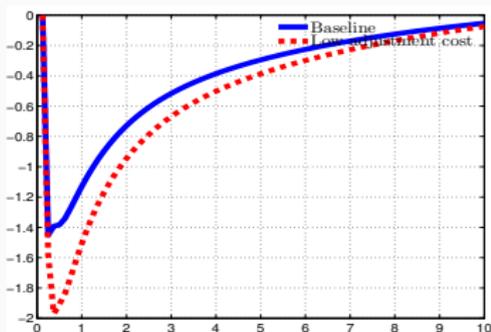
EXPERIMENT 4.2: ADJUSTMENT COST



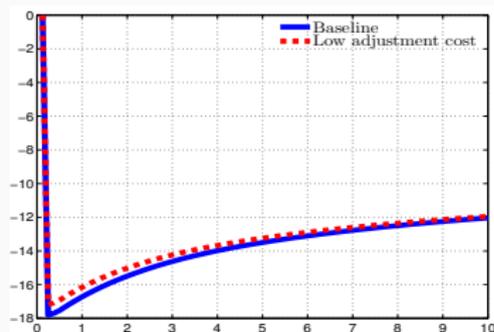
Real output



Unemployment rate

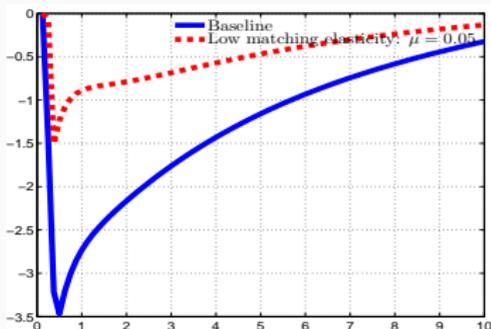


TFP

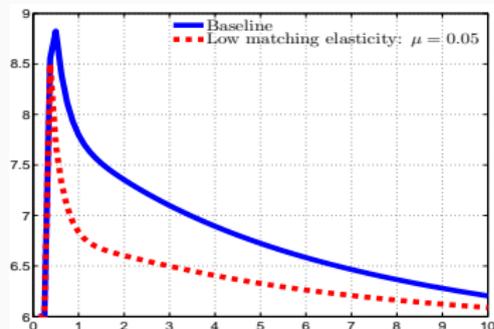


Housing price

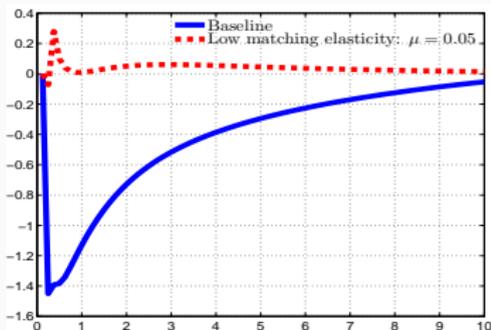
EXPERIMENT 4.3: GOODS MARKET FRICTIONS



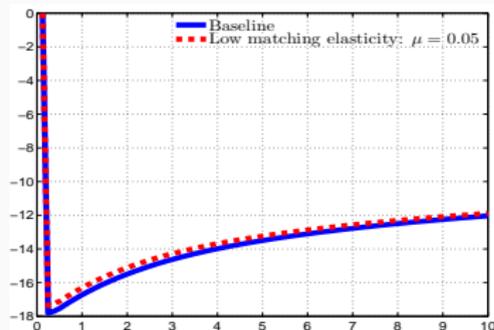
Real output



Unemployment rate

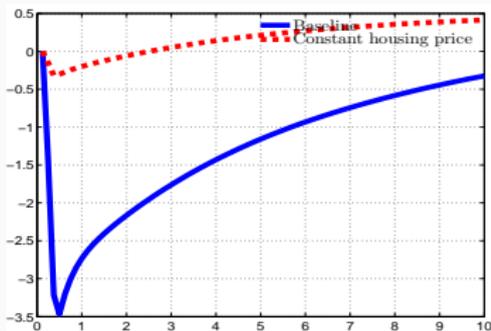


TFP

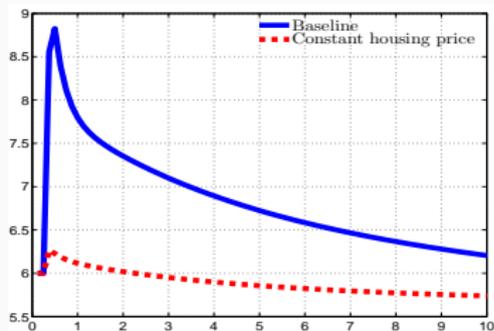


Housing price

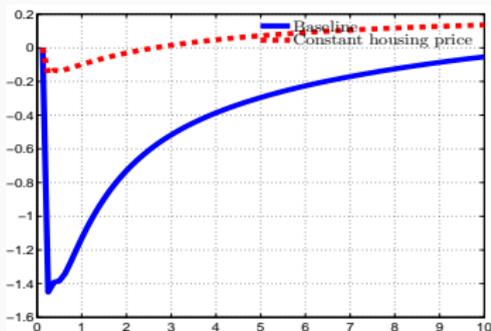
ANOTHER EXPERIMENT: CONSTANT HOUSING PRICES



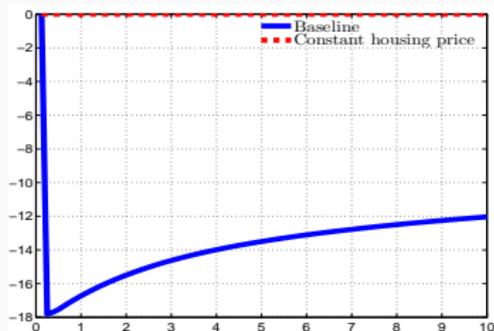
Real output



Unemployment rate



TFP



Housing price

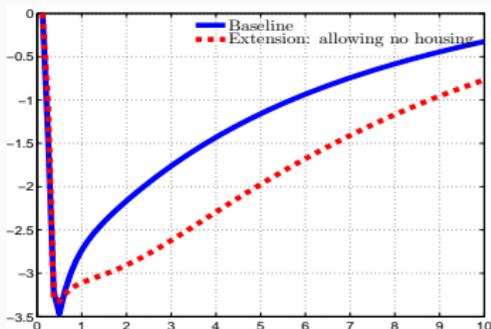


- 30% of households hold zero houses in the United States
- Change preference slightly to match this moment

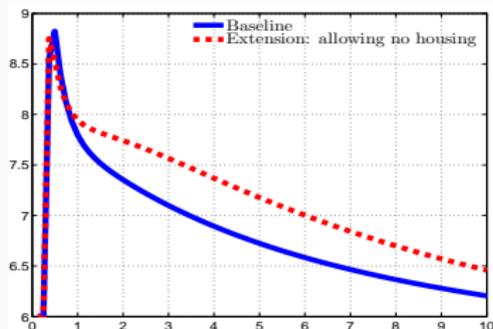
$$v(h) = \begin{cases} \xi_h \log(h + \underline{h}), & \text{if } h < \hat{h}_1, \\ \frac{\xi_h}{1-\sigma_h} (h + \xi_h^1)^{1-\sigma_h} + \xi_h^2, & \text{if } \hat{h}_1 \leq h \leq \hat{h}_2, \\ \xi_h^3 \sqrt{\bar{h}^2 - (\bar{h} - h)^2} + \xi_h^4, & \text{if } h > \hat{h}_2. \end{cases}$$

- Similar aggregate response, but richer cross-sectional implications

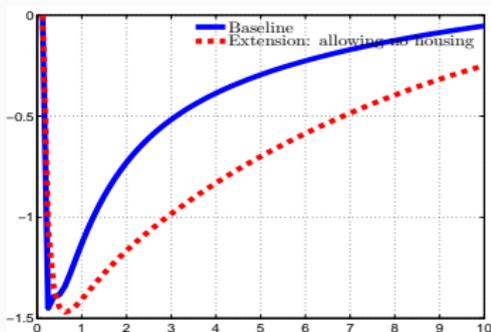
EXPERIMENT 5: AGGREGATE RESPONSE



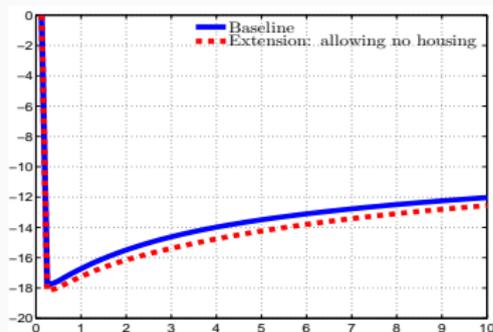
Real output



Unemployment rate

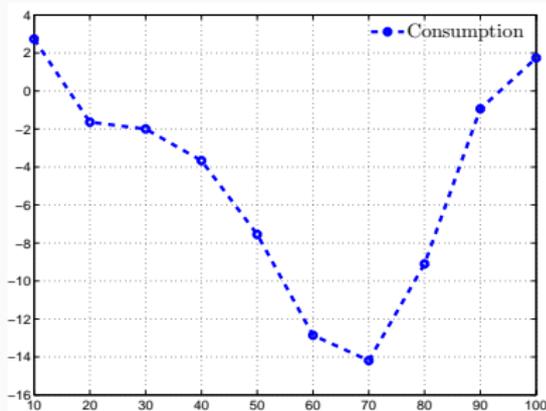
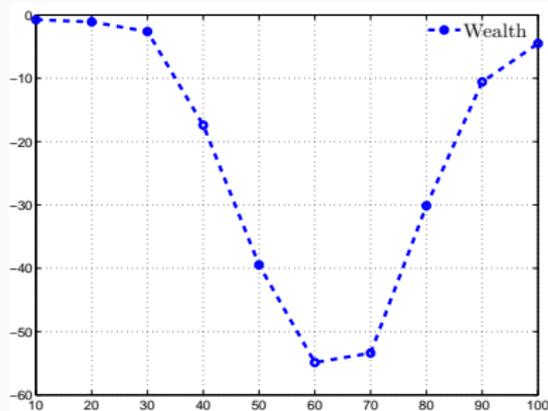


TFP



Housing price

EXPERIMENT 5: CROSS-SECTIONAL EFFECTS



- This agrees with the evidence in ? and ?



- Borrowing interest rate's surcharge goes from zero to 1%.
- Housing price drops more than 20%, and agents may be underwater.
- Allow borrowers to default, but savers suffer from the capital loss.



- Total saving in financial wealth in the economy is

$$L_{+,t} = \int_{b>0} b_t(\epsilon, e, a) dx$$

- Mortgages in the economy are

$$L_{-,t} = \int_{b<0} -b_t(\epsilon, e, a) dx$$

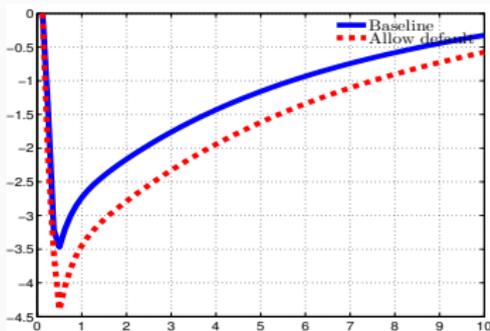
- Net foreign asset position of the country

$$B_t = L_{+,t} - \left(\Omega_t^N - \pi_t^N + \Omega_t^T - \pi_t^T + \frac{1}{1+r^*} L_{-,t} \right)$$

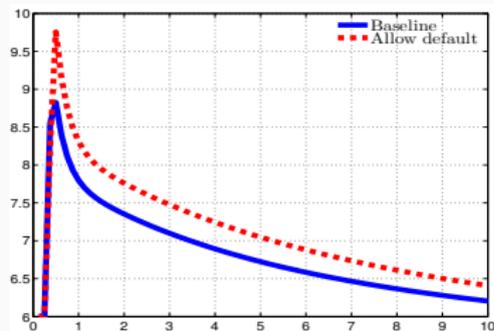
- The realized rate of return in next period is

$$1 + r_{t+1} = \frac{\Omega_{t+1}^N + \Omega_{t+1}^T + (1+r^*)B_t}{L_+} - \frac{\int_{b<0} \mathbb{I}_{p_{h,t+1}h_t(\epsilon,e,a)+b_t(\epsilon,e,a)>0} [p_{h,t+1}h_t(\epsilon, e, a) + b_t(\epsilon, e, a)] dx}{L_+}$$

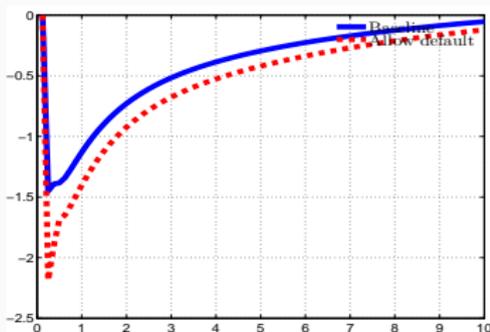
EXPERIMENT 6: ALLOWING DEFAULT



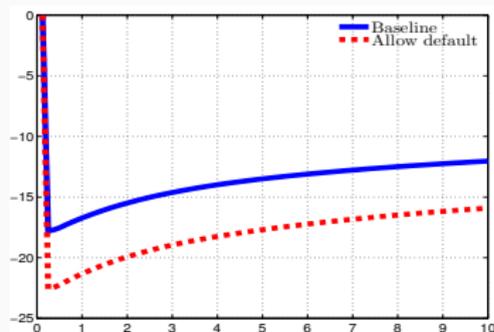
Real output



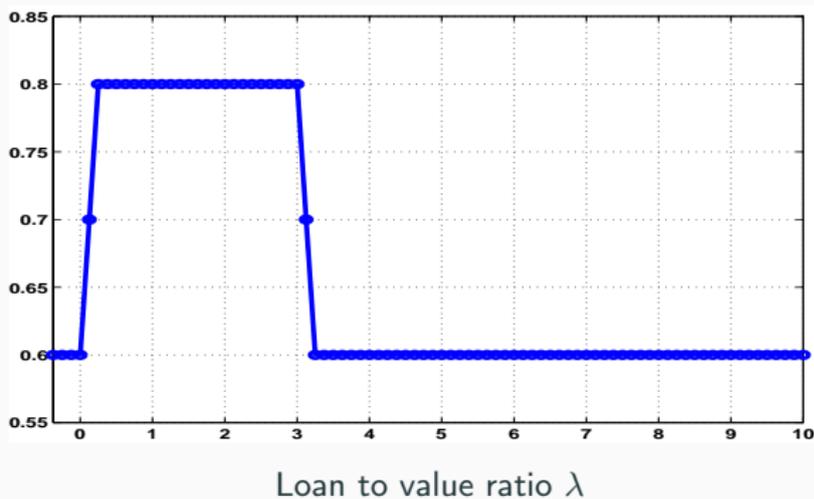
Unemployment rate



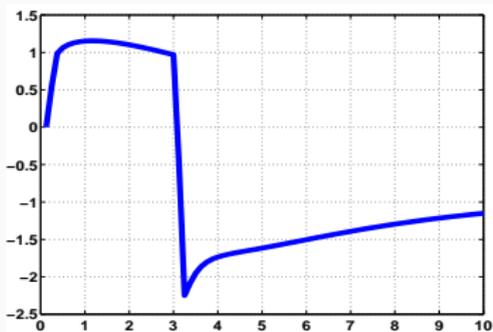
TFP



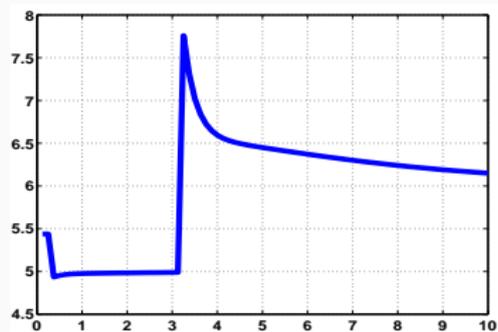
Housing price



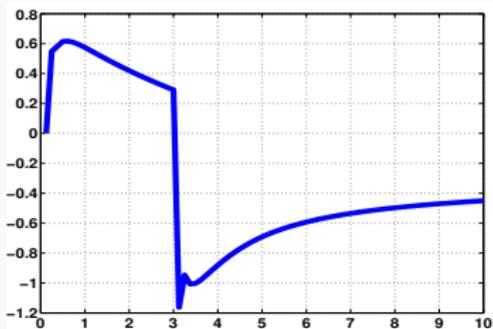
EXPERIMENT 7: CREDIT CYCLE



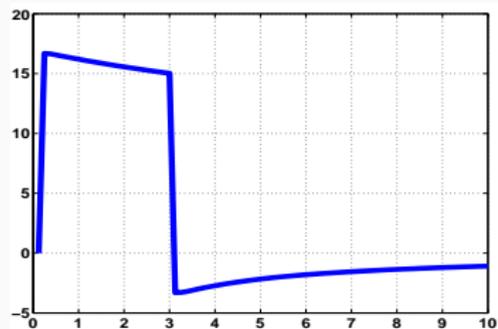
Real output



Unemployment rate



TFP



Housing price

3 Conclusion





- We have a recession generated purely by increased difficulties to borrow on the part of households



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- The recession comes together with



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 - TFP loses



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 - Drop in Housing prices (movements too sharp because of lack of house frictions)



- We have a recession generated purely by increased difficulties to borrow on the part of households
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 - TFP losses
 - Drop in Housing prices (movements too sharp because of lack of house frictions)
 - Drop in Stock Market



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- The literature is trying hard to get this (?, ?) with limited success.



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- Still ways to go:
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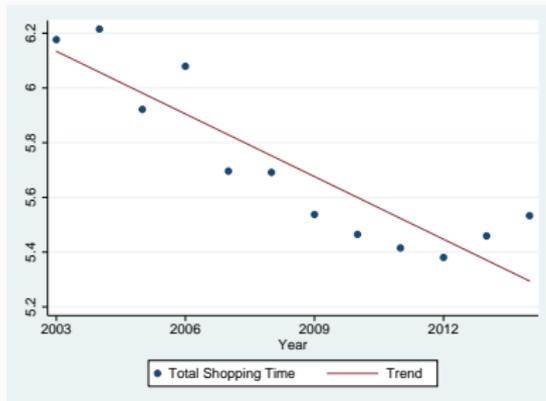


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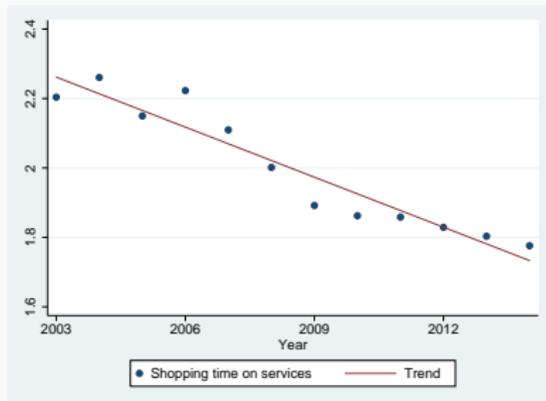


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- Still ways to go:
 - Foreclosures; slow housing frictions; Long term Mortgages.
 - Slow expanding export industries.
 - Model of banking cycles.

Thank you very much



Total shopping time



Shopping time on services



- ?, ?



- ?, ?
- Firms cannot borrow as much.



- ?, ?
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- Not all good projects will be undertaken.



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- In fact there is some of this in the data: Since 2007 employment of the young firms went down by 24.5% and in 2012 it was at the historically lowest level.
- Firms make themselves vulnerable by being close to their credit limit to improve their bargaining position over wages ?

WHY WAS THERE A FINANCIAL SHOCK? (WHAT WAS THE TRIGGER?)



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- Increased variance in the cross-sectional returns of firms ?, ? ?, ? ?.

WHY WAS THERE A FINANCIAL SHOCK? (WHAT WAS THE TRIGGER?)



- Increased variance in the cross-sectional returns of firms ?, ? ?, ? ?.
- Straight shocks to credit constraints ?, ?, ?.

WHAT HAVE WE LEARNED





- It is hard to get a large recession only from the product side and only from lower investment.



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- The largest success (to my knowledge) (?) works by having the financial shocks increase the probability of default and inducing firms to pursue very conservative use of inputs despite their almost normal productivity.
- Still it is hard to have a reduction of marginal cash to create a large recession (?).
- It may have played a larger role in the expansion of new firms (?)



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