

# Course in Heterogeneity and Fluctuations

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

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Jose-Victor Rios-Rull

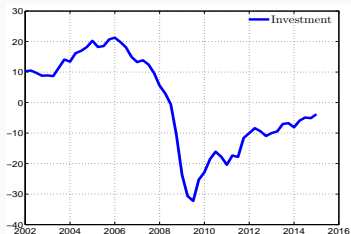
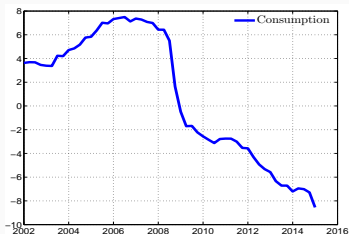
University of Oslo

August 2019

Based on joint work with Zhen Huo

We have had a Great Recession

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

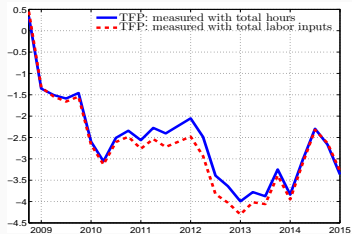
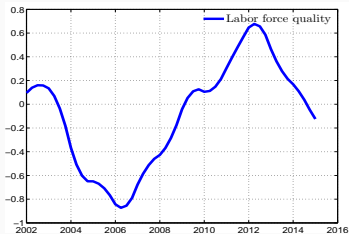
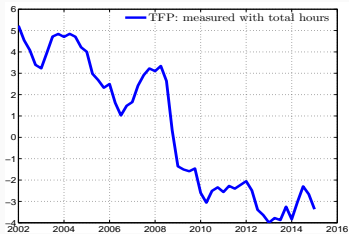


Note: Except for unemployment, figures show percentage deviation from a linear trend.

# 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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- When looking for triggers of the Great Recession some form of financial breakdown comes out in most popular explanations.
- 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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  - 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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3. Frictions in the goods markets that generate movements in measured GDP.
4. Households that differ in job prospects.
5. Some labor market frictions that limit wage adjustments.



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  2. Large reductions in assets (housing and stocks) prices.

# 1 Model

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- Households also like tradables and housing and dislike goods



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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.

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

# HOUSEHOLDS' PROBLEM

$$V(\epsilon, e, a) = \max_{c_N, i, c_T, I_N, h, d} u(c_A, h, d) + \\ \beta \sum_{\epsilon', e', \theta'} \Pi_{\theta, \theta'}^\theta \Pi_{e'|e, \epsilon}^w \Pi_{\epsilon, \epsilon'} V[\epsilon', e', a'(b, h)] \quad \text{s.t.}$$

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

## NONTRADABLE FIRMS' PROBLEM

$$\Omega^N(k, n) = \max_{\substack{i, v, p_i \\ l_1, l_2}} \Psi^f[Q^g] p_i \int c(p_i, \epsilon, e, a) dx - wl - i - \kappa v$$
$$+ \sum_{\theta'} \Pi_{\theta, \theta'}^{\theta} \frac{\Omega^N(k', n')}{1 + r^*} \quad \text{s.t.}$$

$$l_2 \geq \Psi^f[Q^g] \int f^l[c(p_i, x), k, l_1] \frac{d(x, S)}{D} \quad \text{DC}$$

$$l_1 + l_2 = n\bar{e} \quad \text{SL}$$

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

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

## TRADABLE FIRMS' ARE COMPETITIVE AND HAVE ADJUSTMENT COSTS

- 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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# THE FINANCIAL SHOCKS

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- Solve for the transition
- We have to take care of wages dynamics. They are determined via the following formula Gornemann, Kuester, and Nakajima (2012).

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

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

# EQUILIBRIUM

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

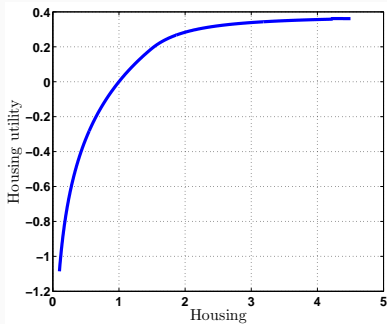
$$c_A = \left[ \omega (c_N I_N^\rho)^{\frac{\eta-1}{\eta}} + (1 - \omega) c_T^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$$

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

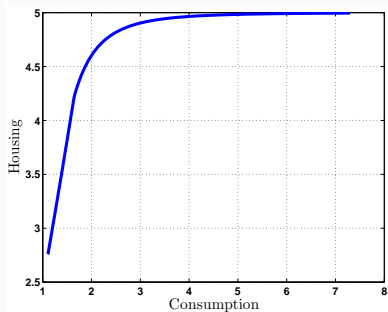
$$v(h) = \begin{cases} \xi_h \log(h), & \text{if } h < \hat{h}_1 \\ \frac{\xi_h}{1 - \sigma_h} h^{1 - \sigma_h}, & \text{if } \hat{h}_1 \leq h \leq \hat{h}_2. \\ \xi_h \sqrt{\bar{h} - h}, & \text{if } h > \hat{h}_2. \end{cases}$$

# HOUSING UTILITY FUNCTION

Housing utility function



Engel Curve: consumption vs housing



# FUNCTIONAL FORMS

- Production function

$$F^N(k, \ell_1, \ell_2) = z_N k^{\alpha_0} \ell_1^{\alpha_1} \ell_2^{\alpha_2}, \quad F^T(k, \ell) = z_T k^{\theta_0} \ell^{\theta_1}$$

- 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

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

## EXOGENOUSLY DETERMINED PARAMETERS

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

*Note: model period is half a quarter*

# ENDOGENOUSLY DETERMINED PARAMETERS: AGGREGATE

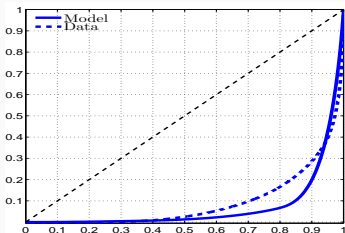
Target	Value	Parameter	Value
Wealth to output ratio	4.00	$\beta$	0.97
Housing value to output ratio	1.70	$\xi_h$	0.54
Debt to output ratio	0.40	$\epsilon_4$	37.41
Fraction of housing held by bottom 70%	0.25	$\hat{h}_1$	1.48
Fraction of housing held by bottom 80%	0.39	$\hat{h}_2$	4.22
Fraction of housing held by bottom 90%	0.58	$\sigma_h$	2.92
Share of tradables	0.30	$\omega$	0.98
Occupancy Rate	0.81	$\nu$	0.81
Capital to output ratio	2.00	$\delta_k$	0.01
Labor Share in nontradables	0.64	$\alpha_0$	0.27
$\alpha_1 = \alpha_2$	—	$\alpha_1$	0.36
Labor Share in tradables	0.66	$\theta_1$	0.66
Vacancy cost to output ratio	0.02	$\kappa$	0.42
Home production to lowest earning ratio	0.50	$\bar{w}$	0.07

## Units Parameters

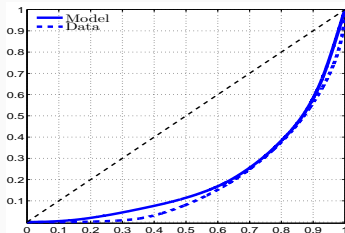
Output	1	$z_N$	0.93
Relative price of nontradables	1	$z_T$	0.48

Target	Value	Parameter	Value
Job duration for type 1	1.5 year	$\delta_n^1$	0.083
Job duration for type 3	5 year	$\delta_n^3$	0.025
Job duration for type 4	5 year	$\delta_n^4$	0.025
Unemployment rate	6%	$\delta_n^2$	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



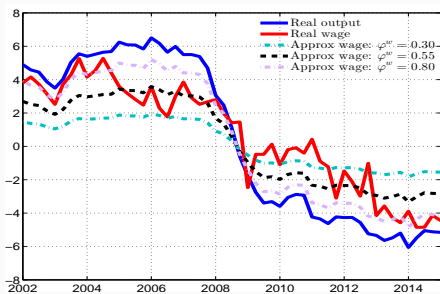
Housing





# DYNAMIC PARAMETER I

- 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

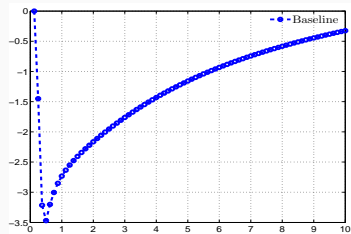
Parameter	Value	Target
Adjustment cost, $\psi$	1.60	Decrease in investment: 30%
DRS in tradables, $\theta_0$	0.21	Increase in tradable sector: 4%
Goods market matching elasticity in, $\mu$	0.80	Decrease in TFP: 1.5%
Wage elasticity, $\varphi_w$	0.55	Ratio of wage to output change: 0.55

# EXPERIMENTS: ONCE AND FOR ALL SET OF SURPRISES

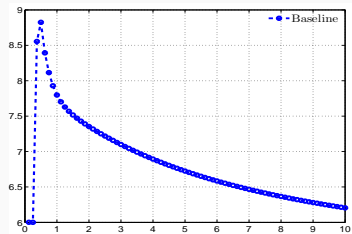
1. Baseline
  - Over three months the down payment changes from 20% to 40%
  - The borrowing interest rate's surcharge goes from zero to 0.5%
2. Decomposition: with only down payment or interest rate change
3. Role of asset price: constant housing price
4. Role of frictions: wage elasticity, matching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

- Typically like in all Aiyagari (1994) - Bewley (1986) - Huggett (1993) - Imrohoroglu (1989) type models, in the long run output and wealth end up being higher.
  
- But in our economies the transition is associated to a recession.

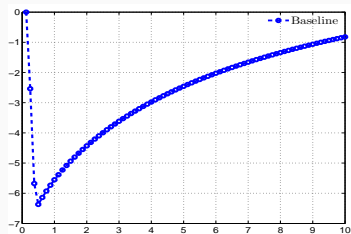
# EXPERIMENT 1: BASELINE



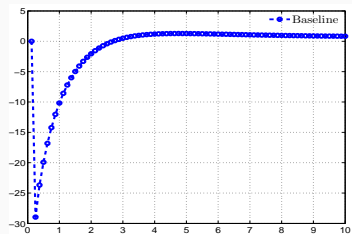
Real output



Unemployment

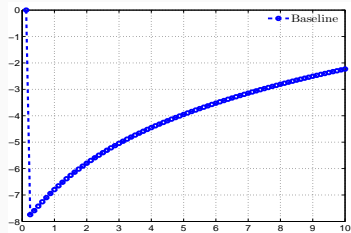


Consumption

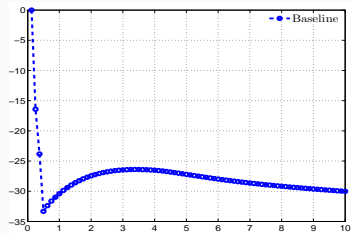


Investment

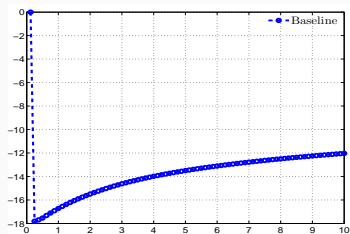
# EXPERIMENT 1: BASELINE



Wealth

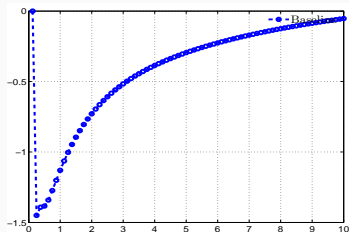


Debt

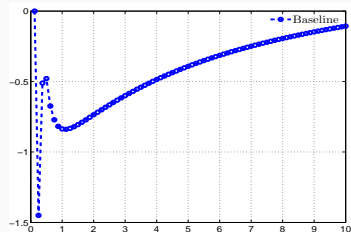


Housing price

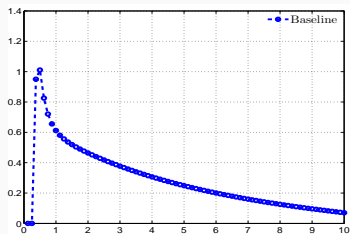
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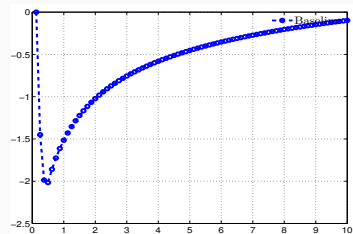
TFP with total hours



Labor Productivity

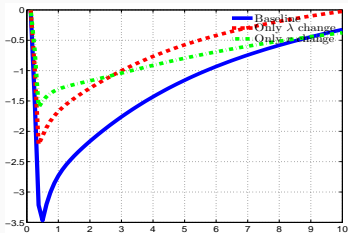


Labor quality

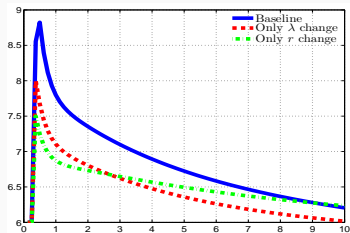


TFP with total labor inputs

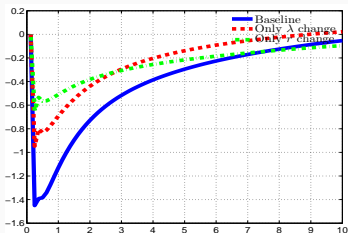
## EXPERIMENT 2 : ONLY $\lambda$ OR $r$ CHANGE



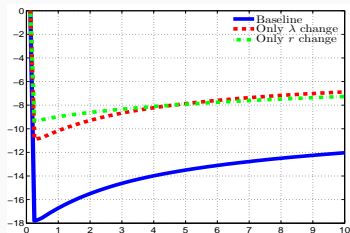
Real output



Unemployment rate



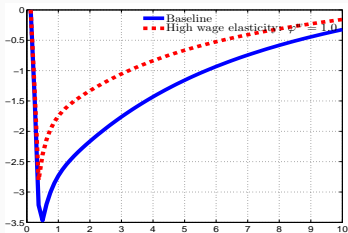
TFP



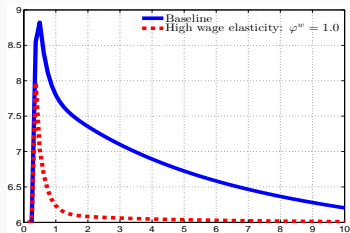
Housing price



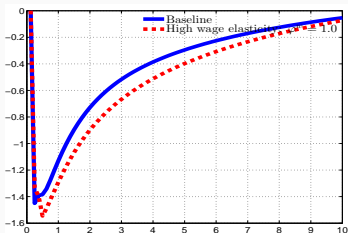
# EXPERIMENT 4.1: WAGE ELASTICITY



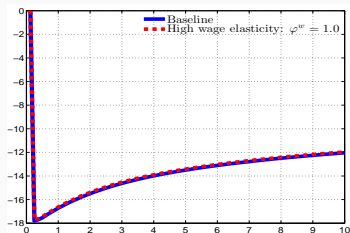
Real output



Unemployment rate

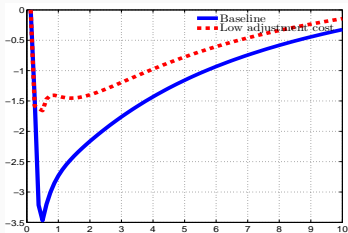


TFP

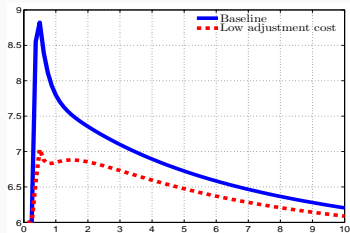


Housing price

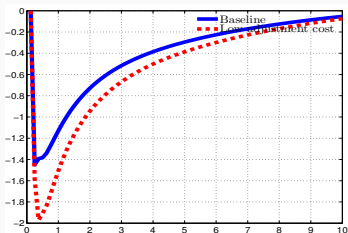
# EXPERIMENT 4.2: ADJUSTMENT COST



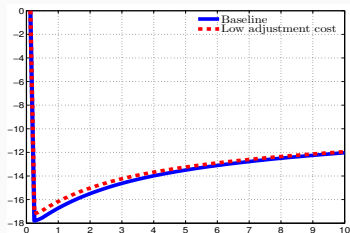
Real output



Unemployment rate

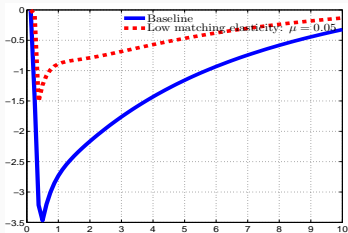


TFP

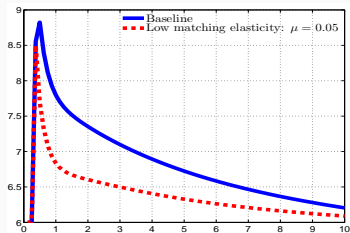


Housing price

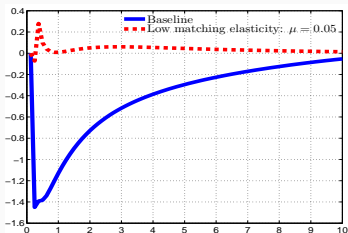
# EXPERIMENT 4.3: GOODS MARKET FRICTIONS



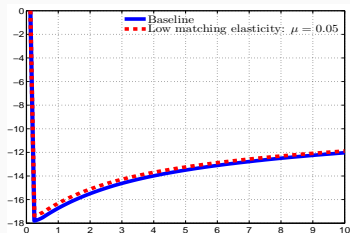
Real output



Unemployment rate

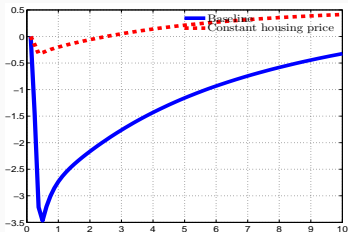


TFP

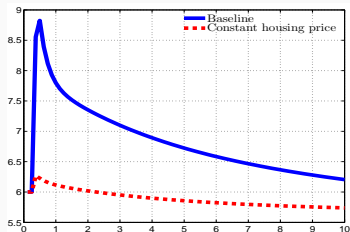


Housing price

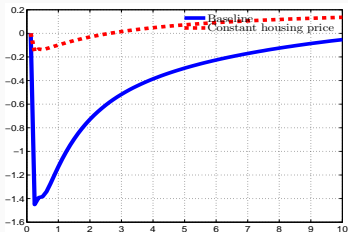
# ANOTHER EXPERIMENT: CONSTANT HOUSING PRICES



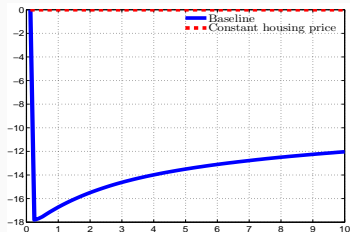
Real output



Unemployment rate



TFP



Housing price

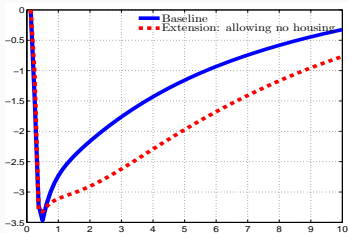
## EXPERIMENT 5: ALLOWING HOUSEHOLDS HOLDING NO HOUSING

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

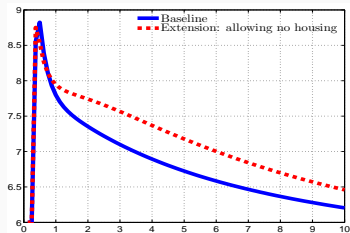
$$v(h) = \begin{cases} \xi_h \log(h + \underline{h}), & \text{if } h < \hat{h}_1, \\ \frac{\xi_h}{1-\sigma_h} (h + \xi_h^1)^{1-\sigma_h} + \xi_h^2, & \text{if } \hat{h}_1 \leq h \leq \hat{h}_2, \\ \xi_h^3 \sqrt{\bar{h}^2 - (\bar{h} - h)^2} + \xi_h^4, & \text{if } h > \hat{h}_2. \end{cases}$$

- Similar aggregate response, but richer cross-sectional implications

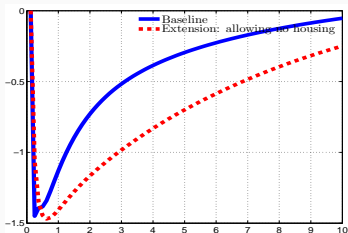
# EXPERIMENT 5: AGGREGATE RESPONSE



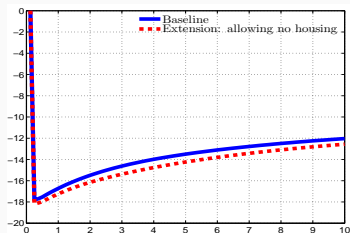
Real output



Unemployment rate

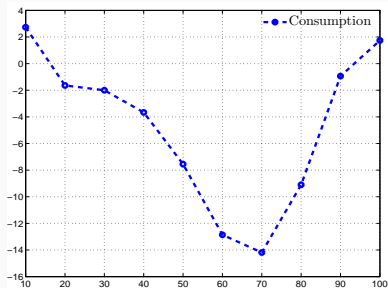
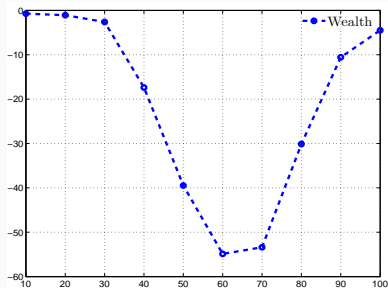


TFP



Housing price

## EXPERIMENT 5: CROSS-SECTIONAL EFFECTS



- This agrees with the evidence in Petev, Pistaferri, and Eksten (2012) and Parker and Vissing-Jorgensen (2009)

## EXPERIMENT 6: ALLOWING DEFAULT

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- 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.



## EXPERIMENT 6: ALLOWING DEFAULT

- 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

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

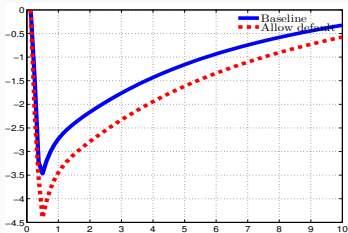
- Net foreign asset position of the country

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

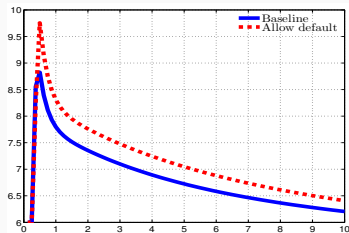
- The realized rate of return in next period is

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

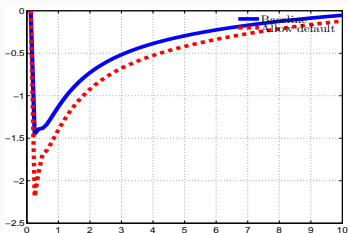
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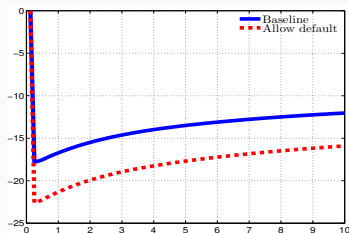
Real output



Unemployment rate

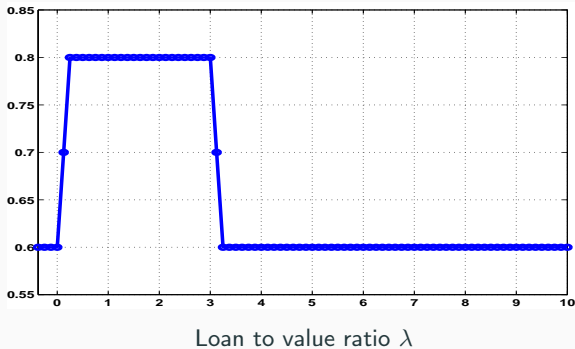


TFP

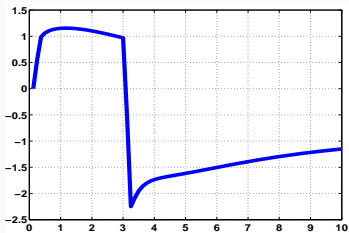


Housing price

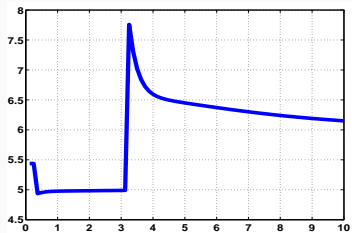
## EXPERIMENT 7: CREDIT CYCLE



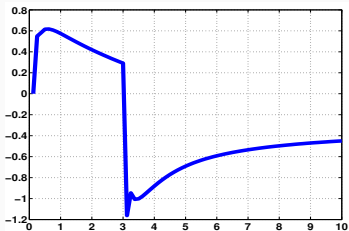
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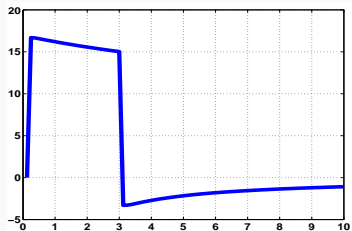
Real output



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## 3 Conclusion

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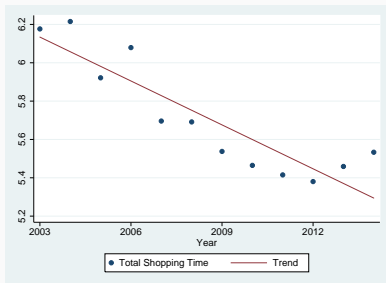
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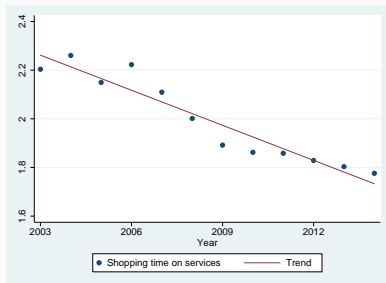


Thank you very much

# AMERICAN TIME USE SURVEY DATA ON SHOPPING TIME



Total shopping time



Shopping time on services

- Bernanke and Gertler (1989), Bernanke, Gertler, and Gilchrist (1999)

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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 Monacelli, Quadrini, and Trigari (2011)



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

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

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- Increased variance in the cross-sectional returns of firms Bloom (2009), Bloom et al. (2011) Arellano, Bai, and Kehoe (2012), Christiano, Motto, and Rostagno (2014) Dyrda (2015).
- Straight shocks to credit constraints Jermann and Quadrini (2012), Perri and Quadrini (2011), Macera (2015).

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- Still it is hard to have a reduction of marginal cash to create a large recession (Zetlin-Jones and Shourideh (2012)).
- It may have played a larger role in the expansion of new firms (Dyrda (2015))



# REFERENCES

- Aiyagari, S. Rao. 1994. "Uninsured Idiosyncratic Risk and Aggregate Saving." *Quarterly Journal of Economics* 109 (3):659–684.
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