Reassessing the Role of Heterogeneity to Understand Business Cycles

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Heterogeneity and Inequality are a Sign of the Times

- It has increased a lot recently with hard to predict consequences.
- It permeates many facets of life:
  - Consumption
  - Politics
  - Migration
  - Family Formation
  - Health and Longevity
- But as Macroeconomists, should we care?

- It does not do a very good job.
    - Sources of Shocks
        - Technology (Nobody has ever seen them)
        - Preference (patience, markups), what are they?.
        - Monetary (as in New Keynesian Models) are too small (and is Central Bank Moodiness so large?)
    - It requires an unsuitably large Frisch Elasticity of Labor to move employment.
    - There is a lot of wealth that can be used efficiently to weather changes in available resources.
- The Great Recession has highlighted its shortcomings: How come we got such a large recession.

Aiyagari-Bewley-Huggett-Imrohoroglu models with Aggregate Shocks

- Heterogeneous Households only (just for this talk).
- Why could they generate larger fluctuations?
  - First set of Empirical Reasons
    1. Recessions hit (lower earnings, more unemployment) more vulnerable (poor) households more.
    2. Poor households have a higher Marginal Propensity to Consume out of income than rich households Johnson, Parker, and Souleles (2004), Misra and Surico (2014).

Data: Marginal Distributions (Sorted by each variable)

Heterogeneity (Inequality) in 2006:
Marginal Distributions

	y	c	a	SCF 07 a
Mean (2006$)	62,549	43,980	291,616	497,747
%*Share* : *Q*1	4.5	5.6	-0.9	-0.2
*Q*2	9.9	10.7	0.8	1.2
*Q*3	15.3	15.6	4.4	4.6
*Q*4	22.8	22.4	13.0	11.9
*Q*5	47.5	45.6	82.7	82.5
90 – 95	10.8	10.3	13.7	11.1
95 – 99	12.8	11.3	22.8	25.3
Top 1%	8.0	8.2	30.9	33.5

- *a*: Bottom 40% holds basically no wealth
- *y*, *c*: less concentrated

Heterogeneity (Inequality) in 2006: Joint Distributions (Sorted by wealth)

	% Share of:		Exp.Rate
a	y	c	c/y (%)
$Q1$	8.6	11.3	92.2
$Q2$	10.7	12.4	81.3
$Q3$	16.6	16.8	70.9
$Q4$	22.6	22.4	69.6
$Q5$	41.4	37.2	63.1

- Wealth-rich earn more and save at a higher rate
- Bottom 40% hold no wealth, account for 25% of spending
- 80% poorest acount for 63% of consumption

Theory Mechanisms in narrowly defined neoclassical models

1. Models of Employment not Hours: Misery is concentrated.

2. Poor households (those that consume most of their income) are now poorer.

3. All this allows in principle the Jensen inequality to do its job: Mean behavior is not the same that the behavior of the mean. Quantitatively it requires

   3.1 Nonlinear decision rules (at least on the low levels of income and wealth)

   3.2 A lot of agents in the states where their behavior is non linear (close to zero cash in hand).

Original Findings: Heterogeneity does not matter

- Krusell Smith (1997-98) broke the fear of computational unfeasibility. They showed how to solve for equilibria in these (then) monster looking thingies.
- They also found out a property of these models: Quasilinearity.
    1. The aggregate law of motion is (almost) linear. So effectively no Jensen inequality.
    2. Moreover, most agents are in the most linear part of the state space/
- Heterogeneous agents models are like Rep Agent models for business cycle purposes. Also confirmed in life-cycle models.

Why in those models Heterogeneity did not matter much?

- Agents had plenty of wealth for the purpose of effectively smoothing consumption across time (even in high wealth dispersion models due to $\beta's$ differences) .
- Agents that do worse do not do so badly. Unemployment is short lived and lives no scars.
- So early models did not have
  1. High enough Marginal Propensity to Consume of poor people
  2. Enough Low wealth people
  3. Large enough shocks

A first update to Heterogeneous Agent Models

Krueger, Mitman and Perri (2016a): more inequality, larger shocks

- Augmented Krusell and Smith (1998): aggregate shock moves TFP and unemployment $\Pi_Z(u)$
- Rare but severe recessions (Y drops $\approx 7\%$) and long (5 years)

$$Y = Z^* K^\alpha N(Z)^{1-\alpha}$$

- Exogenous individual income risk
  - Unemp risk $s \in \{u, e\}$. Increases in recessions (8.4% vs 5.3%).
  - Income risk y.
- Individual preference heterog. and some life cycle to have poor agents.
- Unemployment insurance system with size $\rho = 50\%$.

Inequality in the Benchmark Economy

Net Worth	Data		Model
% Share held by:	PSID, 06	SCF, 07	
$Q1$	-0.9	-0.2	0.3
$Q2$	0.8	1.2	1.2
$Q3$	4.4	4.6	4.7
$Q4$	13.0	11.9	16.0
$Q5$	82.7	82.5	77.8
$90-95$	13.7	11.1	17.9
$95-99$	22.8	25.3	26.0
Top 1%	30.9	33.5	14.2
Gini	0.77	0.78	0.77

- Get's inquality almost right at the very bottom

Joint Distributions (2006): data v/s model

	% Share of:					
	y		c		%c/y	
a Quintile	Data	Model	Data	Model	Data	Model
$Q1$	8.6	6.0	11.3	6.6	92.2	90.4
$Q2$	10.7	10.5	12.4	11.3	81.3	86.9
$Q3$	16.6	16.6	16.8	16.6	70.9	81.1
$Q4$	22.6	24.6	22.4	23.6	69.6	78.5
$Q5$	41.4	42.7	37.2	42.0	63.1	79.6

- But Still overstates consumption and saving rates of the rich.
- Rudimentary life cycle is crucial for level of consumption rates and their decline with wealth.

Consumption Decline from a Large TFP Shock (4%)

	Models*		
% Share:	KS	no UI	+UI
ΔC	-1.9%	-2.9%	-2.4%

- Still Relative Minor Action.
- If we were to think of Endogenous Labor, it would be Worse (Guerrieri-Lorenzoni-2009)

Taking Stock

- Still Small Effects of Modelling Heterogeneity even with a Silly Theory of the Great Recession (4% TFP drop)
    1. Small Response of Household Consumption.
    2. Automatic Stabilizers do their job (smaller role of Heterogeneity)
    3. Other margins (investment, labor) not clearly helped by household Heterogeneity.

- Some other features could add some further action
    - Higher risk in recessions (Bayer, et al (2016), Storesletten, et al (2004), Guvenen, et al (2015)) Nakajima and Rios-Rull (2018).

But not by much

A Parallel Story with New Kenesian Models

- Heterogeneous Agent environments have also been used in New Keynesian environments and some of the same findings go through:
  - Kaplan et al. (2016)
  - Luetticke (2015)
  - Bayer et al. (2015)
  - McKay and Reis (2016)
  - Ravn and Sterk (2012)
  - Gornemann, et al. (2016)
- The main feature is to imply a slightly larger drop in consumption to that in Rep agent Models.

Where do we go from here

- There are still various margins that when combined with inequality can give us the possibility of larger fluctuations

    1. Assets are not very liquid (Kaplan et al. (2016)): Pension plans, financial transactions,

    2. Wealth disappears: We need to model wealth differently than accumulated output: Asset Prices that can move dramatically.

    3. Expenditures play a role in productivity

    4. Sectoral Reallocation is costly: Nontradables to tradables.

- These margins open the door to other type of shocks (financial shocks, government policy shocks, international shocks).

A second update: Heterogeneity and the new margins

- Asset Holdings
  - The portfolio composition of households of different wealth levels is very different. Capital gains and loses are a property of asset type. Models should replicate portfolios by wealth levels.
- Wealth Destruction
  - In Rep Agent Models assets are priced by their shadow value. Proper movements of assets (houses) should include transactions and a theory of their determination. Moreover, Bankruptcies destroy wealth and redistribute wealth. (Hedlund various papers, Head, Lloyd-Ellis & Sun (14), Huo & Rios-Rull (14), Kaplan, Mitman & Violante (16), Head, Sun & Zhou (15)).
- Expenditures play a role and adjustment is costly.
  - These are mechanisms that transform a drop in consumption into drops in TFP without reallocation of output to investment. Triggered by drops in Consumption.

Let me show an example of how this works

A recession triggered by a shock to households' ability to borrow

- The environment includes from +to- quantitative relevance

  1. Real frictions that difficult the switch from production of consumption goods to exports or investment.
  2. Houses that are traded with ownership requiring loan to value ratio. These houses are owned by the 2/3 richest households with the empirically relevant leverage.
  3. Frictions in the goods markets that generate movements in measured GDP.
  4. Some labor market frictions that limit wage adjustments.
  5. Households that differ in job prospects.
  6. Households can go bankrupt: lenders lose.

The Model Characteristics: Steady State

- Enhanced Aiyagari-94 Heterogenous Agent Economy:
    1. Multisector: Tradables and nontradables.
    2. Houses (land) that need to be purchased to be enjoyed.
    3. Endogenous productivity movements (frictions in goods markets).
    4. Various job market frictions

Households: Preferences

- Consumption requires payment and search. It is monotonic in both:
  - Negative Wealth shock cuts consumption and search.
- Households have to search for varieties, its number is a *choice*:

$$\mathrm{I}_N = d\ \Psi^d(Q^g).$$

  - $\Psi^d(Q^g)$: Probability (per search unit) of finding a variety.
- Households also like housing and dislike searching

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

- Most of consumption is non tradable and non investable.

Households: Endowments and Wealth

- Households differ in skill type. Low skilled are more prone to unemployment. They do not choose whether to work.
- Households either have a job $e = 1$ or not $e = 0$.
  - Type-dependent exogenous job destruction rate.
  - Job finding rate is type independent and depends on job creation by firms (workers are rationed) (Lei Nie (2013).
- Households assets are in houses and/or in financial assets with a collateral constraint.

Households' problem

$$V(\epsilon, e, a) = \max_{c_i, \mathrm{I}_N, h, d} \; u(c, h, d) + \beta \sum_{\epsilon', e', \theta'} \Pi^{\theta}_{\theta,\theta'} \Pi^{w}_{e'|e,\epsilon} \Pi^{\epsilon}_{\epsilon,\epsilon'} \; V[\epsilon', e', a'(b, h)] \qquad \text{s.t.}$$

$$\int_0^{\mathrm{I}_N} p_i c_i + p_h h + b = a + 1_{e=1} w \epsilon + 1_{e=0} \underline{w} \qquad \text{BC}$$

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

$$b \geq -\lambda \; p_h \; h \left[\frac{1}{1 + r^*} - \varsigma \right] \qquad \text{FC}$$

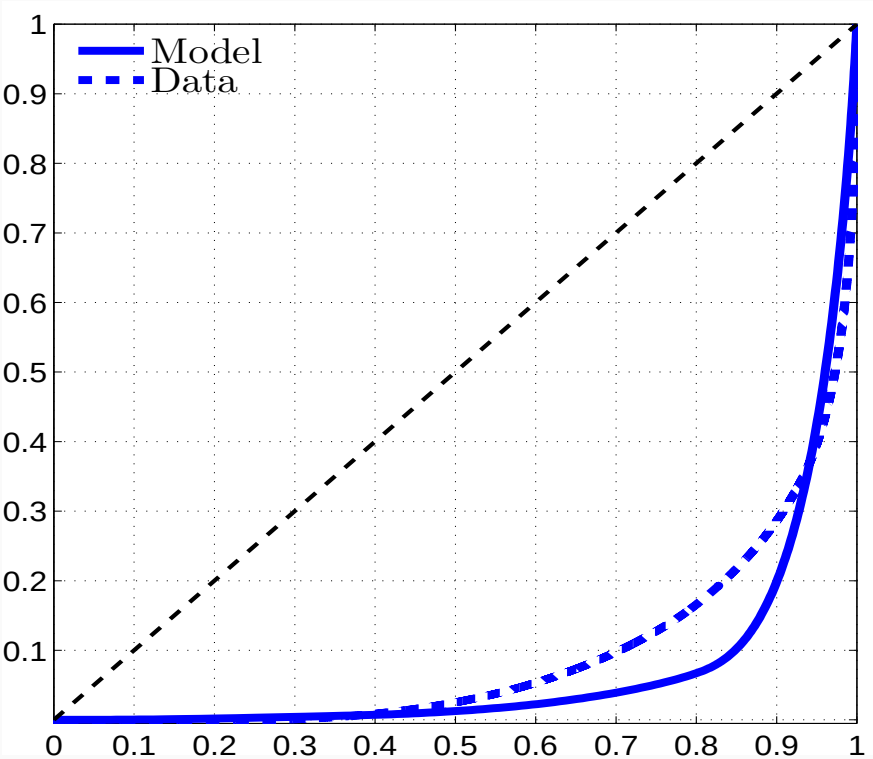
$$\mathrm{I}_N = d \; \Psi^d[Q^g] \qquad \text{SC}$$

Mapping the model to data

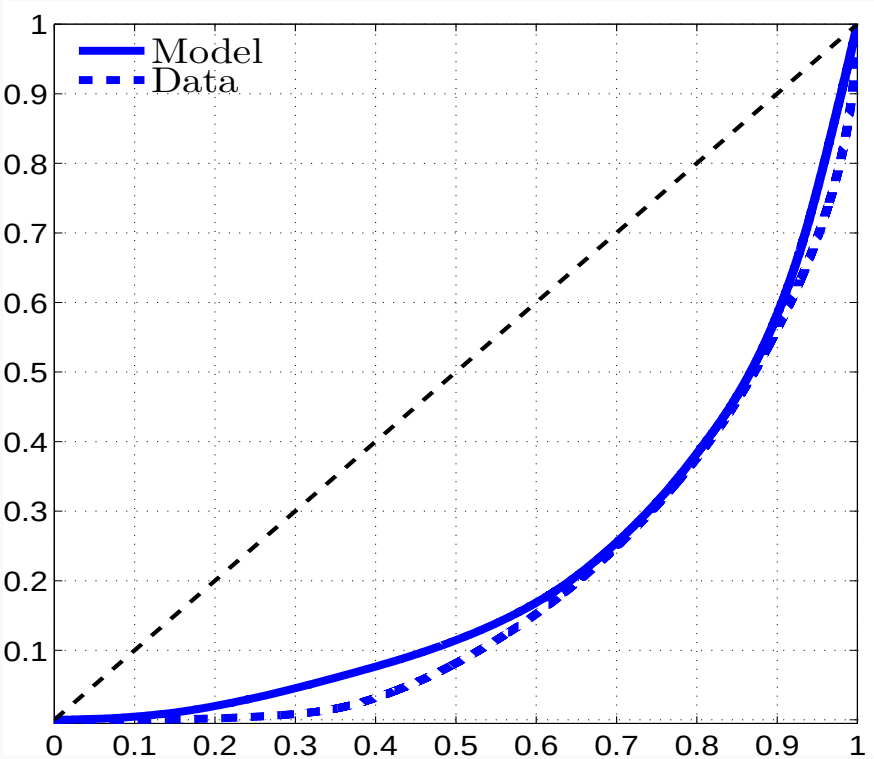
- It requires the specification of
  - Functional forms for Preferences and Technology
  - As well as Parameter Values
- Slowly moving towards some form of Method of Moments
- We want to replicate properties from before the crisis:
  - Standard relative Macro Aggregates
  - Employment distribution and Flows
  - Earnings Dispersion and Wealth Inequality
- Some additional parameters involve the transition and are specified later

A Glimpse: Lorenz Curves of Net Worth and Housing

Networth



Housing



1 Putting the Model to Use: An Experiment

An (MIT) financial shock hits

- We can estimate the extent of frictions to generate the Recession.

    1. Adjustment costs/Decreasing Returns of Tradables (Relative Change of Investment and Consumption and Expansion of Net Exports)

    2. Size of Frictions in goods markets: To match productivity changes.

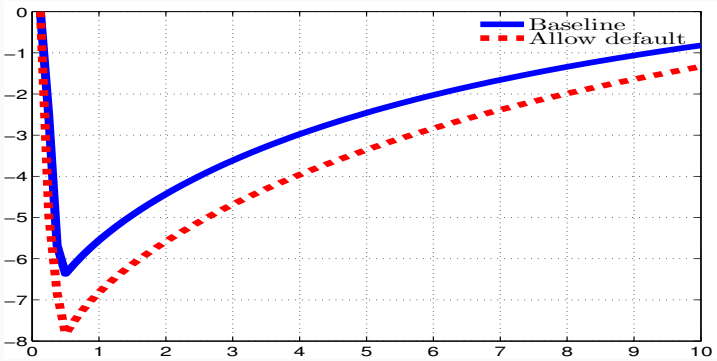
    3. Wage rigidity: Directly from Wage dynamics:

- We look at the transition. It involves solving for the steady state and then iterating backwards (with the additional problem of solving for equilibrium prices. Hard, but not too hard. Dynare can do it.)

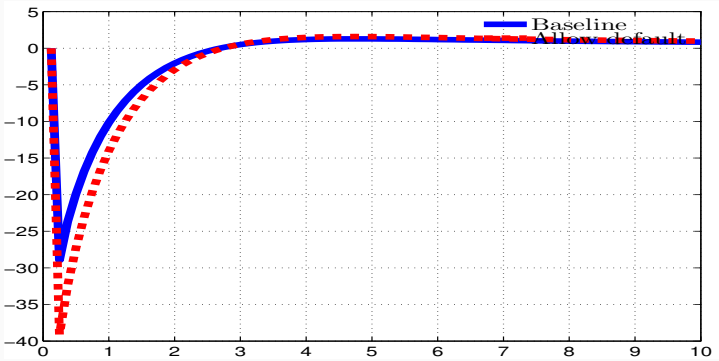
Experiment: Tightening of credit

1. An Economy with Default
    - Over three months the down payment changes from 20% to 40%
    - The borrowing interest rate's surcharge goes from zero to 1.%

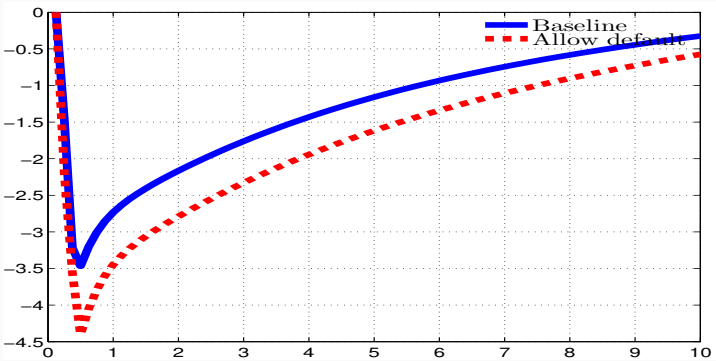
2. Long Run Properties
    - Like in all heterogeneous agents models, more frictions imply that in the long run output and wealth end up being higher.
    - But in our economies the transition is associated to a recession.



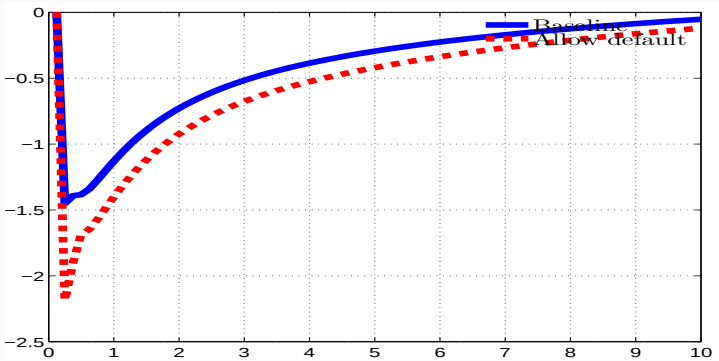
Consumption



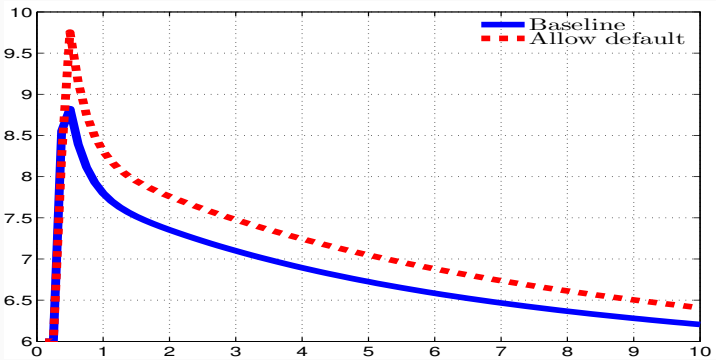
Investment



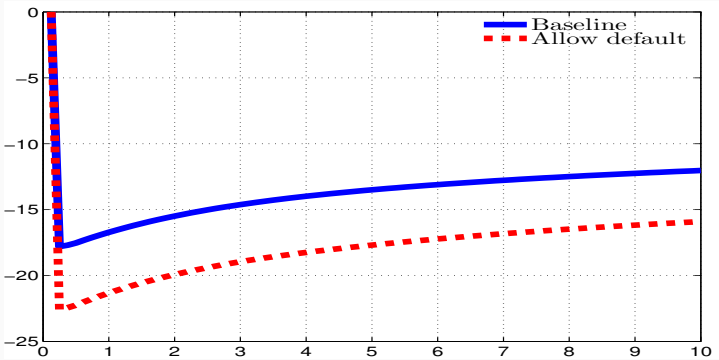
Output



TFP

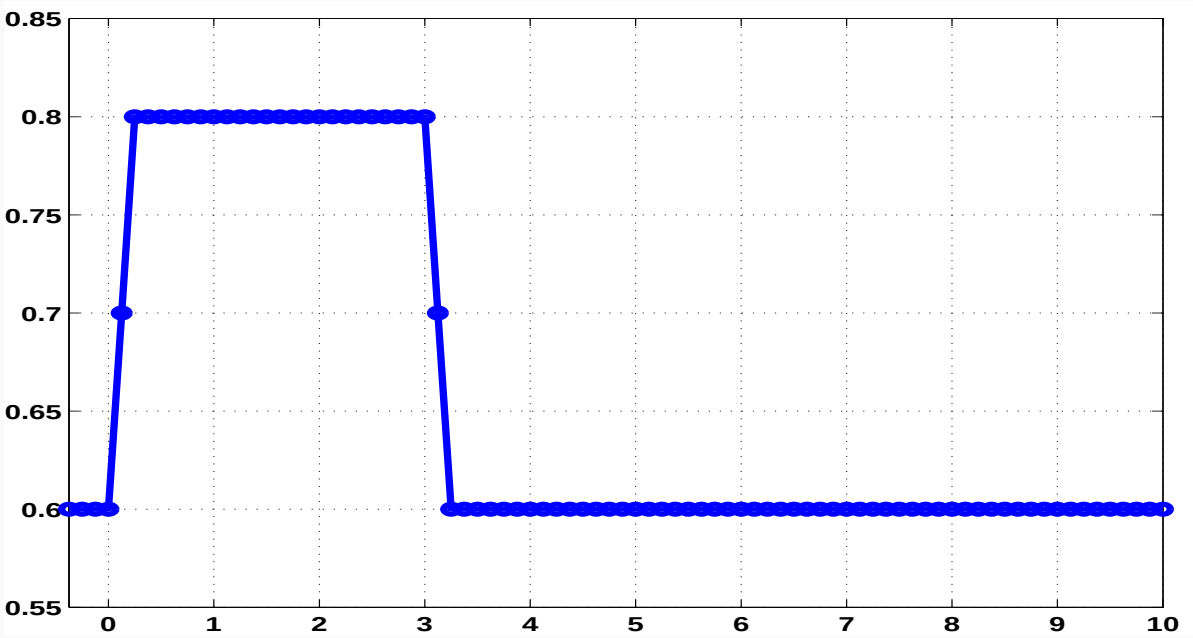


Unemployment rate



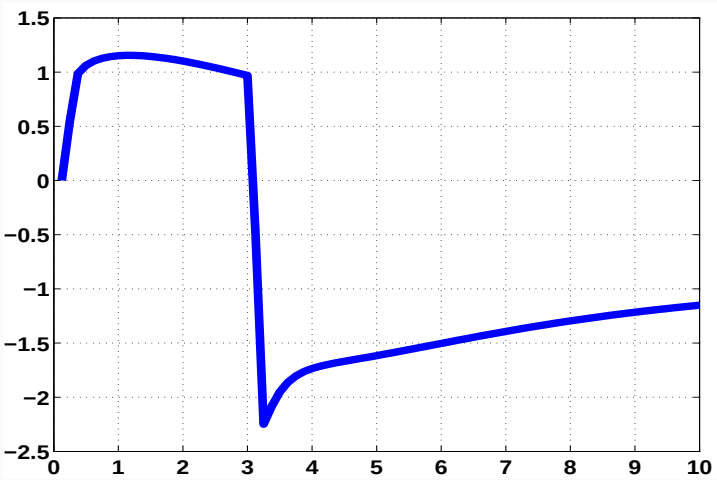
Housing Prices

What about Expansions?: A Credit Cycle

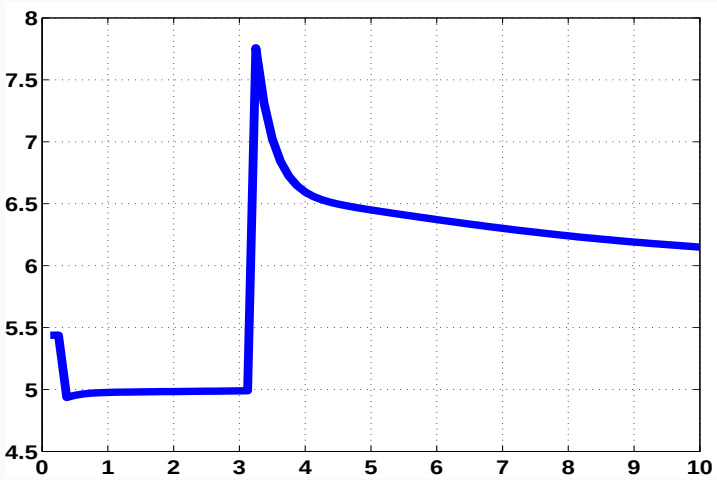


Loan to value ratio λ

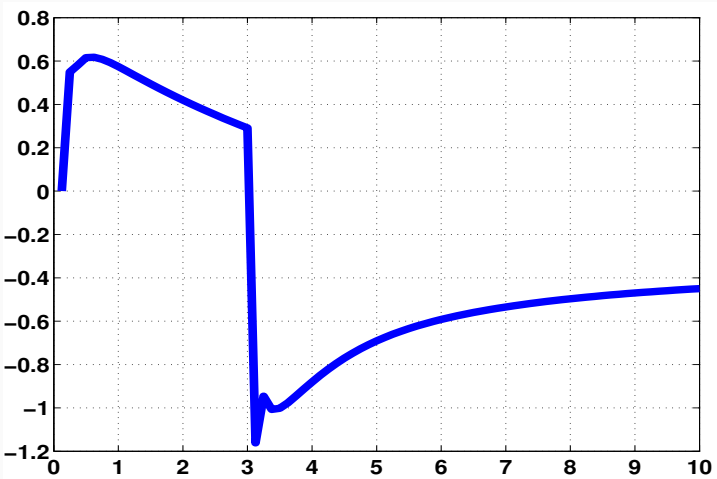
Another Experiment A Credit Cycle



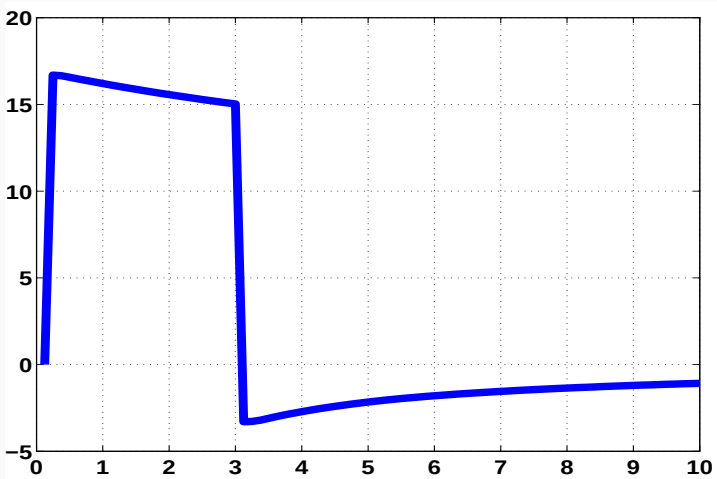
Real output



Unemployment rate



TFP



Housing price

What about Standard Analysis of Fluctuations?

- MIT shocks are NOT the way to study fluctuations.
- Traditionally very complicated methods have been proposed.

  Some of them based on *quasilinearity* or aggregate capital is the only thing that matters (Krusell and Smith (97,98)) interesting really happens. There are modern linearization versions based on Reiter such as Ahn et al. (17) and Childers (17).
- They approximate somehow the distribution of agents and look for its equilibrium law of motion.

But we can do a lot better than that

- There is a wonderful recent innovation Boppart, Krusell and Mitman (17) that uses the Impulse Response from an MIT Shock as a Numerical Derivative to evaluate linear approximations.
  - Only the transition to one (or more) MIT shock needs to be computed.
  - Let x_t denote the response of statistic x in period t to an innovation of size one in period zero of say TFP.
  - Consider now a sequence of innovations labeled $\{\epsilon_t\}_{t=0}^{T}$. Then a linear approximation to x in period t, labeled $\widehat{x}_t$ is

$$\widehat{x}_t = x_0\epsilon_t + x_1\epsilon_{t-1} + x_2\epsilon_{t-2} + ...$$

  - And we are done!!!!
- Adding more shocks is linearly more costly

2 Conclusion

Conclusions

- We should use routinely Heterogeneous Agents Models to study fluctuations.
  - Consumption is more responsive to Economic Conditions.
  - Asset (housing) trades generate sharp changes in wealth.
  - Have to include other features that complement Heterogeneity
    - Reallocation Frictions
    - Endogenous TFP
    - Some form of Wage Rigidity
    - Perhaps even some type of price rigidity.
- The Cost of using this type of models is much lower than before.
- Provide natural environment for new mechanisms Disagreement in forecasts
- Not only Heterogeneity of households but of firms and financial entities.

Thank You for Coming and Listening!