

# Course in Heterogeneity: Econ 081

## I: Reassessing the Role of Heterogeneity for Business Cycles

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José Víctor Ríos Rull  
Penn, CAERP, UCL

With material developed jointly with Akihisa Kato, Zhen Huo and by Dirk Krueger

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- 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.



- 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).



Heterogeneity (Inequality) in 2006:  
Marginal Distributions

	y	c	a	SCF 07 a
Mean (2006\$)	62,549	43,980	291,616	497,747
<i>%Share</i> : Q1	4.5	5.6	-0.9	-0.2
Q2	9.9	10.7	0.8	1.2
Q3	15.3	15.6	4.4	4.6
Q4	22.8	22.4	13.0	11.9
Q5	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)



a	% Share of:		Exp. Rate c/y (%)
	y	c	
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 account for 63% of consumption



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).



- Krusell Smith (1997-98) broke the fear of computational unfeasibility. They showed how to solve for equilibria in these (then) monster looking things.
- 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 essentially linear part of the state space
- Heterogeneous agents models are like Rep Agent models for business cycle purposes.  
Also confirmed in life-cycle models.





- 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



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  $\rho = 50\%$ .



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 inequality almost right at the very bottom



a Quintile	% Share of:				%c/y	
	y		c		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.



% Share:	Models*		
	KS	no UI	+UI
$\Delta C$	-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)



- 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. \(2020a\)](#), [Bayer et al. \(2020b\)](#) [Heathcote et al. \(2004\)](#) [Güvener et al. \(2014\)](#), [Nakajima and Ríos-Rull \(2014\)](#)) .

But not by much



- Interest Rate Movements as Analyzed by Central Banks Operate through Intertemporal Substitution.
  - They are typically studied with Representative Agent Models.
  - Any effect of wealth or income changes has a small consumption increase: There is a lot of wealth (25 times quarterly consumption implying at best a Low Marginal Propensities to Consume  $< 3\%$ )
  - Consumption response is then humped via habits.
- Yet Evidence (Fagereng et al. (2021), Crawley and Kuchler (2021)) points to much larger Marginal Propensities to Consume.
- So Heterogeneous Agent Models with Incomplete Markets have arisen as an alternative (Carroll (1997), Auclert et al. (2020), Alves, Bustamante, Guo, Kartashova, Lee, Pugh, See, Terajima, and Ueberfeldt (2022)) because they have poor people that respond to transitory income changes while less concerned with direct changes in real interest rates (Blundell et al. (2008)).
- Heterogeneity is not enough by itself since there is a lot of wealth in the economy (about 4 times GDP) SO
  - Models difficult access to wealth by imposing large transaction costs in two asset models (Kaplan et al. (2018))
  - Habits or sticky expectations to delay a bit the response (Auclert et al. (2020)) rather than the more grounded rational inattention (Sims (2003), Mackowiak and Wiederholt (2009)).



- Without restrictions on access to assets
  - Redistribution effects between borrowers and lenders
  - The implications of labor employment losses concentrated on those of the low end of the income distribution magnifying some income effects ([Castañeda et al. \(1998\)](#), [Fang and Nie \(2013\)](#))
  - The further reduction of consumption (more precautionary savings) in recessions associated to countercyclical earnings risk (more skewness) ([Gornemann et al. \(2021\)](#), [Ravn and Sterk \(2021\)](#)).
  - Heterogeneity of business can also be posed with similar flavor.
- With restrictions on access to assets
  - Much larger response to changes in interest rates.
- Overall, indirect effects of an unexpected changes in interest rates, operating through a general equilibrium increase in labor demand ([Kaplan et al. \(2018\)](#)) outweigh intertemporal substitution mechanisms.





- Changes in Aggregate Wealth
  - Not because of asset destruction
  - Because of changes in valuation of assets (partially noted by [Auclert \(2019\)](#))
  - Especially important because empirically Wealth Effects Matter. (which requires both household elastic responses and changes in wealth itself). ([Petev et al. \(2012\)](#), [Mian et al. \(2013\)](#), [Pistaferri \(2016\)](#), [Aladangady \(2017\)](#), [Guren, McKay, Nakamura, and Steinsson \(2020\)](#), [Graham and Makridis \(2021\)](#), [Padula \(2022\)](#), [Gilraine, Graham, and Zheng \(2022\)](#))
- It requires to have models that can change prices
  - Not Physical Capital
  - Land
  - Fixed factors that are sources of rents (especially in the presence of production adjustment costs)
- Adds an extra layer of complexity to the models because it requires finding those market clearing asset prices.
- We are into it.



- They abstract from any channel that allows for productivity changes being the result of expenditure changes
- An Old-Keynesian Amplification Mechanism
  - Having the shop full of customers increases business productivity without paying for it
  - The missing factor of production is household effort or inconvenienced ([Bai et al. \(2019\)](#), [Huo and Ríos-Rull \(2020\)](#))
- Can be easily implemented via an expenditure externality ([Krueger, Mitman, and Perri \(2016\)](#))



- 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).



- Asset Holdings
  - The portfolio composition of households of different wealth levels is very different. Capital gains and losses 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 et al. \(2017\)](#), 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.



- Pose an Aggregate Model Economy (i.e. it replicates relevant macro aggregates (wealth and its distribution) where
  - Shocks Change Wealth (house and business prices)
  - Changes in Wealth Induce Large Changes in Behavior (associated to redistribution through leverage of many)
- It requires/has
  - Assets (Business and Houses) with Prices that Change Endogenously
  - Heterogeneous Households (with many very leveraged)
  - Real Frictions that difficult reallocation of resources
  - Sluggish wage adjustments
  - Expenditure externality
- The economy can be seen as a small open economy or as a study of regions (today the interest rate is exogenous and there is no monetary policy)
- Lot's of work ahead



- Adverse Events
  1. Raise of (Real) Interest Rates
  2. Fall in price of Exports
  3. Financial tightening
    - Loan to Value (LTV)
    - Debt Service to Income (DTI)
  
- Trigger Recessions where
  - Fall in Housing Prices and Local Business (insufficient diversification)
  - Reduce Expenditures (amplified via externalities in TFP)
  - Which in turn reduce output
  - The economy is too rigid to turn negative wealth effect into an expansion via harder working



- We want our model to be consistent with the Great Recession
- But also we want to interpret our model as a financial stability view of:
  - Monetary Policy (it moves real interest rates)
    - Typically looked at as a units of account issue that interacts with “slow” price adjusting firms to generate desired real effects.
    - Unlike in HANK models, in ours wealth disappears, not just inaccessible.
  - We are concerned with the asset price effects implied when assets are not just reproducible capital.
- More financial stability than standard new-Keynesian inflation-output tradeoffs.



- Standard Heterogeneous Incomplete Markets Model ([Bewley \(1984\)](#), [Imrohoroglu \(1989\)](#), [Huggett \(1993\)](#), [Aiyagari \(1994\)](#))
- Large Amount of Wealth, some in fixed supply (fixed factors, land), some reproducible (physical capital with adjustment costs and buildings), and risk free liquid assets.
- Large Wealth Concentration: Due to
  - Shocks to Earnings
  - Shocks to Shares of Local Businesses (the fixed factor in production)
- Incomplete markets: there are are financial frictions
  - Loan to Value Restrictions
  - Interest to Income Restrictions
  - Non tradable assets (not very important)
- Sluggish wages
- We also explore slow adjustment of nontradable prices (insufficient devaluation)





- Details of the environment
- Discussion of how to Map the model to data
- A bunch of Impulse Responses
  1. Pure real interest rate hike
  7. Perfect Storm: real interest rate hike, worsening of access to financial markets (more difficult to borrow) & fall in foreign demand for exports.
    - Exclude Amplification channel of Expenditures Effects on Productivity after the rate hike
    - Incomplete adjustment on the relative price of inputs (insufficient devaluation) after the rate hike



- Three types of Agents
  - Heterogeneous Households
  - Nontradable producers
  - Export producers
- Three intermediate goods
  - nontradables:  $e$
  - exports:  $x$  (not used domestically at all).
  - imports:  $m$
- Consumption  $C$  (composite of  $e$  and  $m$ ).
- Investment in Business Capital  $I^k$  (composite of  $e$  and  $m$ ).
- Investment in Residential Structures  $I^s$  (composite of  $e$  and  $m$ ).
  - Final Goods may have different ratios of  $e$  and  $m$ .
- Housing  $H$ , a combo of structures  $S$  & land  $L$  in fixed supply.



- Households
  - Hold wealth as houses, liquid assets, and shares of local firms that are illiquid.
  - Standard uninsurable idiosyncratic labor productivity shocks
  - Quasi standard unemployment shocks (may not be stationary)
  - Non Standard shocks to the nontradable shares of local firms (accounts for the cross section of property of non traded firms)
- Production sectors face
  - Decreasing Returns to Scale production technologies due to a fixed factor owned locally (crucial for changes in asset (stocks) prices).
  - Adjustment costs of capital and workers
  - Search frictions when hiring



$$V(z, a) = \max_{b, h, c} u[\Psi^c(e, m), h] + \beta \mathbb{E} \{V(z', a')\} \quad \text{s.t.}$$

$$p^e e + p^h h + m + b = a + \mathbb{1}_{\eta=1}\{w\epsilon\} + \mathbb{1}_{\eta=0}\{\bar{w}\} + \theta^e \pi^e + \theta^x \pi^x \quad \text{BC}$$

$$a' = \underbrace{p^{s'}(1 - \delta_h) s(h, H)}_{\text{value of undeprec Struct}} + \underbrace{p^{e'} \frac{h}{H}}_{\text{value of land}} + (1 + r') b \quad \text{EW}$$

$$b \geq -\lambda p^h h(1 + r) \quad \text{LTVC}$$

$$r b \geq -\mu \mathbb{1}_{\eta=1}\{w\epsilon\} \quad \text{FC}$$

- Imports are the Numeraire



$$\Omega^e(k, \{n^\epsilon\}) = \max_{v, k', m, e} \left\{ p^e F^e(k, n) - m - p^e e - \kappa v - \phi^n(n', n) - w n + \frac{\Omega^e(k', \{n^{\epsilon'}\})}{1 + r'} \right\}$$

s.t.

$$n = \sum_{\epsilon} \epsilon n^{\epsilon}$$

$$k' = (1 - \delta^k)k + \Psi^e(m, e) - \phi^{e,k}[k, \Psi^e(m, e)],$$

$$n^{\epsilon'} = \underbrace{\sum_{\tilde{\epsilon}} (1 - \delta_{\tilde{\epsilon}}) n_{\tilde{\epsilon}} \Gamma_{\tilde{\epsilon}\epsilon}}_{\text{unseparated worker}} + \underbrace{\sum_{\tilde{\epsilon}} \Gamma_{\tilde{\epsilon}\epsilon} \frac{U_{\tilde{\epsilon}}}{u} v}_{\text{measure of hiring } \epsilon \text{ next period}}$$

- Dividends  $\pi^e = p^e F^e(k', l) - m - p^e e - \kappa v - \phi^n(n', n) - w \sum_{\epsilon} n^{\epsilon} \epsilon$



- Export Sector Similar to Non-tradable
- Rich households have no real use for a lot of housing
- Poor/middle households are very leveraged and constrained. They have less housing than they would like.
- Financial constraints limit and change the value of land.



- Employed Households supply labor inelastically and are paid  $w\epsilon$ .
- Unemployed Households earn  $\bar{w}$  from home production.
- Job Flows come from exogenous destruction and endogenous vacancy creation
- High Skilled households are employed more because lose jobs less often
- Note that  $u$  and  $V$  are equilibrium objects.
- Wages adjust slowly



- Nontradable goods are in a frictionless, perfect competitive environment but are subject to an externality in TFP akin to our previous work.
- Both nontradables and exports use capital, labor and a fixed factor to produce goods.
- Adjustment costs to adjust capital and employment.
- Search friction: hiring cost of  $\kappa$  per vacancy.
- Wage is exogenous in steady state (set to get labor share).
  - but is determined by a function of output deviation from steady state along the transition path
- All firms are owned locally



# 1 Steady State



- Model period is a quarter
- Perfect correlation between labor productivity and share holdings
- Households face mortality risk of 0.005 (Average life expectancy of 200 quarters or 40 years). To ensure enough poor people (perf annuity markets).
- Zero Int'l indebtedness
- Non homotetic Utility to prevent housing purchases by the rich

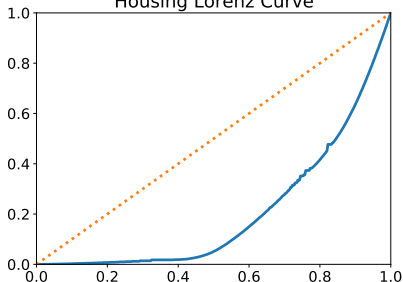
Parameterization for St St	
Risk aversion for consumption	2.0
Satiation level for housing	4.5
Loan to value ratio	0.8
Annual world interest rate	4.0%
Relevant Out of St St Elasticities	
Wage elasticity	0.5
TFP elasticity (with externality) (small)	0.3
Elasticity of Substitution bw nontradable and import	0.8
Adjustment cost coefficient (to be fine tuned)	1.57



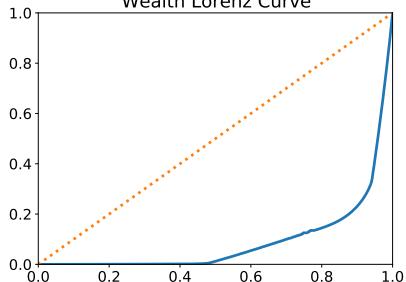
	Target	Model	Tool	Value
Output	1.00	1.00	TFP in Export	0.73
Capital-to-Output	2.00	2.00	Capital dep. rate	0.025
Housing-Value-to-Output	1.80	1.76	Util shifter in housing	0.50
Debt-to-GDP	0.00	0.02	Discount rate	0.92
Wealth-to-Output	4.50	4.57	Dep. rate in housing	0.008
Wealth Gini	0.82	0.82	Top Share holdings	13.20
Frac. of H held by bottom 70%	0.25	0.27	$\hat{h}_1$	0.98
Frac. of H held by bottom 80%	0.39	0.41	$\hat{h}_2$	1.80
Frac. of H held by bottom 90%	0.58	0.64	$\sigma_h$	2.98
Relative Price of Nontradable	1.00	1.00	TFP in $e$	0.73
Share of Export	0.30	0.30	CES weight on $e$	0.75
Employment Rate	0.92	0.92	wage	0.96



### Housing Lorenz Curve



### Wealth Lorenz Curve



- Gini coeff: housing 0.63, Wealth 0.82 (data 0.82 in 2007 SFC)

2

Putting the Model to Use:

Experiments



- 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.)

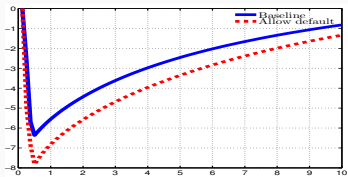


### 1. An Economy with Default

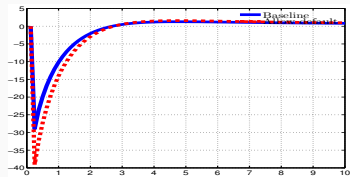
- Over three months the down payment changes from 20% to 40%
- The borrowing interest rate's surcharge goes from zero to 1.0%

### 2. Long Run Properties

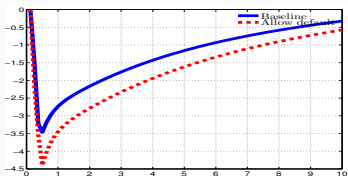
- Like in all heterogeneous agents models, more frictions imply that in the long run output and wealth end up being higher.
- But in our economies the transition is associated to a recession.



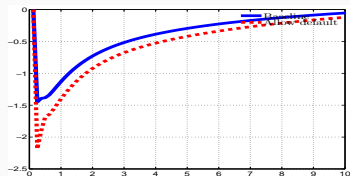
Consumption



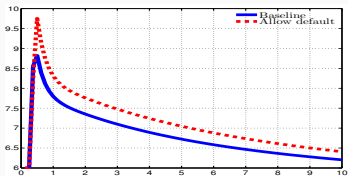
Investment



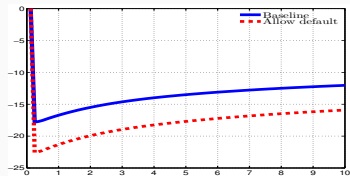
Output



TFP

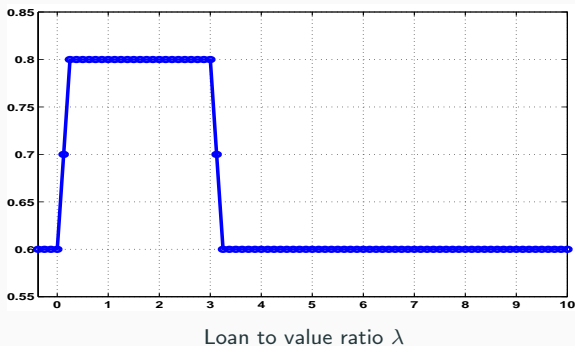


Unemployment rate

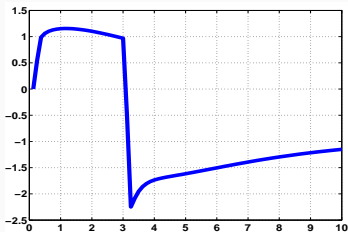


Housing Prices

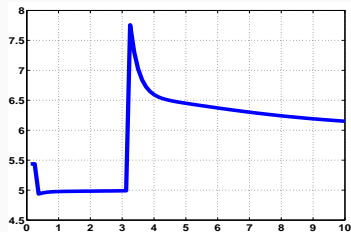




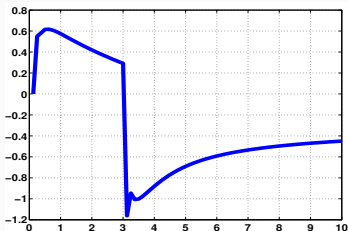
# ANOTHER EXPERIMENT A CREDIT CYCLE



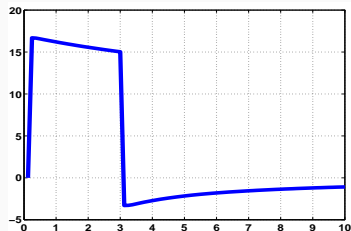
Real output



Unemployment rate



TFP



Housing price



- 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.



- There is a wonderful recent innovation [Boppart et al. \(2018\)](#) 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  $\hat{x}_t$  is

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

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



- 1 Increase in Interest Rate (world event or Policy) 1% (Baseline)
- 2 Perfect Storm: Base + Financial Constraint: Max LTV 80%  $\rightarrow$  60% +  $(p^x - 3\%)$
- 3 Base without any negative effect on TFP
- 4 Base with price stickiness (insufficient devaluation)



- A Temporary but persistent increase in the (World) Interest Rate
- With TFP Externality only on Nontradables

- TFP Elasticity wrt expenditures .5

- Wage Adjustments ( $\psi^w = .5$ )

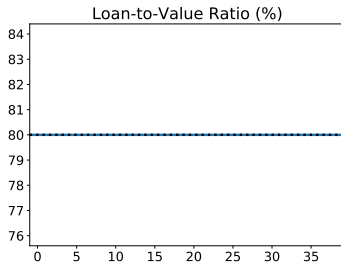
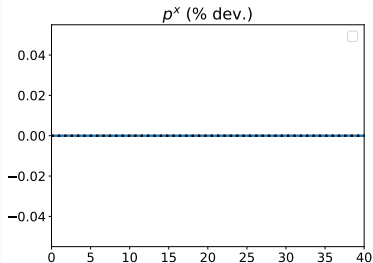
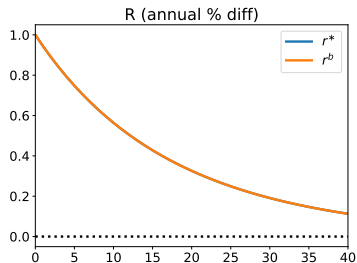
$$\log w_t - \log w^{ss} = -\psi^w (\log U_t - \log U^{ss})$$

- Import Elasticity .8

# 1- EXOGENOUS SHIFTER: (ONLY $r$ MOVES)



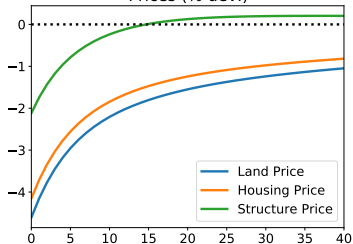
$p^x$  BECAUSE OF DEVALUATION  $LTV$  DOES NOT



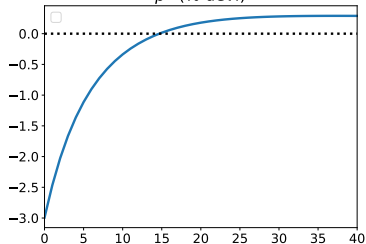
# 1- ASSET PRICES & QUANTITIES (FINANCIAL AND TOTAL WEALTH)



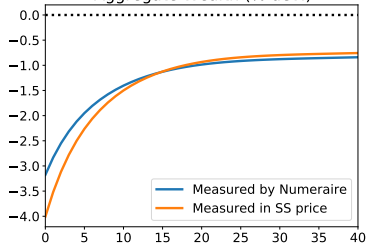
Prices (% dev.)



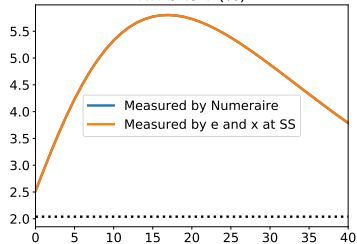
$p^e$  (% dev.)



Aggregate Wealth (% dev.)



HH b to Y (%)

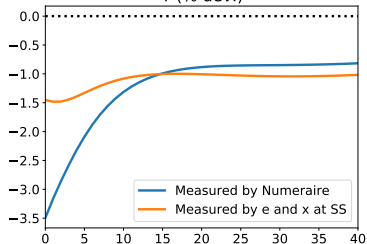




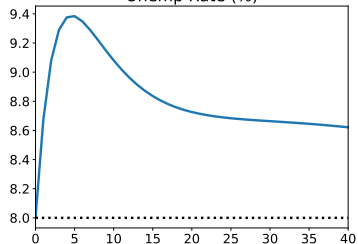
# 1- MAIN BUSINESS CYCLE OBJECTS



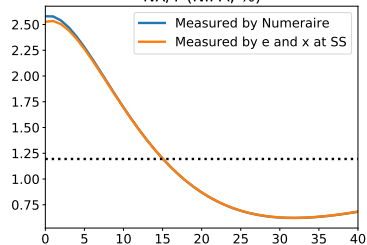
Y (% dev.)



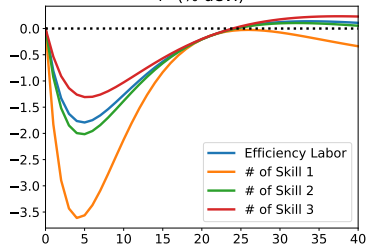
Unemp Rate (%)



NX/Y (NIPA, %)

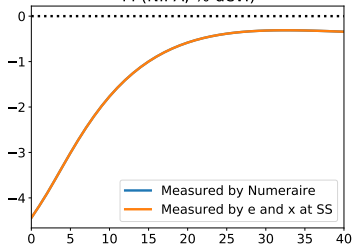


$I^e$  (% dev.)

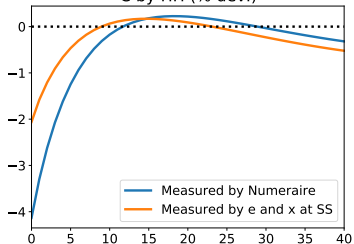




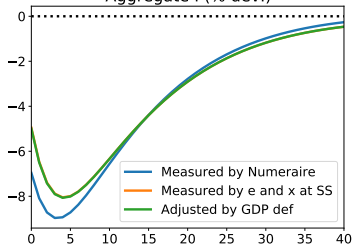
M (NIPA, % dev.)



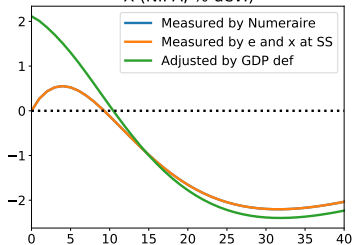
C by HH (% dev.)



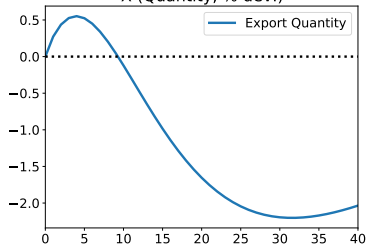
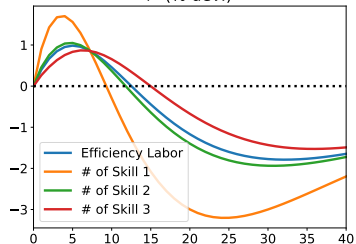
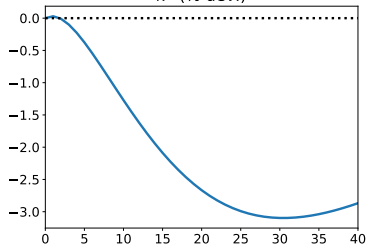
Aggregate I (% dev.)



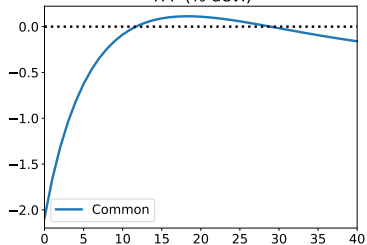
X (NIPA, % dev.)

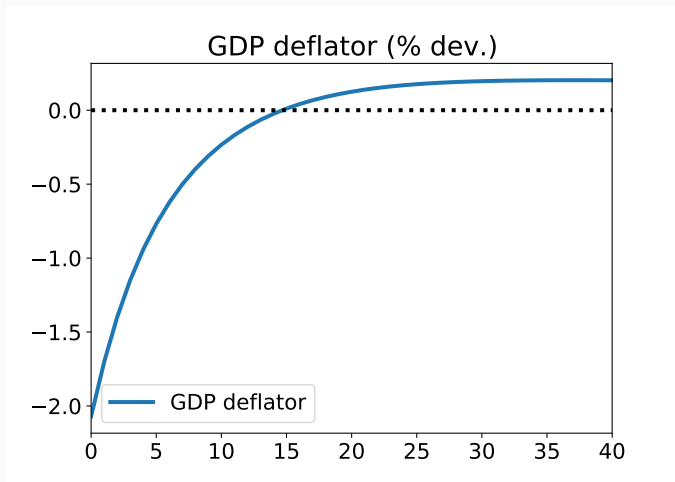


X (Quantity, % dev.)

 $I^x$  (% dev.) $k^x$  (% dev.)

TFP (% dev.)

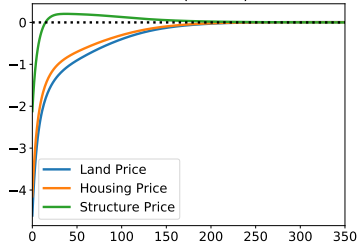




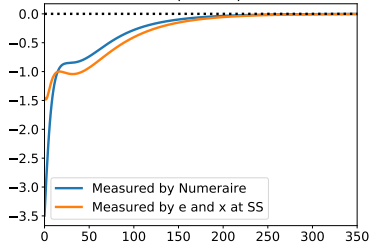
# 1- THE LONGER VIEW: 87 YEARS



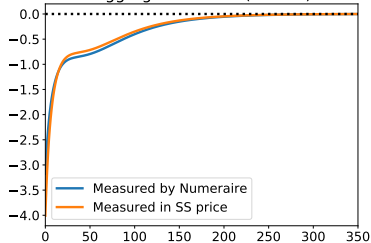
Prices (% dev.)



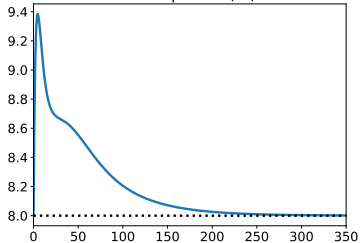
Y (% dev.)



Aggregate Wealth (% dev.)



Unemp Rate (%)





- Sizeable Recession With Large Drop of Wealth
- Large Drop of Consumption.
- Large Reduction in Employment
- Large Devaluation
- But Large Improvement in Balance of Payments (large reduction of imports)
- Exports move up then down. Slowly due to adjustment costs in investment and productivity propagation
- Recessions are Long ([Aguiar and Gopinath \(2007\)](#))

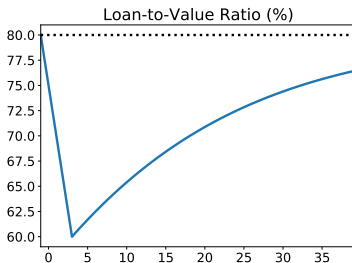
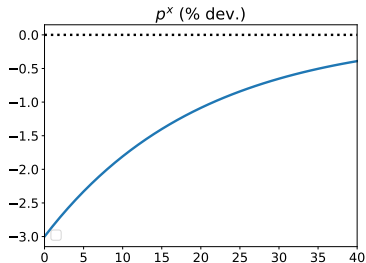
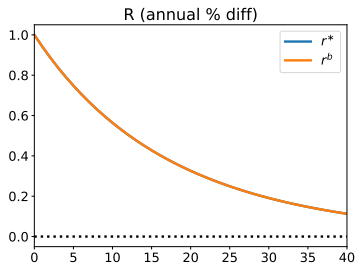


- A Temporary but persistent Increase in Interest Rates
- A 3% Temporary but persistent Decrease in the Terms of Trade
- Reduction in Max LTV from 80% to 60%
- With TFP Externality
  - TFP Elasticity wrt expenditures .5
  - Wage Adjustments ( $\psi^w = .5$ )
$$\log w_t - \log w^{ss} = \psi^w (\log Y_t - \log Y^{ss})$$
  - Import Elasticity .8

## 2. EXOGENOUS SHIFTERS: $r$ MOVES 1% AND $p^x$ 5%

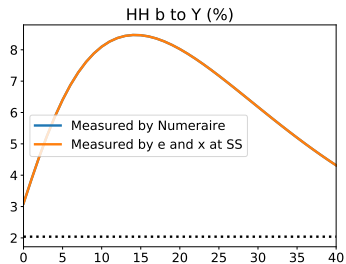
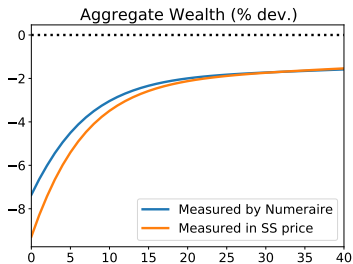
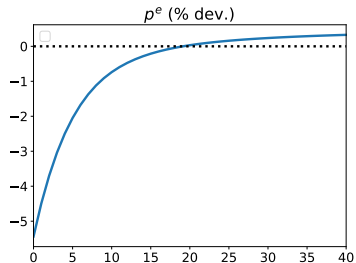
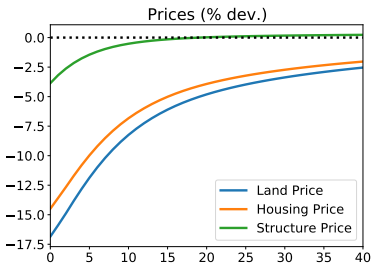


$p^x$  MUCH MORE BECAUSE OF DEVALUATION; LTV DOES NOT





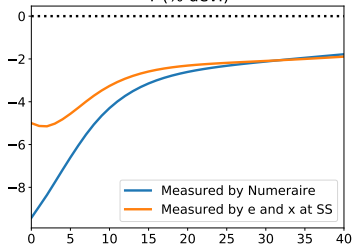
## 2. ASSET PRICES & QUANTITIES (FINANCIAL AND TOTAL WEALTH)



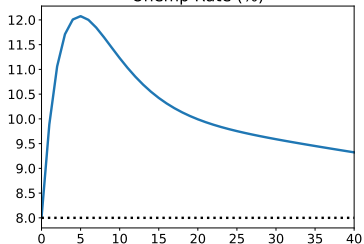
## 2. MAIN BUSINESS CYCLE OBJECTS



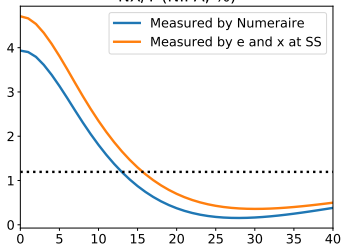
Y (% dev.)



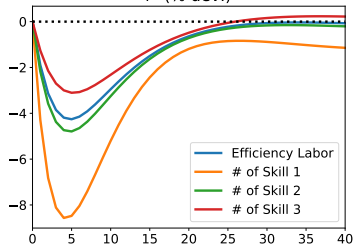
Unemp Rate (%)



$NX/Y$  (NIPA, %)



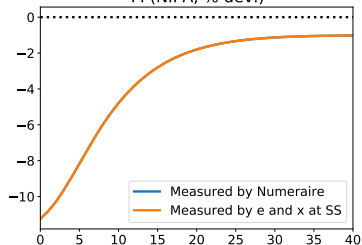
$I^e$  (% dev.)



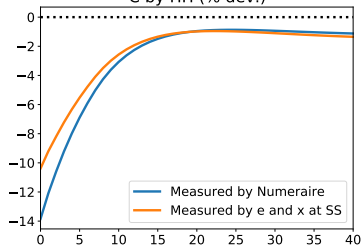
## 2. GDP COMPONENTS



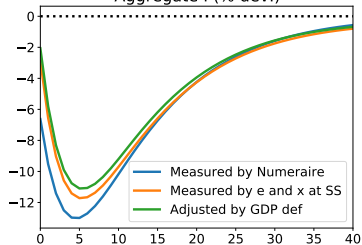
M (NIPA, % dev.)



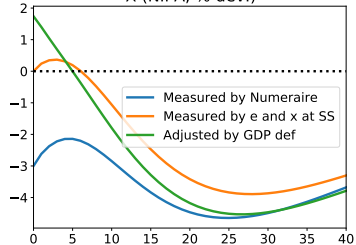
C by HH (% dev.)



Aggregate I (% dev.)



X (NIPA, % dev.)



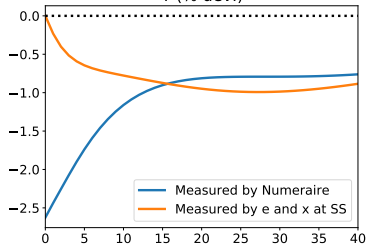


- Everything Larger
- Very Large Devaluation relative to price decrease
- Huge Drop of Consumption, Investment and Exports
- Huge Reduction in Employment
- Humongous reduction of imports: Sizeable Improvement in Balance of Payments.
- Not consistent world wide. Need much larger drop in foreign demand.

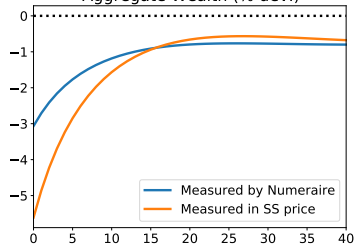
### 3- No AMPLIFICATION VIA EXPENDITURE EXTERNALITY



Y (% dev.)

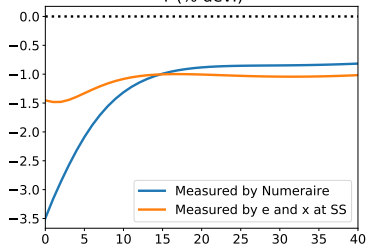


Aggregate Wealth (% dev.)

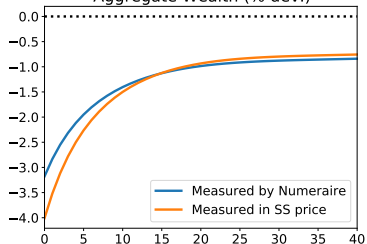


### Comparing with Baseline

Y (% dev.)



Aggregate Wealth (% dev.)



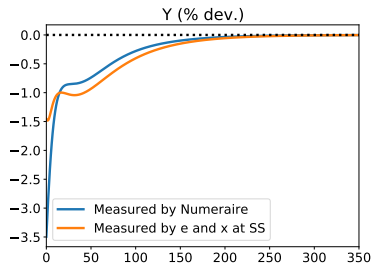


- A Temporary but persistent Increase in Interest Rates
- Elastic Non-tradable price no market clearing on non-tradables, demand determined quantities
- Reduction in Max LTV from 80% to 60%
- With TFP Externality
  - TFP Elasticity wrt expenditures .5
  - Wage Adjustments ( $\psi^w = .5$ )
$$\log w_t - \log w^{ss} = \psi^w (\log Y_t - \log Y^{ss})$$
  - Import Elasticity .8

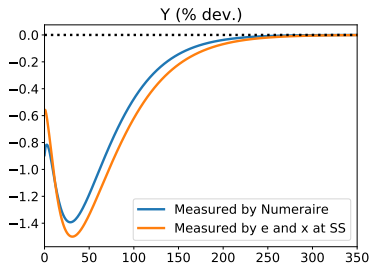
# COMPARING WITH OUTPUT ACROSS HORIZONS BETWEEN BASE AND PARTIAL DEVALUATION



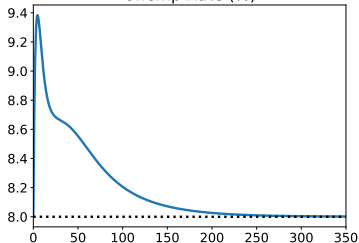
## Baseline



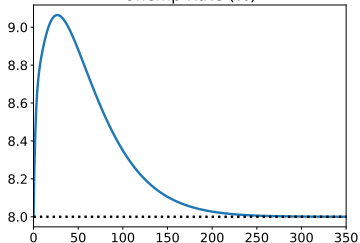
## Partial Devaluation



## Unemp Rate (%)



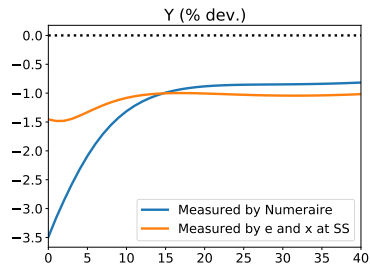
## Unemp Rate (%)



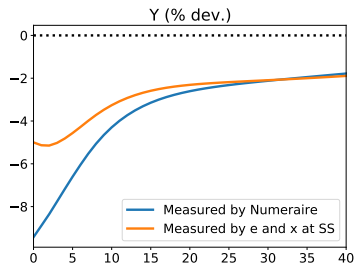
# COMPARISON BETWEEN ALL ECONOMIES: OUTPUT



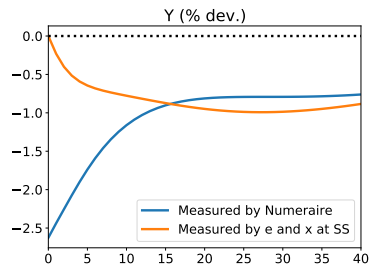
## Baseline



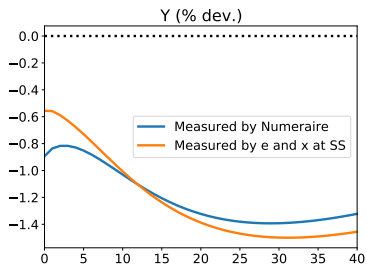
## Perfect Storm



## No TFP Externality



## Insufficient Devaluation

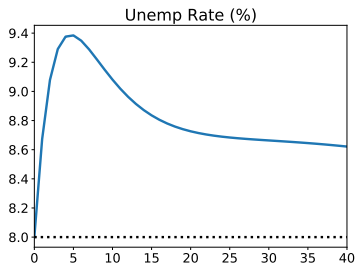




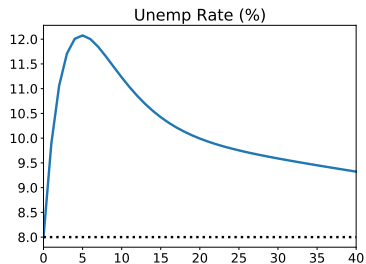
# COMPARISON BETWEEN ALL ECONOMIES: UNEMPLOYMENT



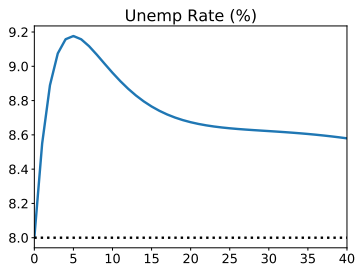
## Baseline



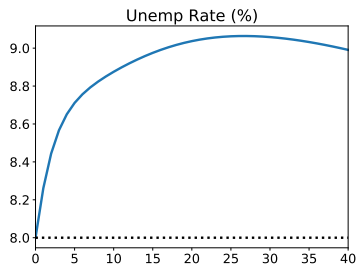
## Perfect Storm



## No TFP Externality



## Insufficient Devaluation





- Some Technical Things
  - Incorporate Financial Restrictions ONLY on newly born
  - Loan to Value Restrictions ONLY to New Loans
- Build this into a World Economy
  - So Interest Rates are Endogenous
  - So Crisis are Simultaneous and Devaluations are Not Helpful
- Have a modern New Keynesian structure to model the link between nominal and real interest rates



- Heterogeneous Agent Models have come a long way (empirically, computationally, theroretically) to become useful tools to understand aggregate economies and to evaluate policy.
- Wider mechanisms than just through intertemporal substitution as in Rep Agent models.
- They incorporate some wealth and redistribution effects.
- Build more Asset prices and productivity propagation into those models.



- We need to develop models of Monetary policy that are beyond those in New Keynesian Models.
- Financial Stability is a Concern
- Not only because financial firms are affected
- But also because Households are affected, especially in Europe where mortgages are NOT indexed.
- In other work we show how expansionary policy (with house price increases) put households more at risk for later interest rate hikes.

Thank you very much

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