Financial Frictions, Asset Prices, and the Great Recession

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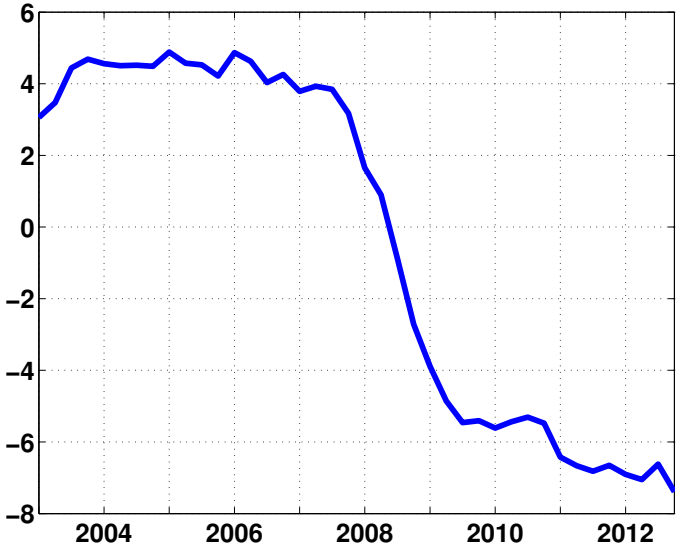
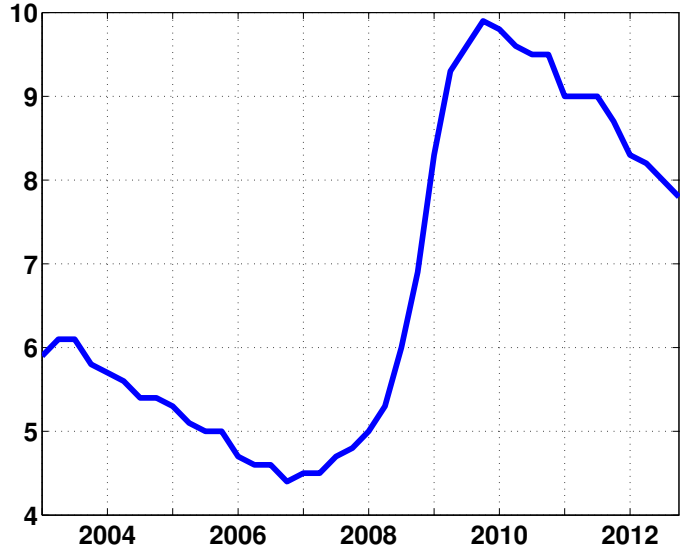
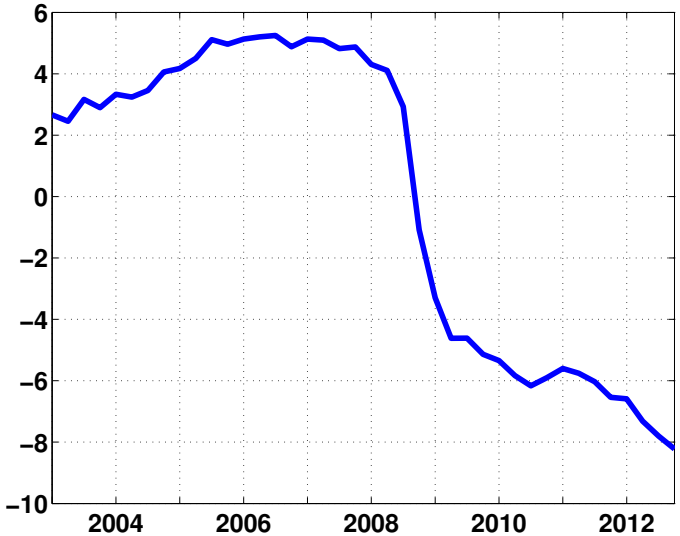
Facts on the last recession: I



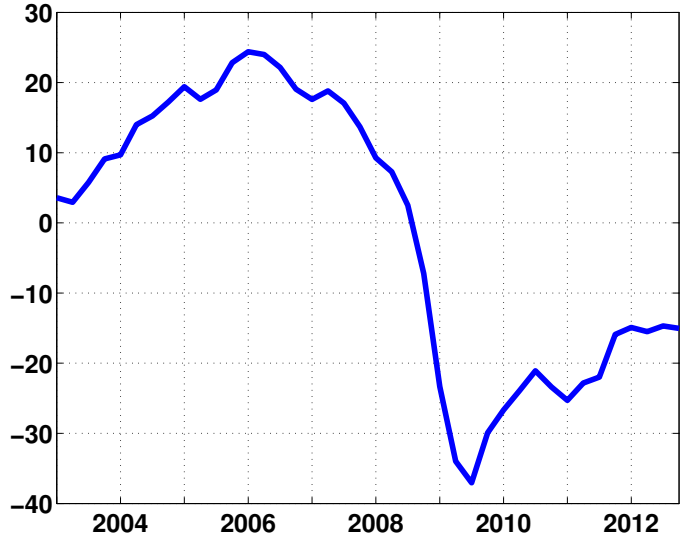
Real output



Unemployment



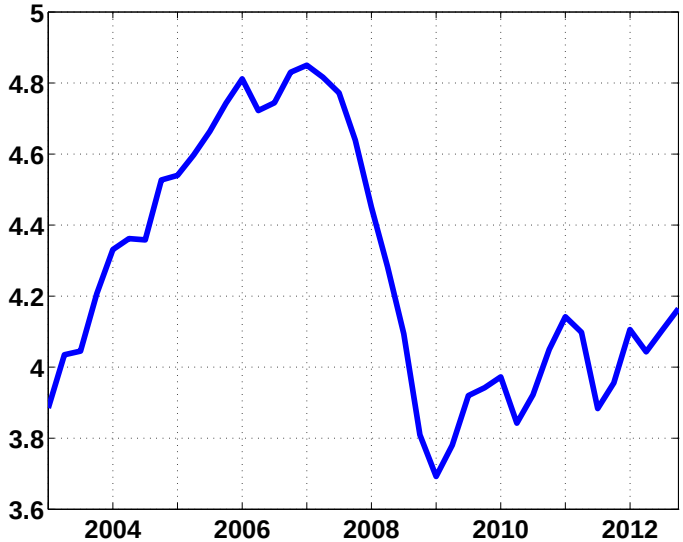
Consumption



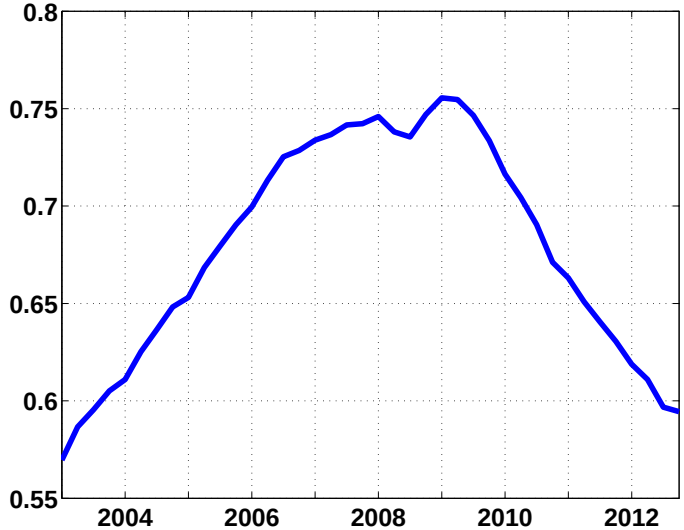
Investment

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

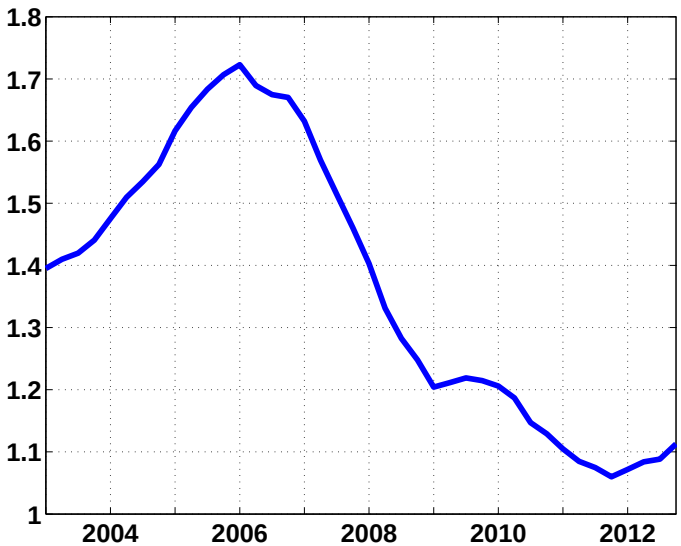
Facts on the last recession: II



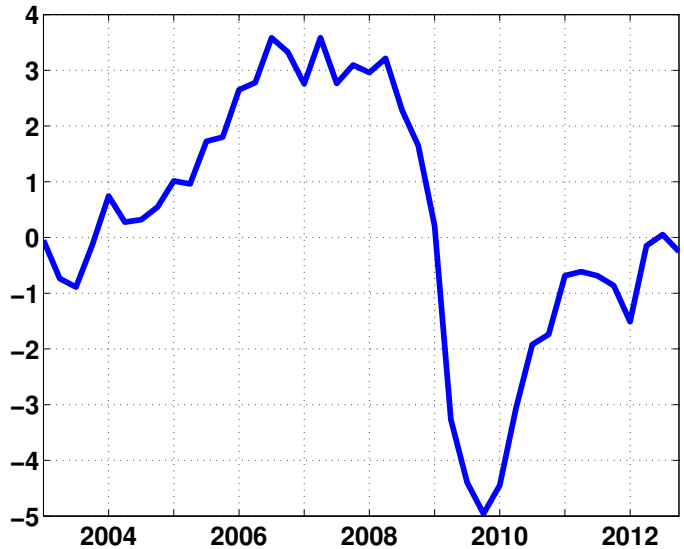
Wealth to output



Debt to output



Housing value to output



Labor Quality adjusted Productivity

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- Total factor productivity dropped.

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- We extend Huo and Ríos-Rull (2013a) and Huo and Ríos-Rull (2013b) in various ways to include a production sector and asset prices that allows us to talk about the U.S. recession.

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- Large reductions in assets (housing and stocks) prices.
- Lower than the data due to inexistence of default, foreclosures, and adjustment costs in house purchases.

Model

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- Households also like tradables and housing and dislike goods searching

$$u \left[c_A(c_N \, \mathrm{I}_N^{\rho}, c_T), \; h, \; d \right]$$

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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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  - Decreasing returns.

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- Perfect competition and frictionless markets for tradables.

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- Employment: $N = N_N + N_T$.
- Same job finding probability across types: $\Phi^e = \frac{V}{1-N}$.
- Wages are determined via the following formula

$$\log w - \log \overline{w} = \varepsilon_w \left(\log Y - \log \overline{Y} \right)$$

It simplifies things.

Gornemann, Kuester, and Nakajima (2012).

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  - The return is

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

State variables

- A household is characterized by $\{\epsilon, e, a\}$.
- Let X denote the measure over types $x = \{\epsilon, e, a\}$.
- The vector of aggregate state variables is

$$S = \{\theta, B, K_N, K_T, N_N, N_T, X\}$$

  Here B is the net foreign asset position. K and N are predetermined factor inputs.

- Hence either we do Krusell-Smith or the transition after an unforeseen shock. Today, we do the latter.

Households' problem

$$V(S,\epsilon,e,a) = \max_{c_{N,i},c_T,\mathrm{I}_N,h,d} u(c_A,h,d) + \beta \sum_{\epsilon',e',\theta'} \Pi^{\theta}_{\theta,\theta'}\, \Pi^{w}_{e'|e,\epsilon}(S')\, \Pi^{\varepsilon}_{\epsilon,\epsilon'}\; V[S',\epsilon',e',a'(S',b,h)]$$

subject to

$$\int_0^{\mathrm{I}_N} p_i(S)c_{N,i} + c_T + p_h(S)h + q(\theta,b)b = a + 1_{e=1}w(S)\epsilon + 1_{e=0}\,\underline{w} \qquad \text{BC}$$

$$a'(S',b,h) = p_h(S')h + R(S,S',b)b \qquad \text{AA}$$

$$q(\theta,b)b \geq -\lambda(\theta)p_h(S)h \qquad \text{FC}$$

$$\mathrm{I}_N = d\;\Psi^d[Q^g(S)] \qquad \text{SC}$$

$$S' = G(S,\theta') \qquad \text{RE}$$

Nontradable firms' problem

- At each location, the production function is

$$F^N(k, \ell_1, \ell_2) = z_N k^{\alpha_0} \ell_1^{\alpha_1} \ell_2^{\alpha_2}$$

  - k and ℓ_1 are pre-installed. ℓ_2 is variable to meet different demands.

- The demand function is given by $c(p_i, S, x) = \left[\frac{p_i}{p(S)}\right]^{\frac{\rho}{1-\rho}} c_N(S, x)$

- When a shopper wants to buy c units of goods at a location, the amount of variable labor ℓ_2 needed to produce c is

$$f^\ell(c, k, \ell_1) = \left(c^{-1} z_N k^{\alpha_0} \ell_1^{\alpha_1}\right)^{-\frac{1}{\alpha_2}}$$

- At the posted price p_i, the total variable labor needed is

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

Nontradable firms' problem

$$\Omega^N(S,k,n) = \max_{\substack{i,v,p_i \\ \ell_1,\ell_2}} \Psi^f[Q^g(S)]p_i \int c(p_i,S,\epsilon,e,a)\,dx - w(S)\ell - i - \kappa v + \sum_{\theta'} \Pi^{\theta}_{\theta,\theta'} \frac{\Omega^N(S',k',n')}{1+r^*}$$

subject to

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

$$\ell_1 + \ell_2 = n\,\bar{\epsilon}(S) \qquad \text{SL}$$

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

$$n' = [1-\bar{\delta}_n(S)]n + v \qquad \text{LML}$$

$$S' = G(S,\theta') \qquad \text{RE}$$

Tradable firms' problem

$$\Omega^T(S,k,n) = \max_{i,v} F^T(k,\ell) - w(S)\ell - i - \kappa v - \phi^{T,n}(n',n) + \sum_{\theta'} \Pi^{\theta}_{\theta,\theta'} \frac{\Omega^T(S',k',n')}{1+r^*}$$

subject to

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

$$\ell = n\,\overline{\epsilon}(S)$$

$$n' = [1-\overline{\delta}_n(S)]n + v$$

$$S' = G(S).$$

Mutual fund

- Financial wealth in the economy is

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

- Mortgages in the economy are

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

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

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

- The realized rate of return is

$$1 + r(S, S') = \frac{\Omega^N(S') + \Omega^T(S') + (1+r^*)B + L_-}{L_+}$$

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

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

- Nontradable prices satisfies

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

- Housing market clears

$$\int h(S, \epsilon, e, a)\, dx = \mathrm{H}.$$

Equilibrium

- Average separation probability and labor force quality

$$\overline{\delta}_n(S) = \frac{\sum_\epsilon \delta_n(\epsilon) n(\epsilon)}{N}, \qquad \overline{\epsilon}(S) = \frac{\sum_\epsilon \epsilon\, n(\epsilon)}{N}$$

- Rate of return to the mutual fund satisfies

$$1 + r(S, S') = \frac{\Omega^N(S') + \Omega^T(S') + (1 + r^*)B + \int_{b<0} b(S, x)}{\int_{b>0} b(S, x)}$$

- Wage satisfies

$$\log w(S) - \log \overline{w} = \varepsilon_w \left(\log Y(S) - \log \overline{Y} \right)$$

- The law of motion $G(S)$ is consistent with households' decisions and employment dynamics.

Mapping the Model to Data

Functional forms

- Preferences

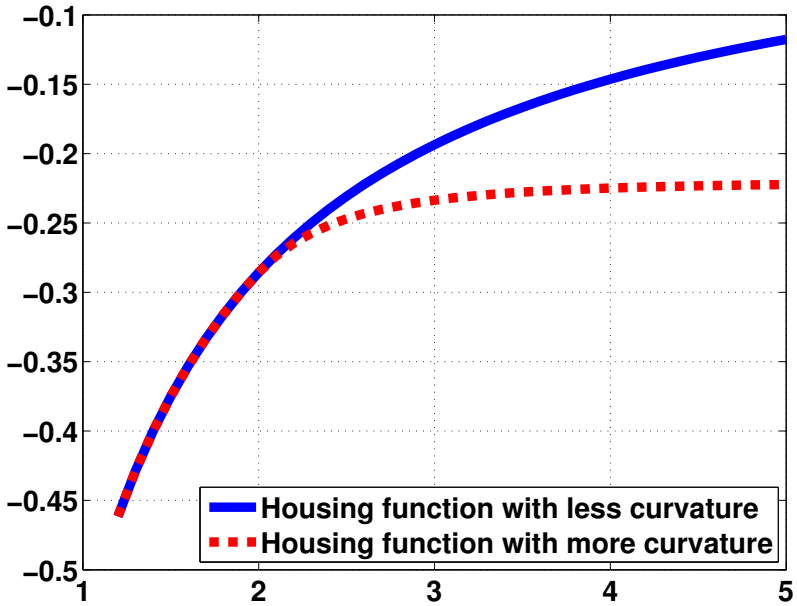
$$u(c_A, h, d) = \frac{1}{1-\sigma_c}\left(c_A - \xi_d \frac{d^{1+\gamma}}{1+\gamma}\right)^{1-\sigma_c} + v(h)$$

- where there is an Armington aggregator for consumption

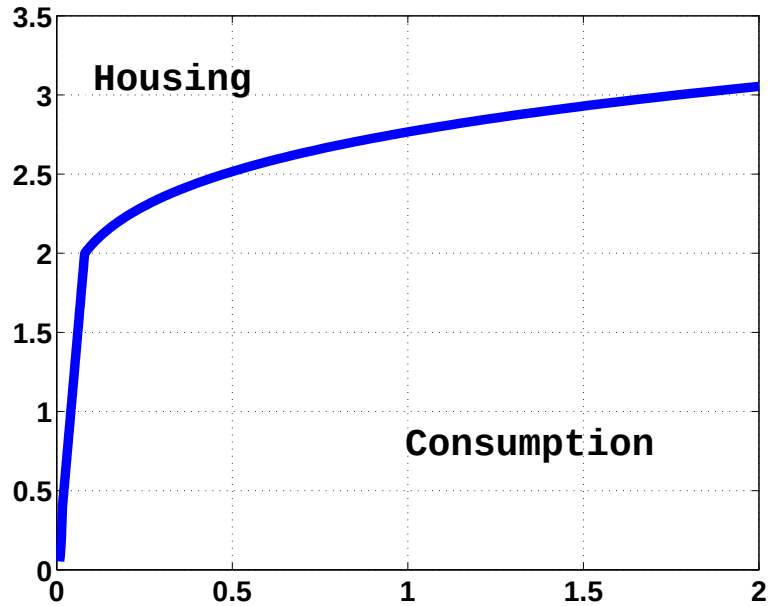
$$c_A = \left[\omega \left(c_N \mathrm{I}_N^{\rho}\right)^{\frac{\eta-1}{\eta}} + (1-\omega) c_T^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}$$

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

$$v(h) = \begin{cases} \frac{\xi_h}{1-\sigma_h^1}\left(h + \underline{h}_1\right)^{1-\sigma_h^1}, & \text{if } h < \widehat{h} \\ \frac{\xi_h}{1-\sigma_h^2}\left(h + \underline{h}_2\right)^{1-\sigma_h^2}, & \text{if } h \geq \widehat{h}. \end{cases}$$



Housing utility function



Engel Curve: consumption vs housing

Functional forms

- Production function

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

- Capital adjustment cost in the nontradable goods sector

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

- Capital and employment adjustment cost in the tradable goods sector

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

- Matching technology

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

Exogenously determined parameters

- A period is half a quarter.

Parameter	Value
Risk aversion for consumption, σ_c	2.0
Risk aversion for housing, σ_h^1	2.0
Risk aversion for housing, σ_h^2	10.0
Curvature of shopping, γ	1.5
Elasticity of substitution bw tradables and nontradables, η	0.80
Cutoff value for housing utility, $\widehat{h}$	1.4
Price markup, ρ	1.1
Loan to value ratio, λ	0.75
Interest rate for international bonds, r^*	4%

Endogenously determined parameters: aggregate

Target	Value	Parameter	Value
Wealth to output ratio	4.70	β	0.98
Housing value to output ratio	1.67	ξ_h	0.95
Debt to output ratio	0.75	ϵ_4	30.77
Share of tradables	0.30	ω	0.95
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
$1.4\theta_0 + \theta_1 = 1$	——	θ_0	0.23
Vacancy cost to output ratio	0.02	κ	0.42
Home production to lowest earning ratio	0.50	$\overline{w}$	0.07
Units Parameters			
Output	1	z_N	0.93
Relative price of nontradables	1	z_T	0.48
Market tightness in goods markets	1	ξ_d	0.03

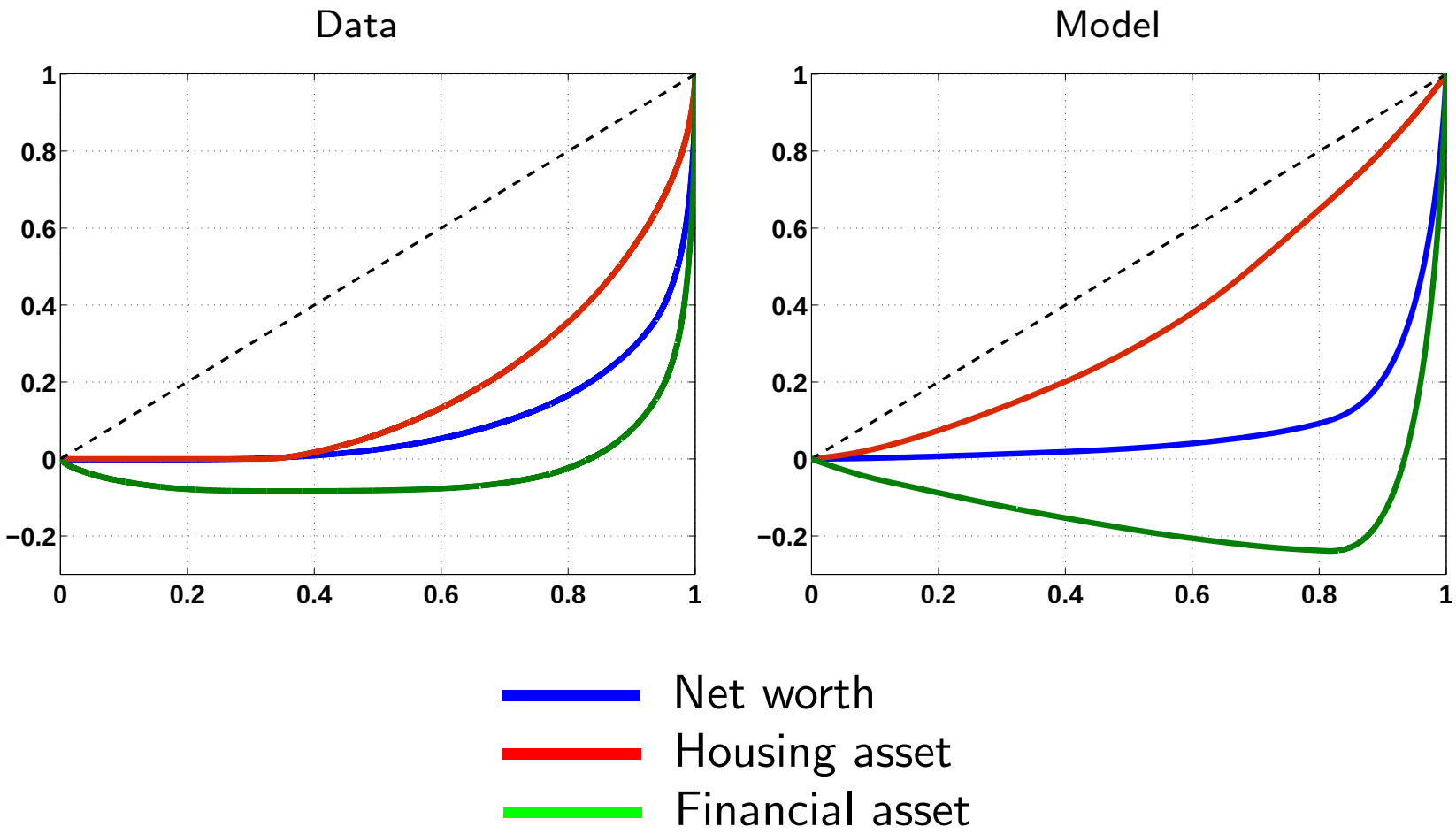
Endogenously determined parameters: cross-section

Lorenz

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	$\Pi_{4,1}^{\epsilon}$	0.0156
Earning autocorrelation	0.91	$\Pi_{1,1}^{\epsilon}$	0.9660
Earning stdev	0.20	$\Pi_{2,2}^{\epsilon}$	0.9774

Lorenz Curve

Return



Experiments: once and for all set of surprises in the environment

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3. Both at the same time.

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3. Both at the same time.
4. The inverse process. Credit expansion.

- All of these with fixed and flexible wages.

Long Run Properties

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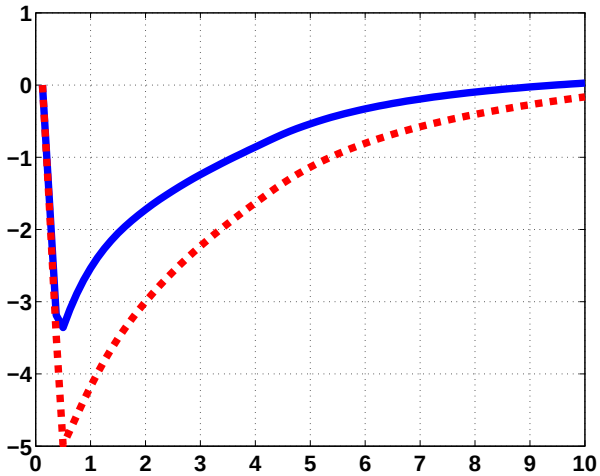
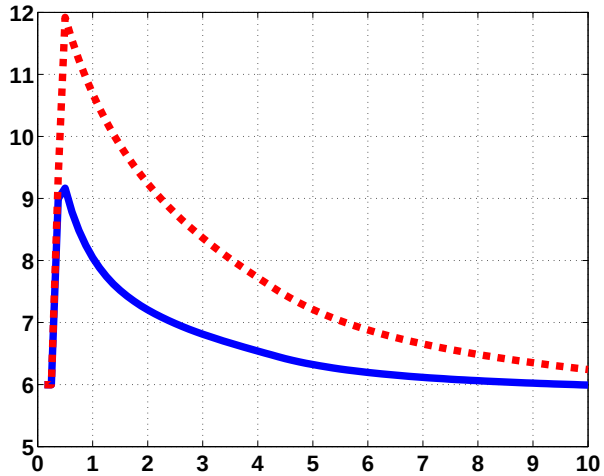
- But in our economies the transition is associated to a recession.

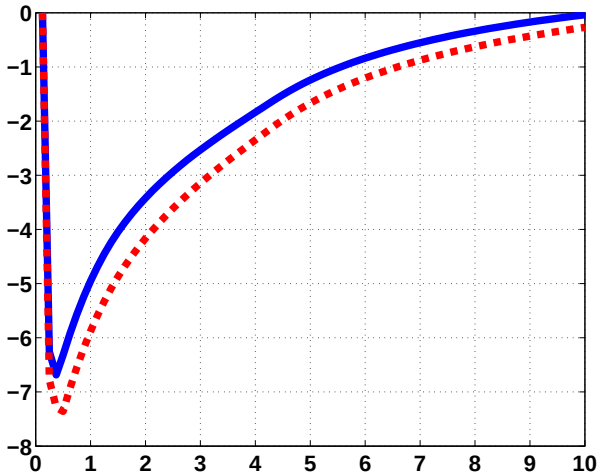
Experiment : gradual worsening of both λ and borrowing cost



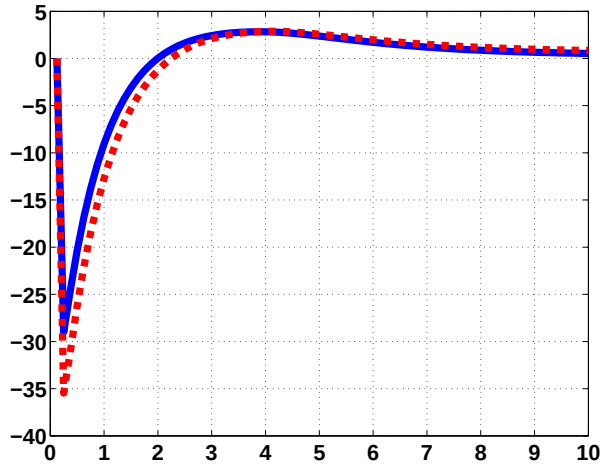
Real output



Unemployment



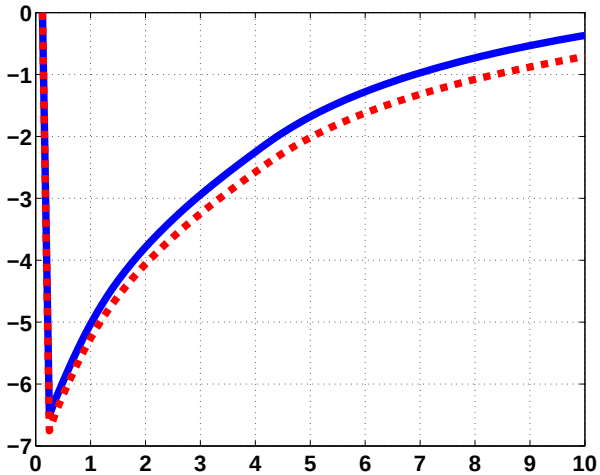
Consumption



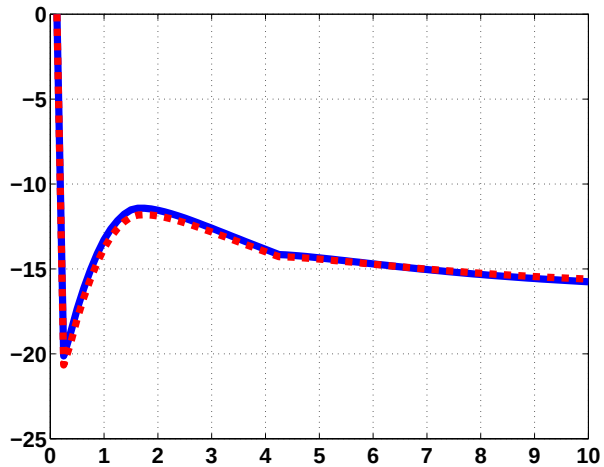
Investment

Flexible wage Fixed wage

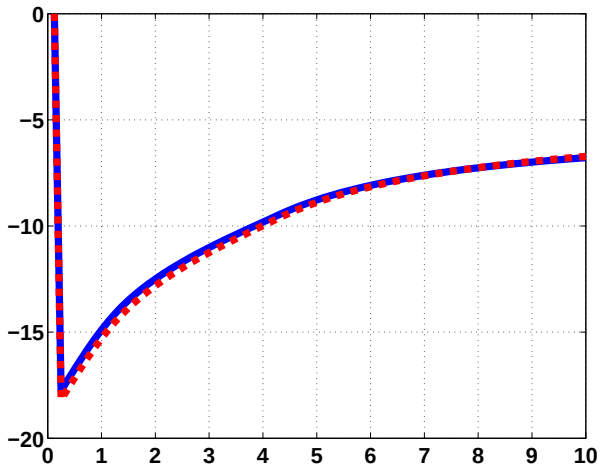
Experiment: gradual worsening of both λ and borrowing cost



Wealth



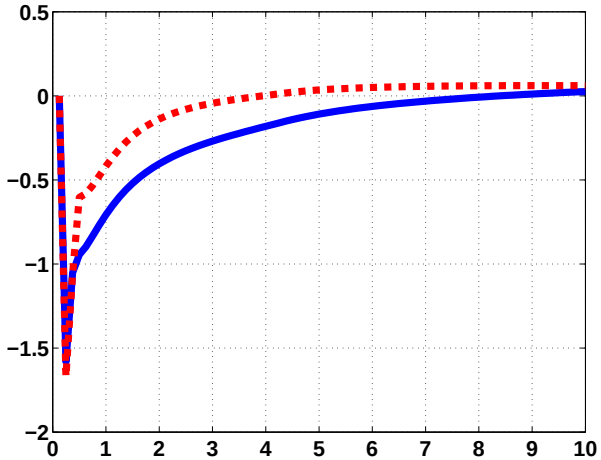
Debt



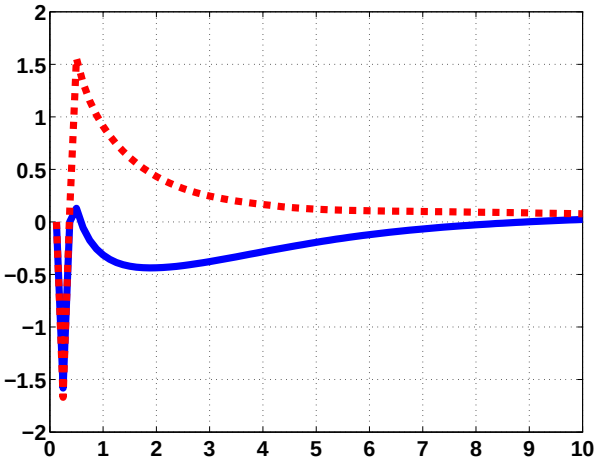
Housing price

Flexible wage Fixed wage

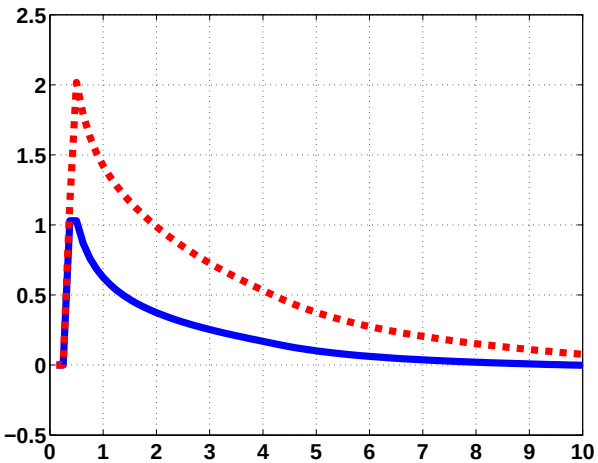
Experiment: gradual worsening of both λ and borrowing cost



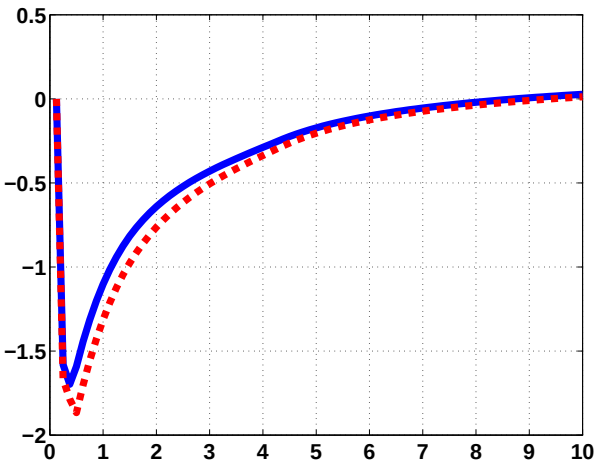
TFP with total hours



Labor Productivity



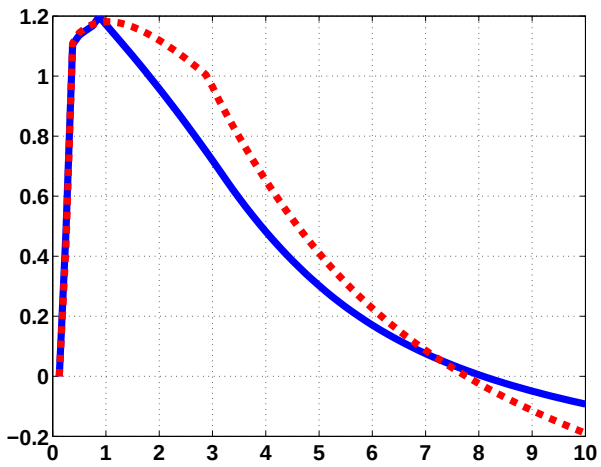
Labor quality



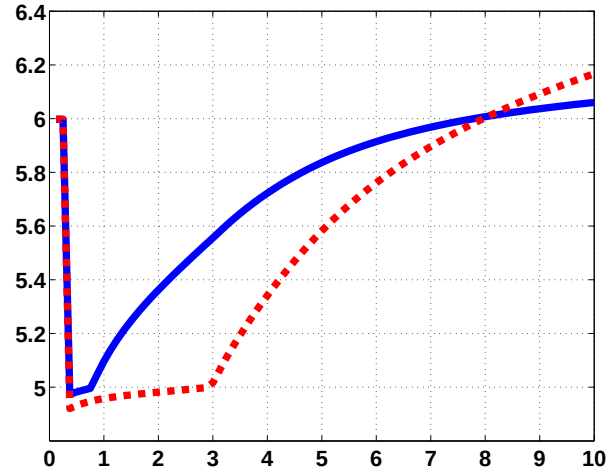
TFP with total labor inputs

Flexible wage Fixed wage

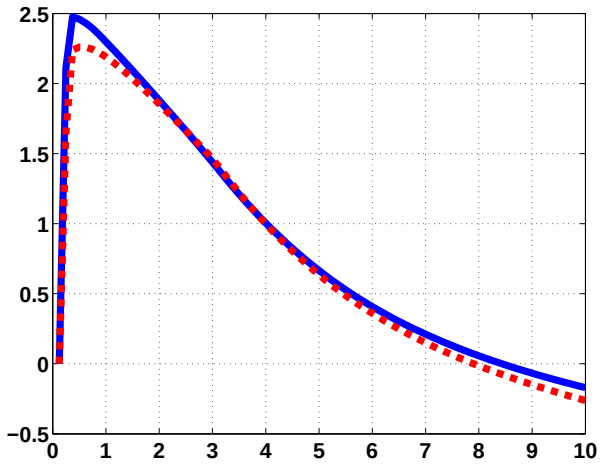
Experiment: gradual improvement of λ from 0.75 to 0.825



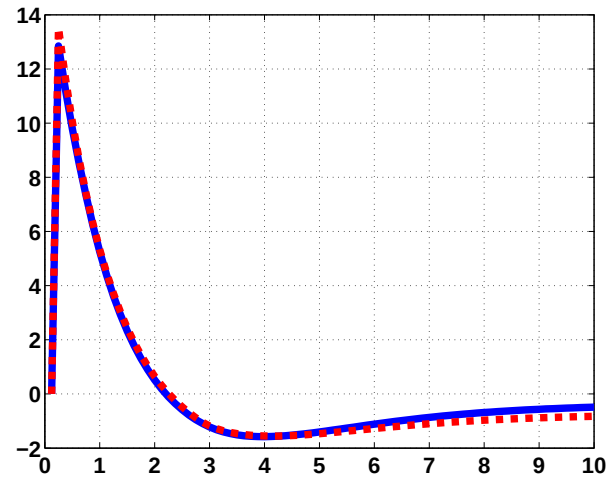
Real output



Unemployment



Consumption



Investment

Flexible wage Fixed wage

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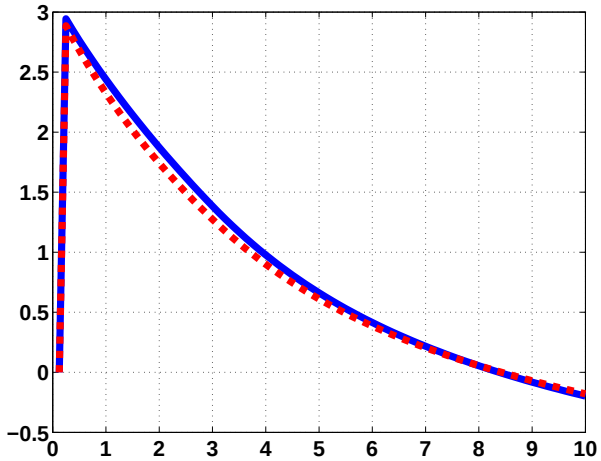
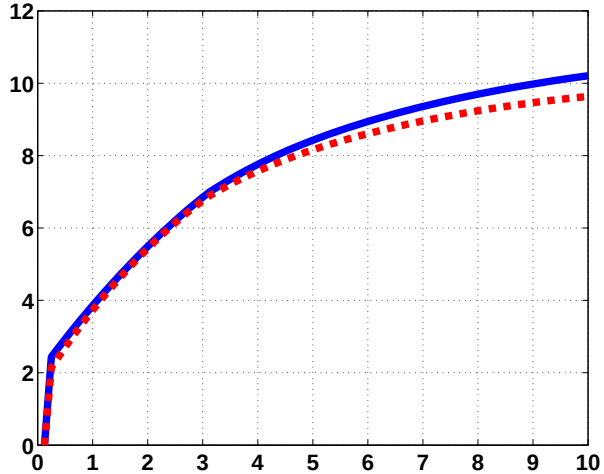
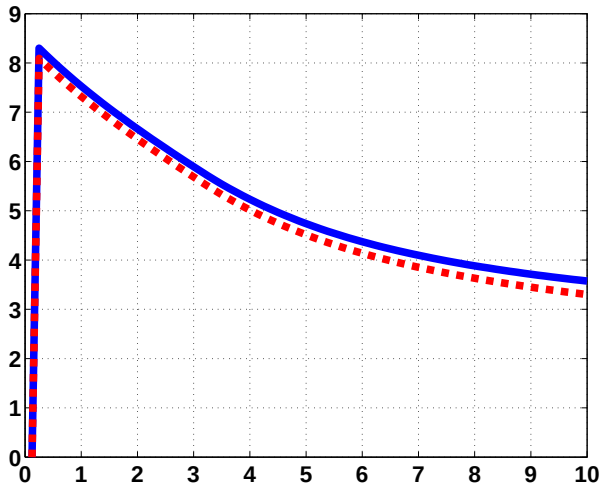


Wealth



Debt



Housing price

Flexible wage Fixed wage

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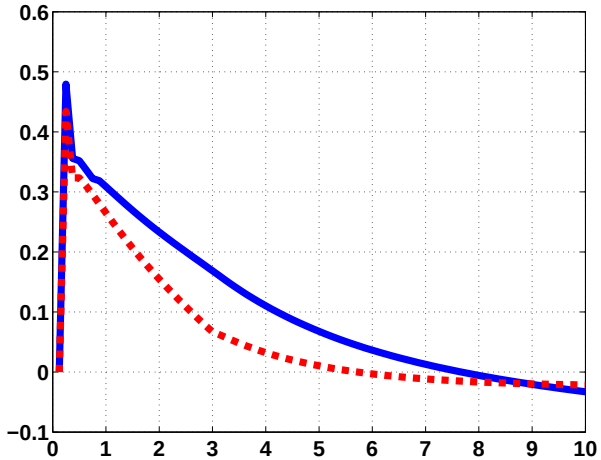
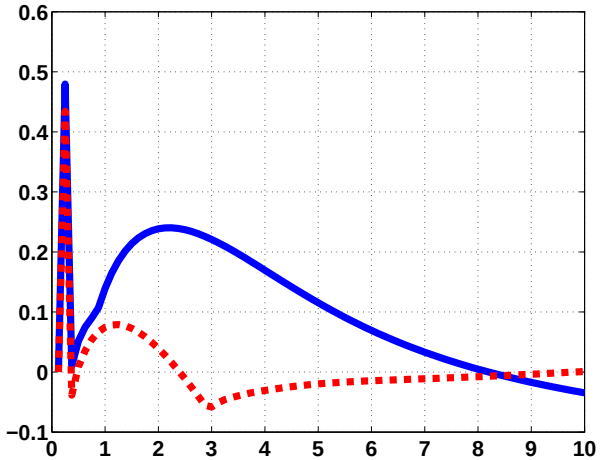
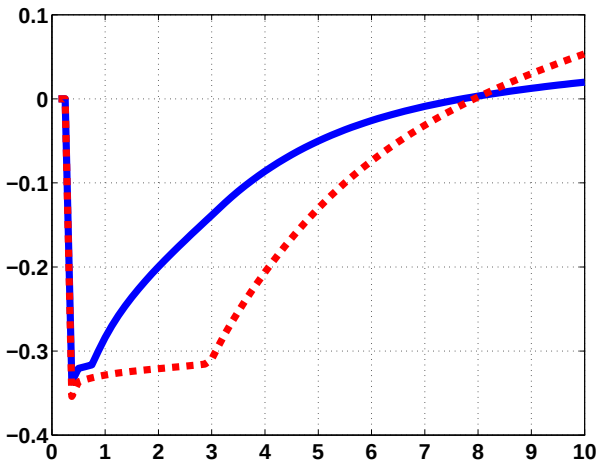


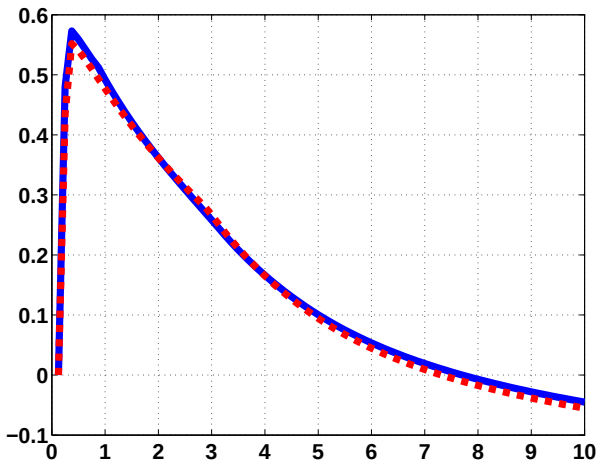
TFP with total hours



Labor Productivity



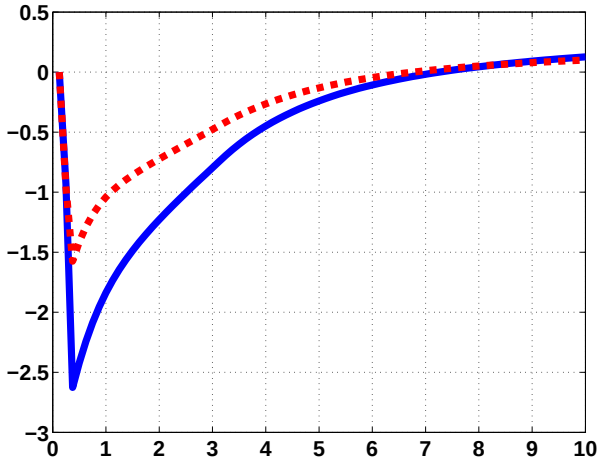
Labor quality



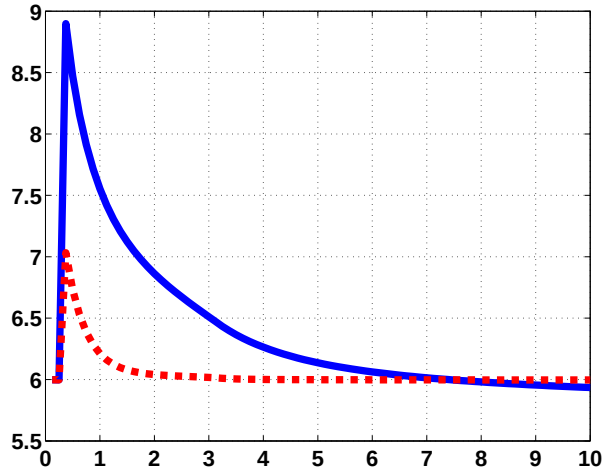
TFP with total labor inputs

Flexible wage Fixed wage

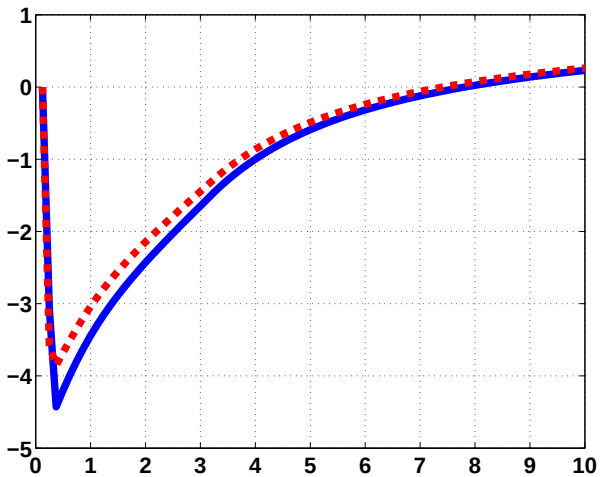
Experiment 5: More flexible wage schedule



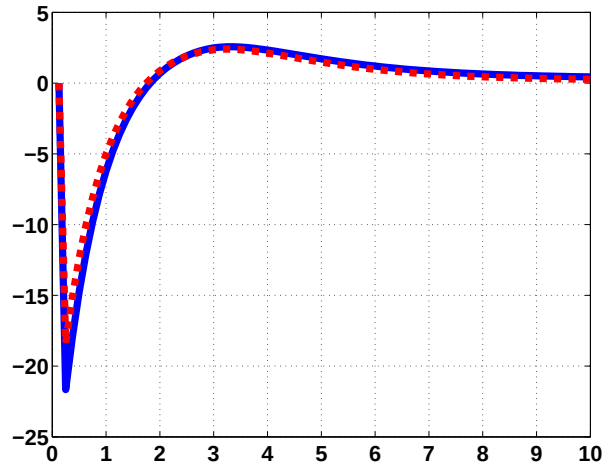
Real output



Unemployment



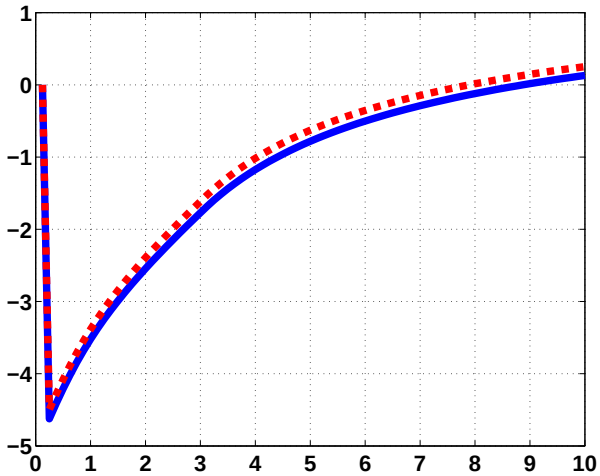
Consumption



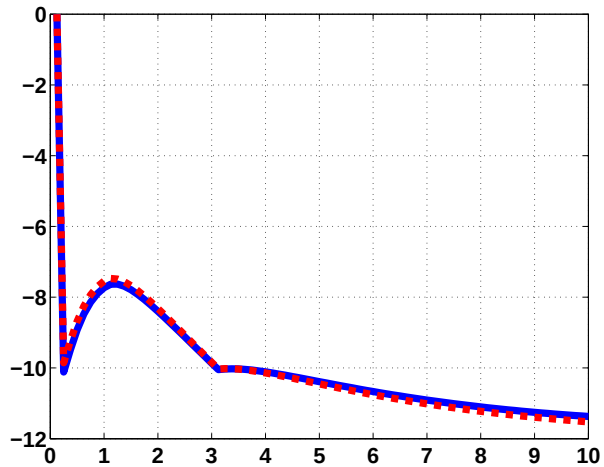
Investment

Flexible wage $\epsilon_w = 0.45$ Flexible wage $\epsilon_w = 1$

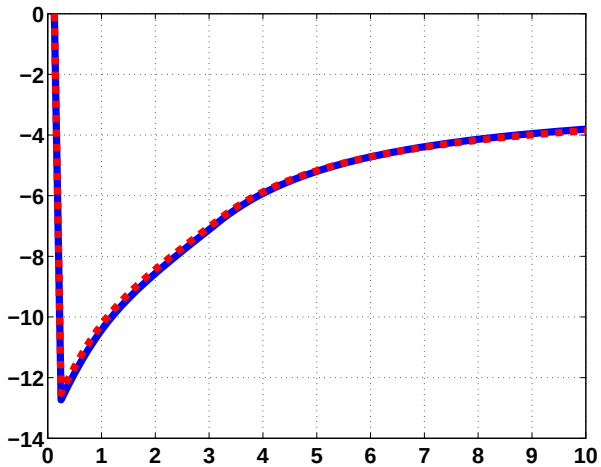
Experiment 5: More flexible wage schedule



Wealth



Debt



Housing price

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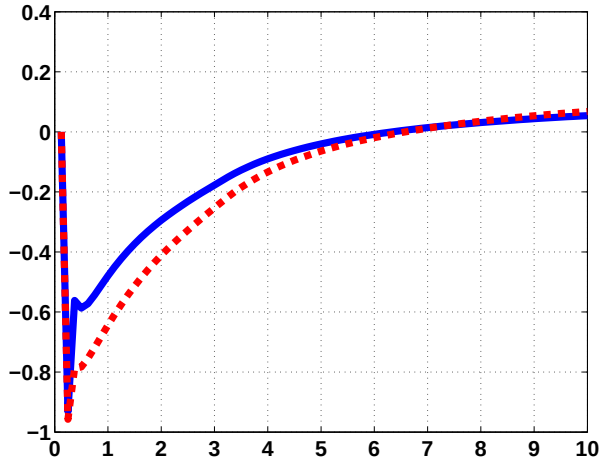
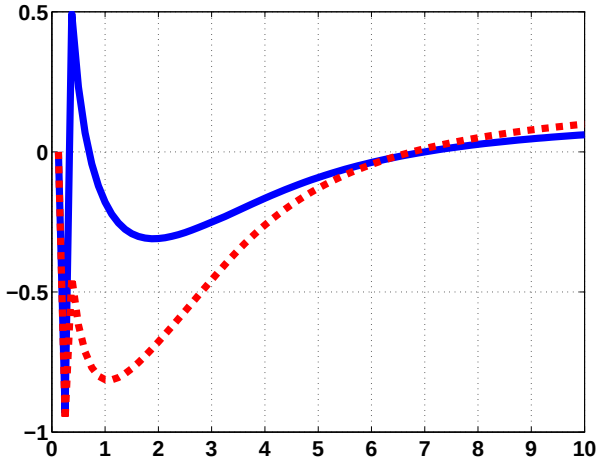
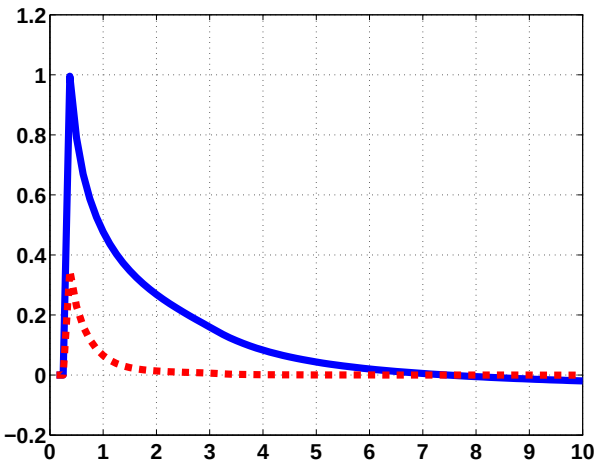


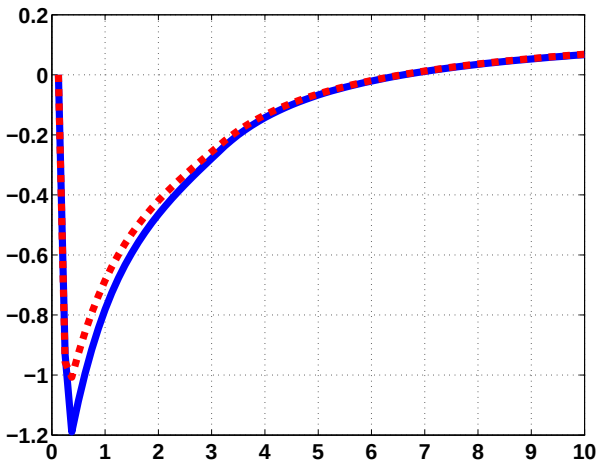
TFP with total hours



Labor Productivity



Labor quality



TFP with total labor inputs

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Conclusions

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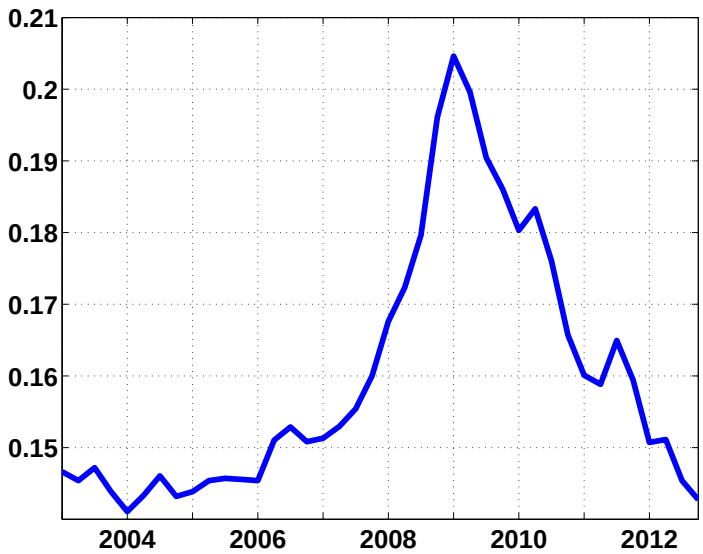
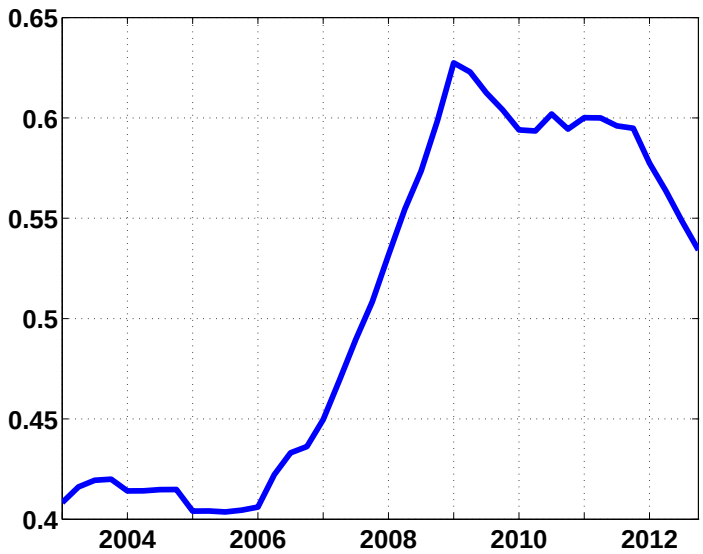
Facts on the last recession: IV

Return



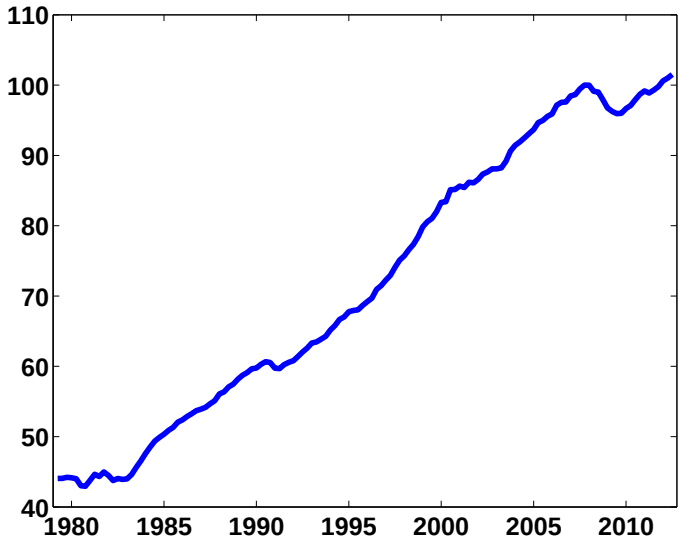
Debt to wealth



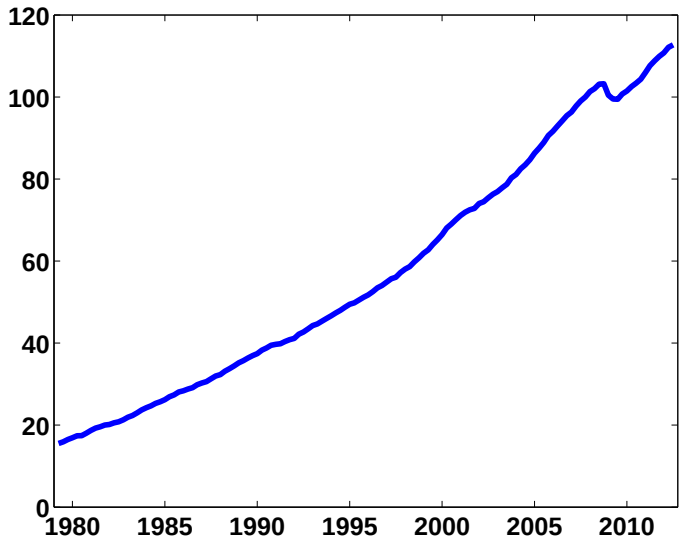
Debt to housing value

Facts: Continued

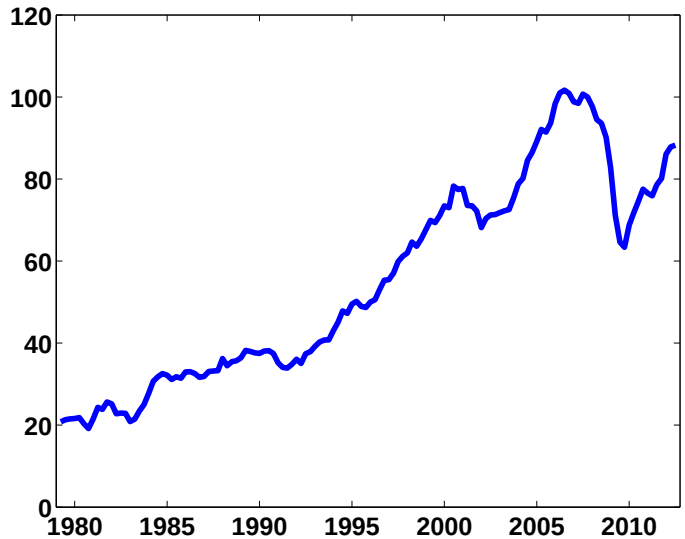
Return



Real output



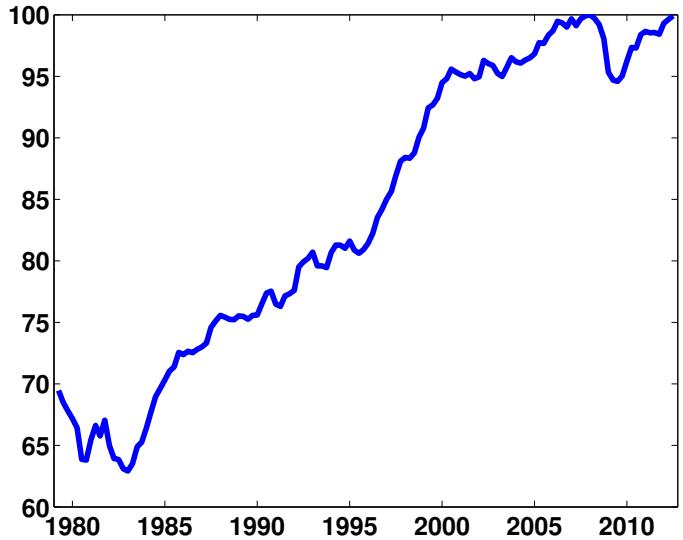
Consumption



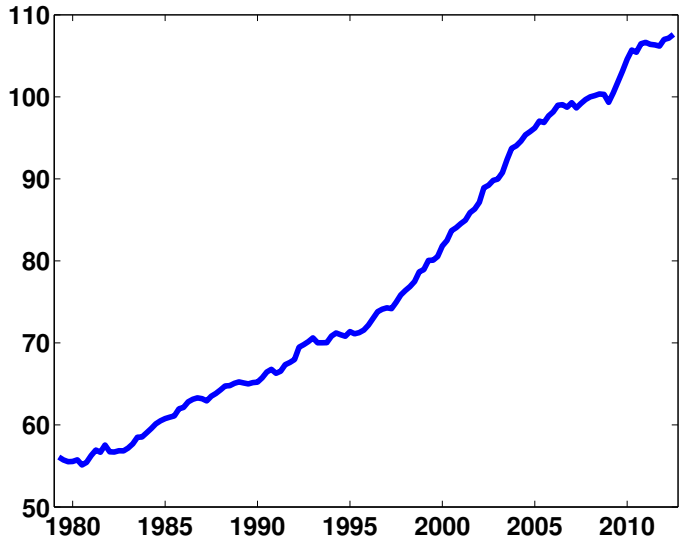
Investment

Facts: Continued

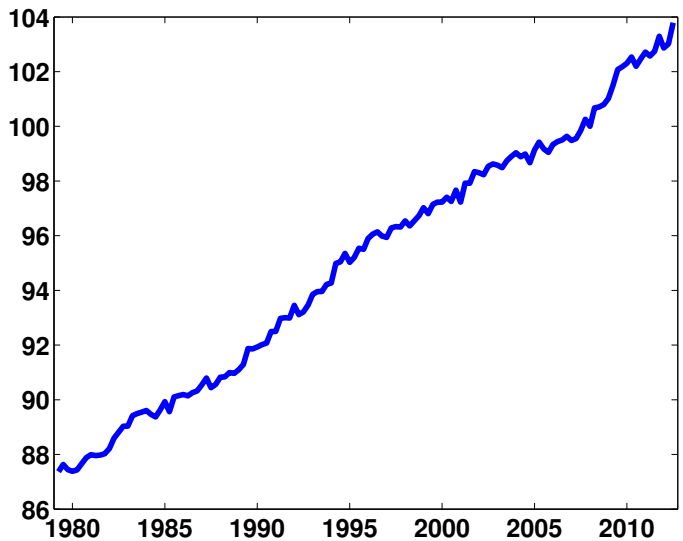
Return



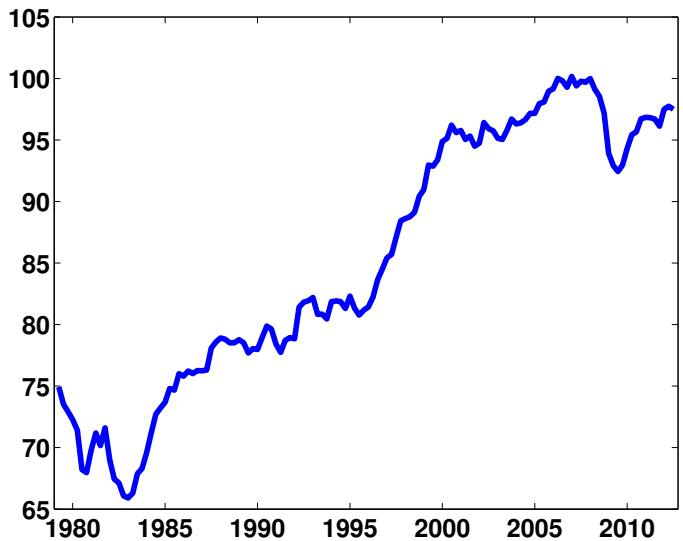
TFP with total hours



Labor productivity



Labor quality

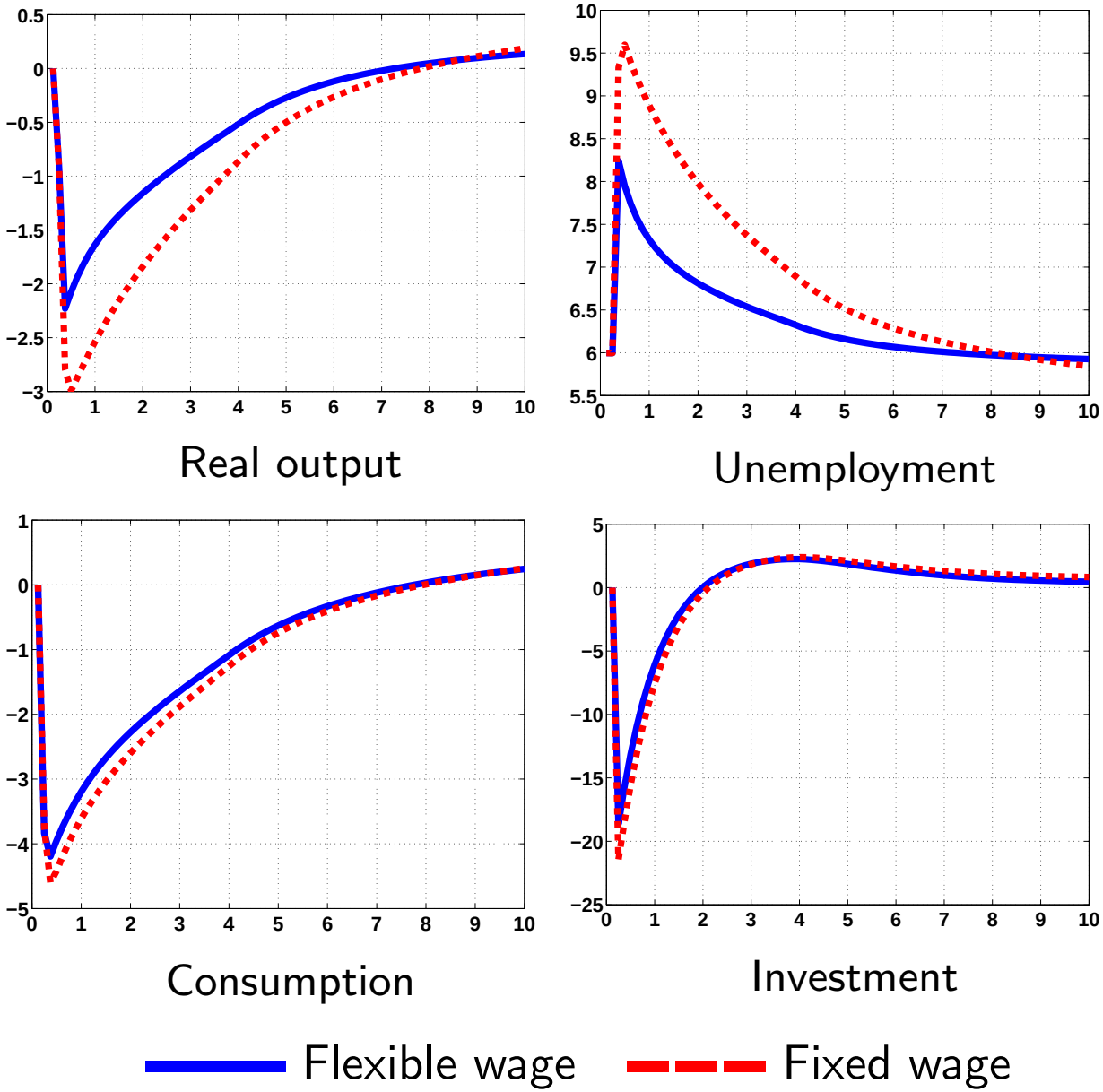


TFP with total labor inputs

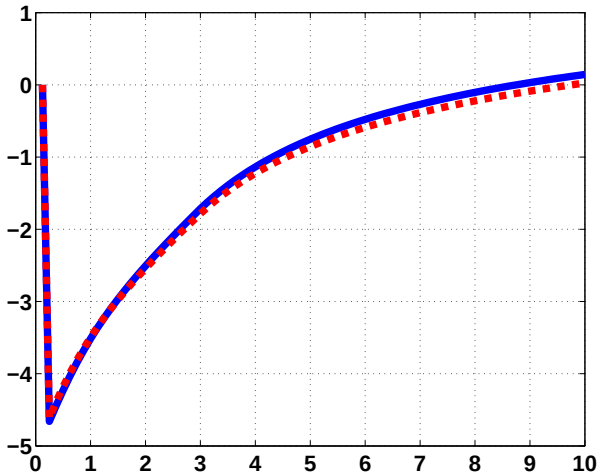
Facts: Continued

- 'Real output', 'consumption' and 'investment' are 'Gross Domestic Product', 'Personal Consumption Expenditures' and 'Gross Private Domestic Investment' from BEA.
- 'TFP with total hours' is calculated by Fernald (2012).
- 'Labor productivity' is total output divided by total hours.
- 'Labor quality' follows Aaronson and Sullivan (2001), which are extended by Bart Hobijn and Joyce Kwok (FRBSF).
- 'TFP with total labor inputs' is total output divided by the product of total hours and labor quality.
- These variables shown at the beginning are deviations from their linear trends. These variables shown in the appendix have their values in 2007 q4 normalized to 100.

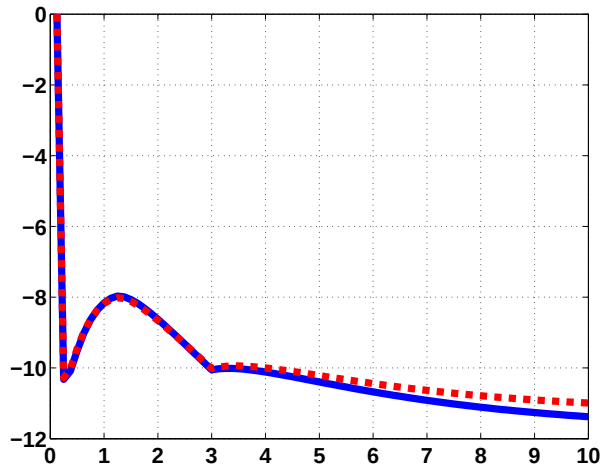
Experiment 1: gradual change of λ from 0.75 to 0.675



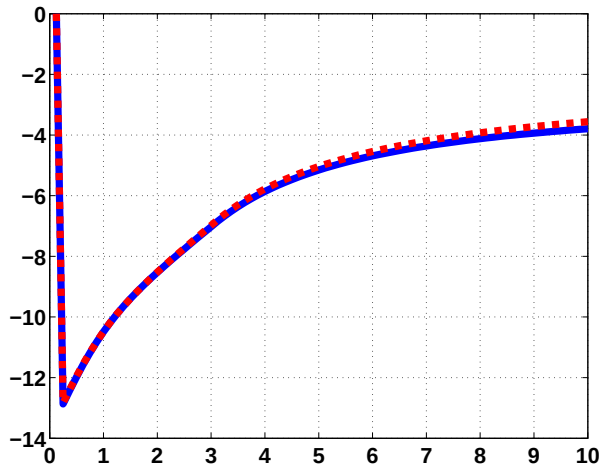
Experiment 1: gradual change of λ from 0.75 to 0.675



Wealth



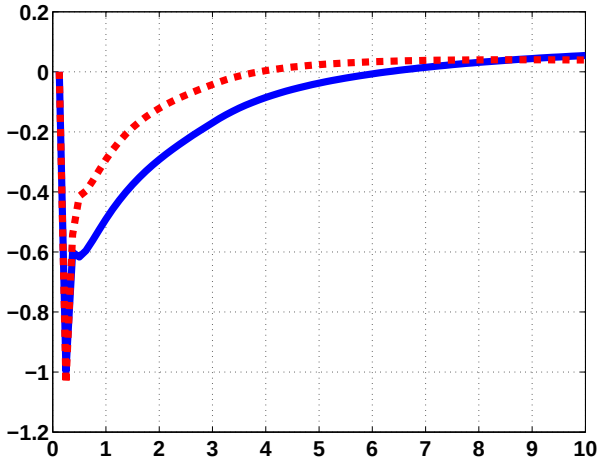
Debt



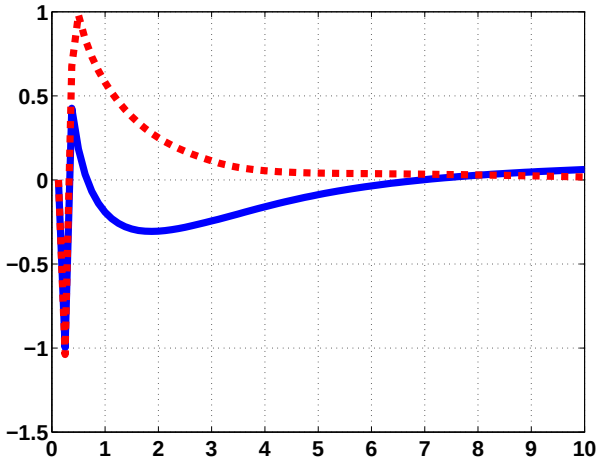
Housing price

Flexible wage Fixed wage

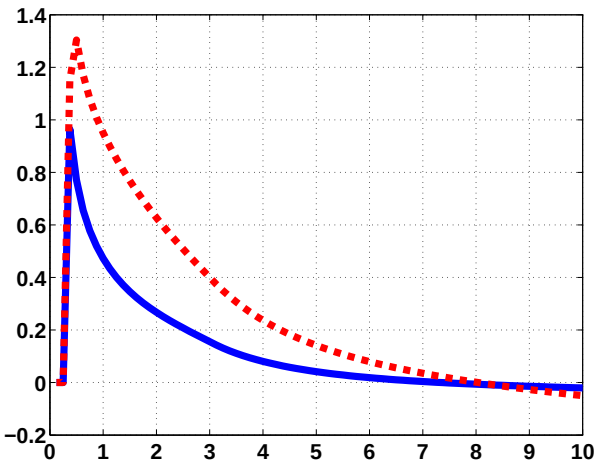
Experiment 1: gradual change of λ from 0.75 to 0.675



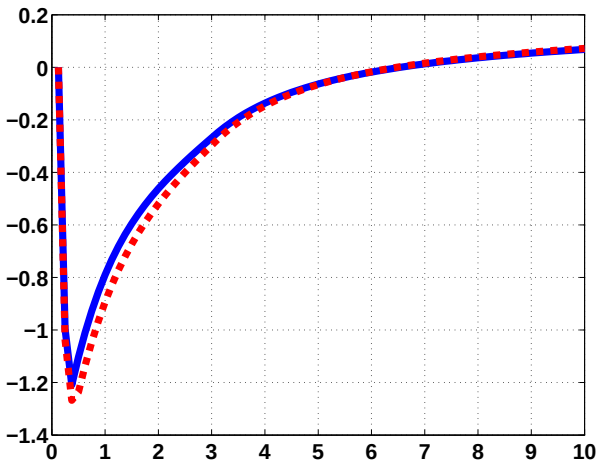
TFP with total hours



Labor Productivity



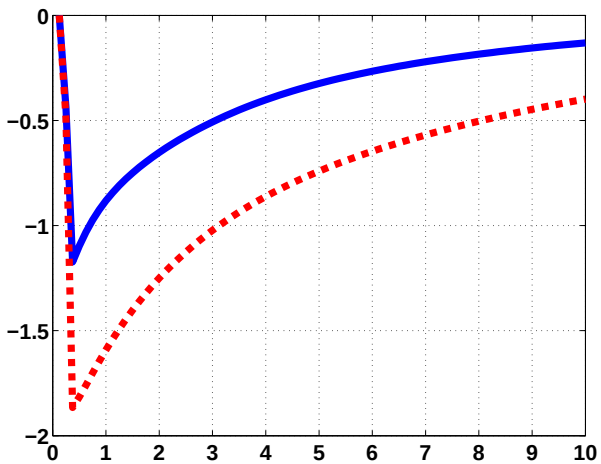
Labor quality



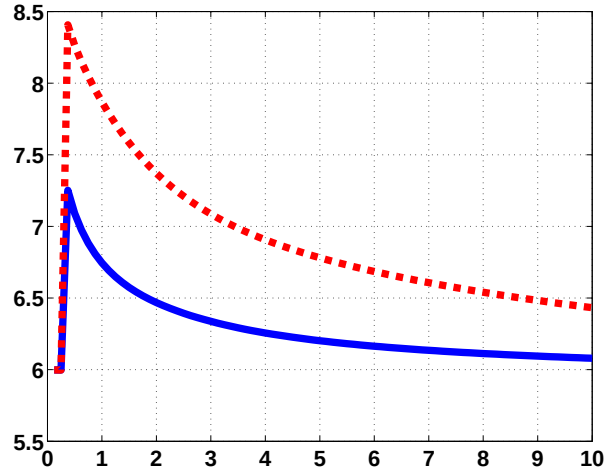
TFP with total labor inputs

Flexible wage Fixed wage

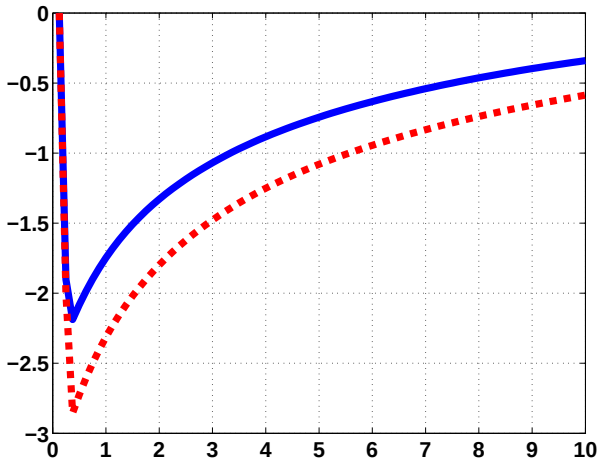
Experiment 2: gradual change of borrowing cost from 0 to 0.3%



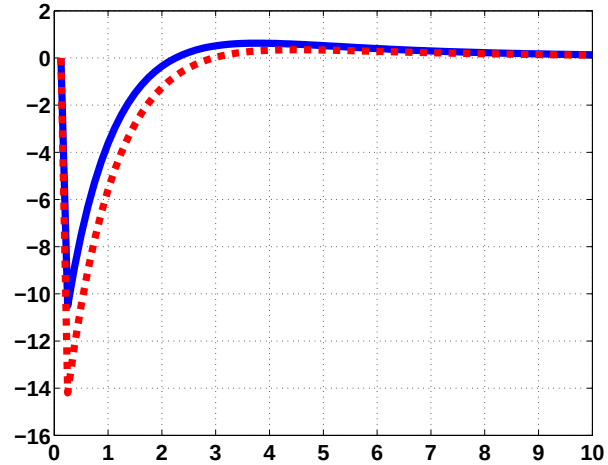
Real output



Unemployment



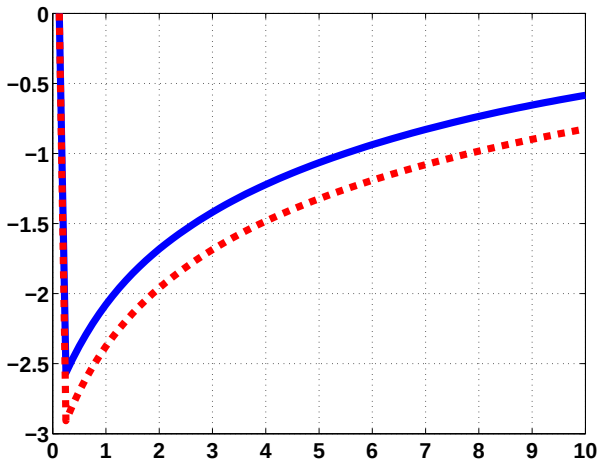
Consumption



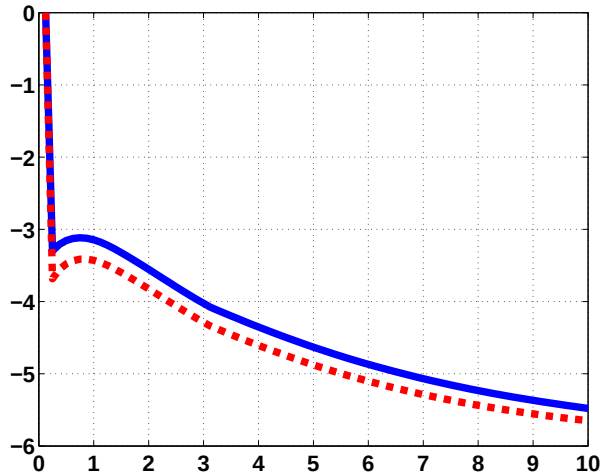
Investment

Flexible wage Fixed wage

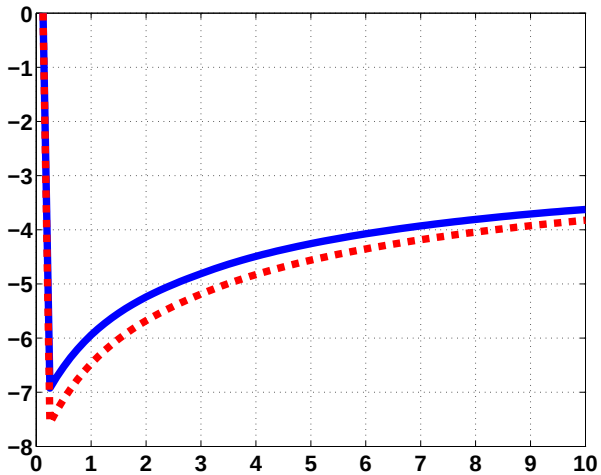
Experiment 2: gradual change of borrowing cost from 0 to 0.3%



Wealth



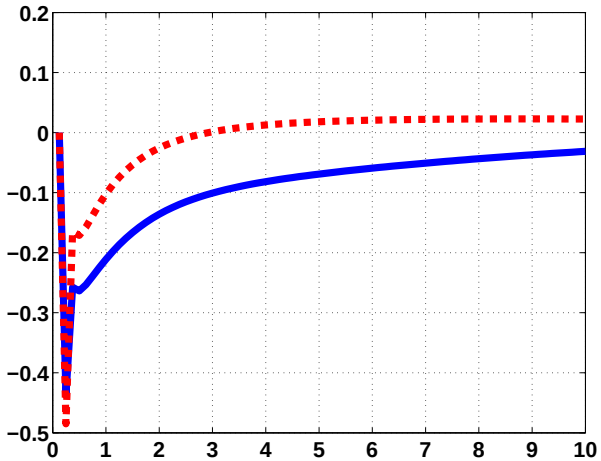
Debt



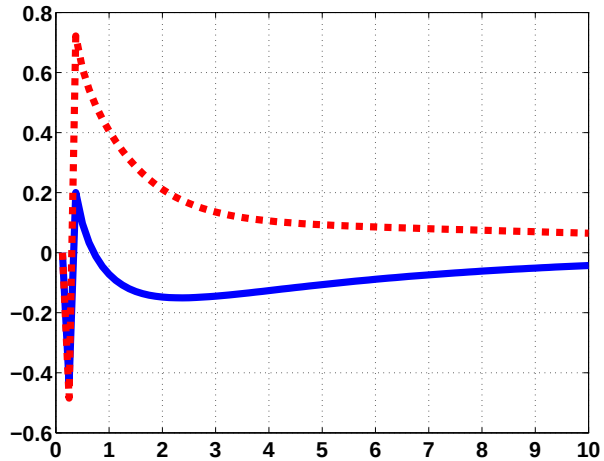
Housing price

Flexible wage Fixed wage

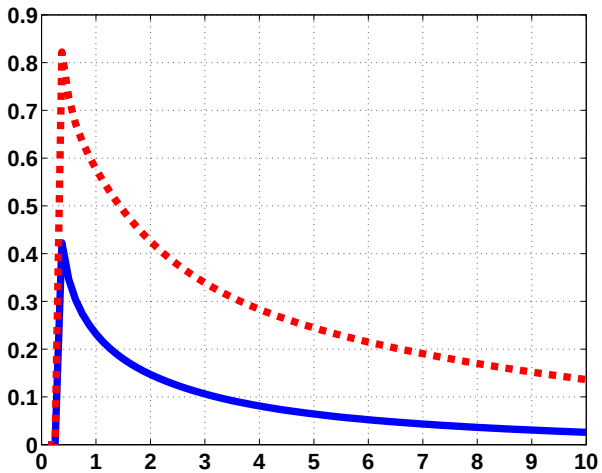
Experiment 2: gradual change of borrowing cost from 0 to 0.3%



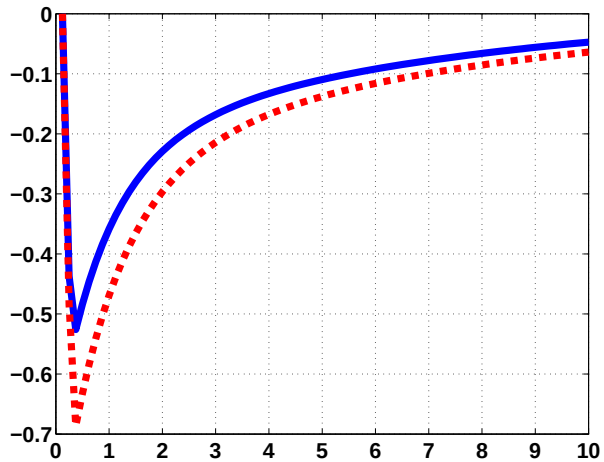
TFP with total hours



Labor Productivity



Labor quality



TFP with total labor inputs

Flexible wage Fixed wage