Course in Heterogeneity: Econ 081

I: Reassessing the Role of Heterogeneity for Business Cycles

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Heterogeneity and Inequality are a Sign of the Times

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- But as Macroeconomists, should we care?

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  - It requires an unsuitably large Frisch Elasticity of Labor to move employment.
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- The Great Recession has highlighted its shortcomings: How come we got such a large recession.

Aiyagari-Bewley-Huggett-Imrohoroglu models with Aggregate Shocks

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- Why could they generate larger fluctuations?
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        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

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Top 1%	8.0	8.2	30.9	33.5

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

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- Heterogeneous agents models are like Rep Agent models for business cycle purposes.
  Also confirmed in life-cycle models.

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  3. Large enough shocks

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- 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 inquality almost right at the very bottom

	% 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
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- Rudimentary life cycle is crucial for level of consumption rates and their decline with wealth.

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ΔC	-1.9%		

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- If we were to think of Endogenous Labor, it would be Worse (Guerrieri-Lorenzoni-2009)

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  - 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)).

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- 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.

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- Can be easily implemented via an expenditure externality (Krueger, Mitman, and Perri (2016))

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

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- 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.

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  - The economy is too rigid to turn negative wealth effect into an expansion via harder working

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- More financial stability than standard new-Keynesian inflation-output tradeoffs.

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- We also explore slow adjustment of nontradable prices (insufficient devaluation)

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    - Incomplete adjustment on the relative price of inputs (insufficient devaluation) after the rate hike

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Household Problem: State is $\{\eta, \epsilon, \theta^e, \theta^x, a\} = \{z, a\}$

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Nontradable Sector with undiscriminating hiring costs

And Skill specific Separation Rates

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

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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

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Relative Price of Nontradable	1.00	1.00
Share of Export	0.30	0.30
Employment Rate	0.92	0.92

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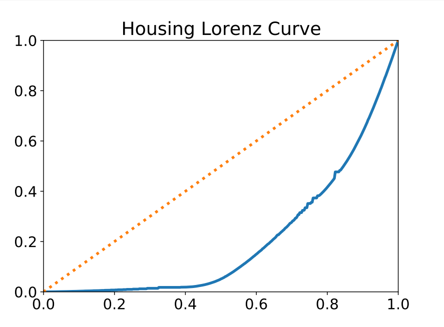
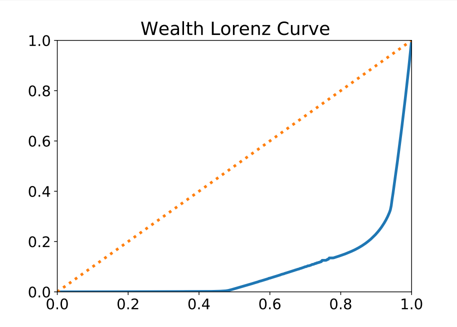
	Target	Model	Tool	Value
Output	1.00	1.00	TFP in Export	0.73
Capital-to-Output	2.00	2.00	Capital dep. rate	0.025
Housing-Value-to-Output	1.80	1.76	Util shifter in housing	0.50
Debt-to-GDP	0.00	0.02	Discount rate	0.92
Wealth-to-Output	4.50	4.57	Dep. rate in housing	0.008
Wealth Gini	0.82	0.82	Top Share holdings	13.20
Frac. of H held by bottom 70%	0.25	0.27	$\widehat{h}_1$	0.98
Frac. of H held by bottom 80%	0.39	0.41	$\widehat{h}_2$	1.80
Frac. of H held by bottom 90%	0.58	0.64	σ_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





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

2 Putting the Model to Use: Experiments

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- 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.)

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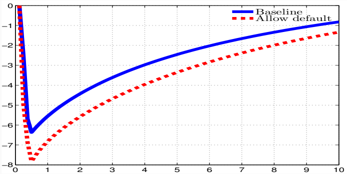
   - Like in all heterogeneous agents models, more frictions imply that in the long run output and wealth end up being higher.
   - But in our economies the transition is associated to a recession.



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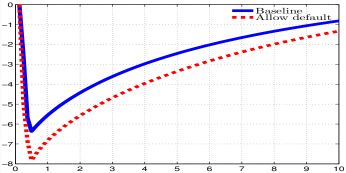

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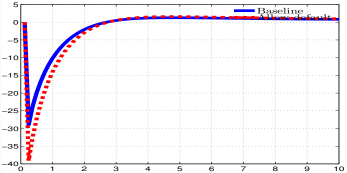
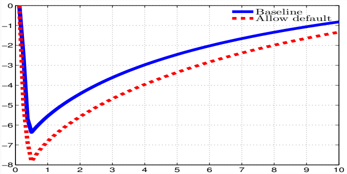
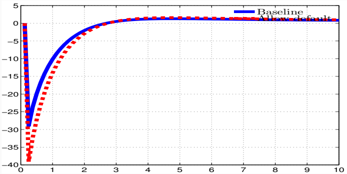


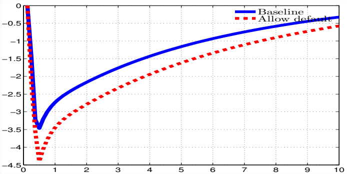
Investment



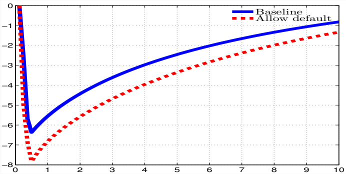
Consumption



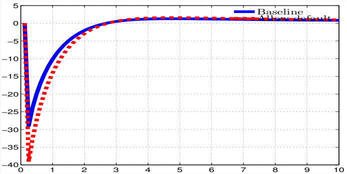
Investment



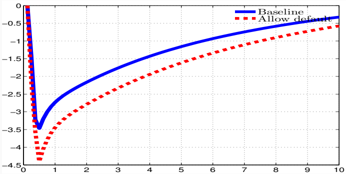
Output



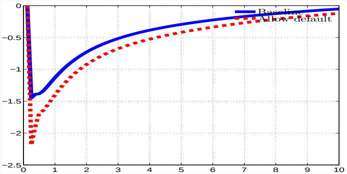
Consumption



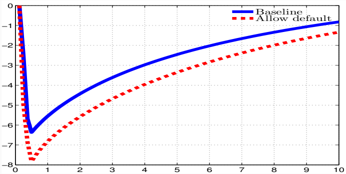
Investment



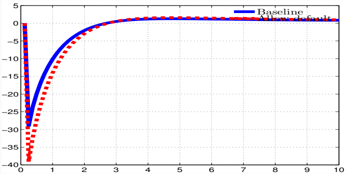
Output



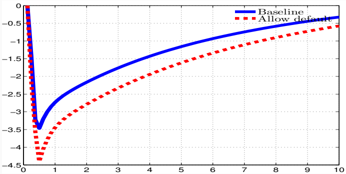
TFP



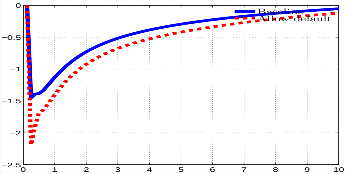
Consumption



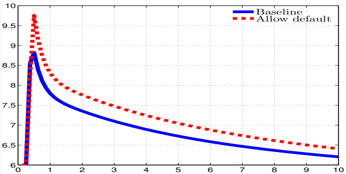
Investment



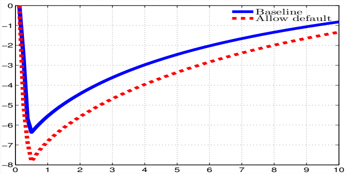
Output



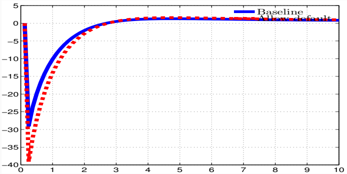
TFP



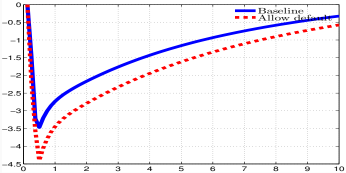
Unemployment rate



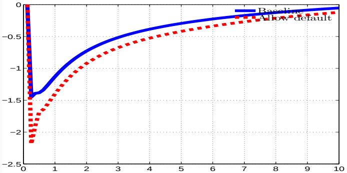
Consumption



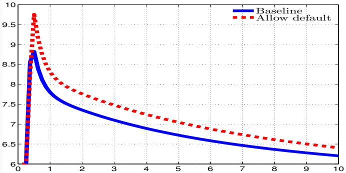
Investment



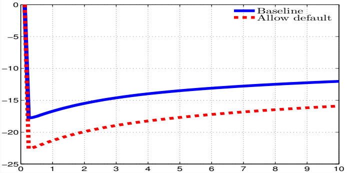
Output



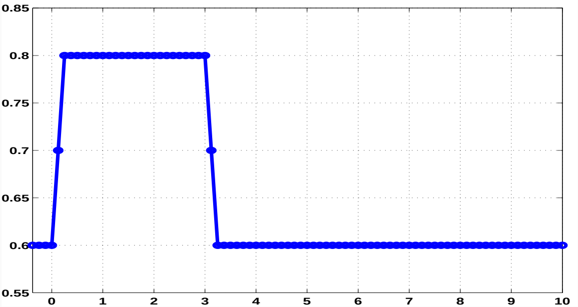
TFP



Unemployment rate

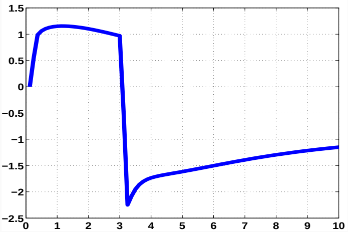


Housing Prices

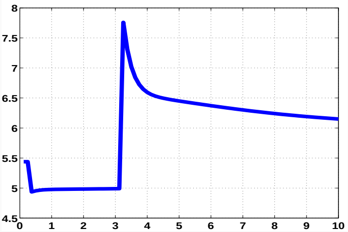


Loan to value ratio λ

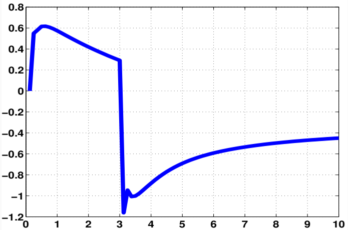
Another Experiment A Credit Cycle



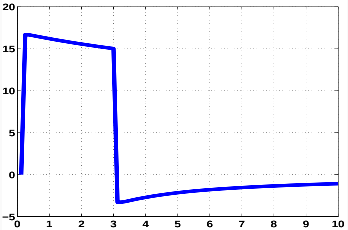
Real output



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

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

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

Look at Impulse Responses of Other Adverse Events

Assess Equilibrium Implications

1. Increase in Interest Rate (world event or Policy) 1% (Baseline)

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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

First Experiment

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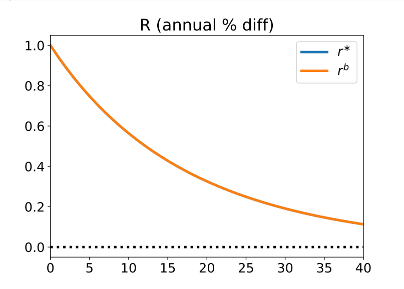
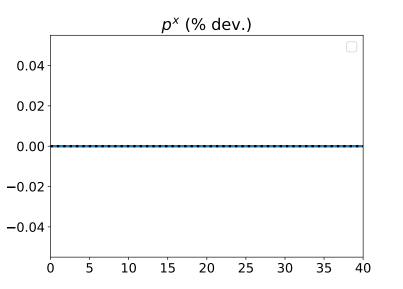
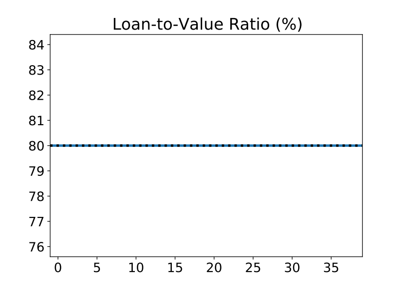
  - Import Elasticty .8

1- Exogenous Shifter: (Only r moves)

p^x because of devaluation LTV Does Not







1- Asset Prices & Quantities (Financial and Total Wealth)

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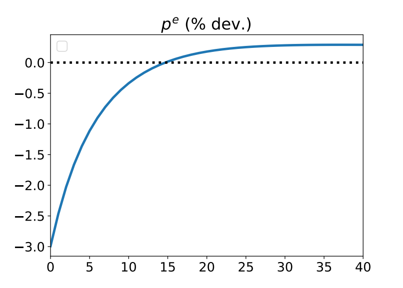

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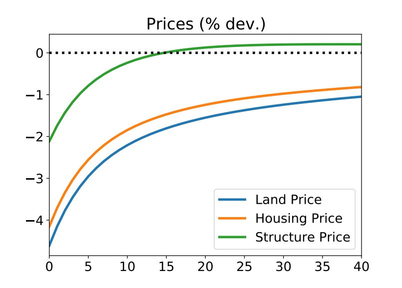

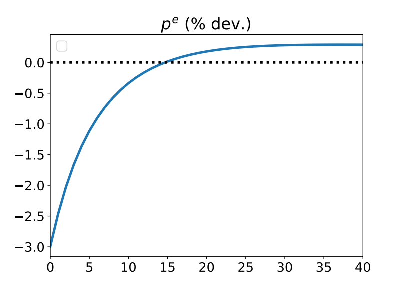

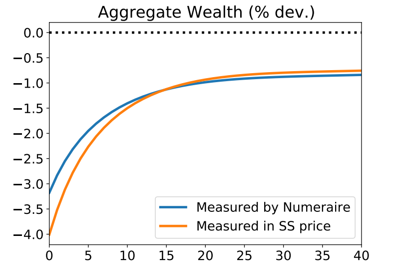

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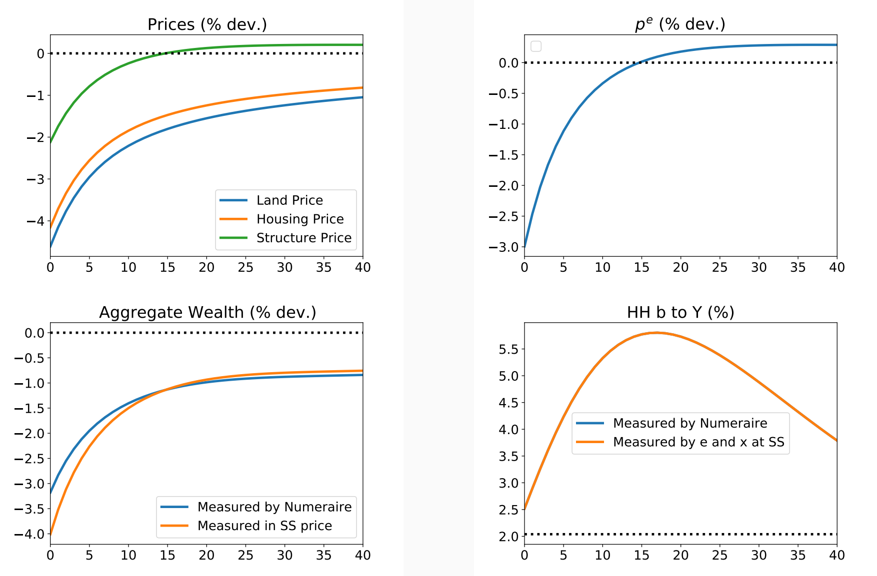
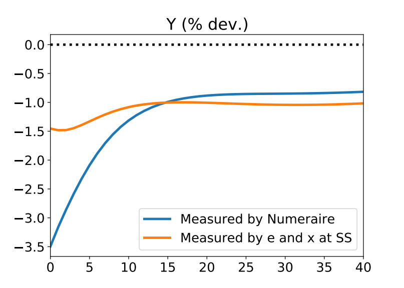
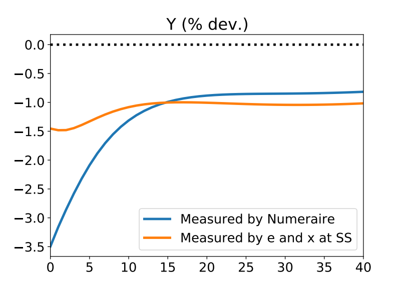
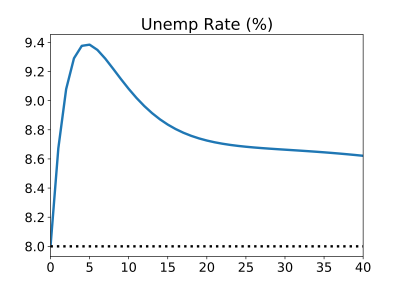
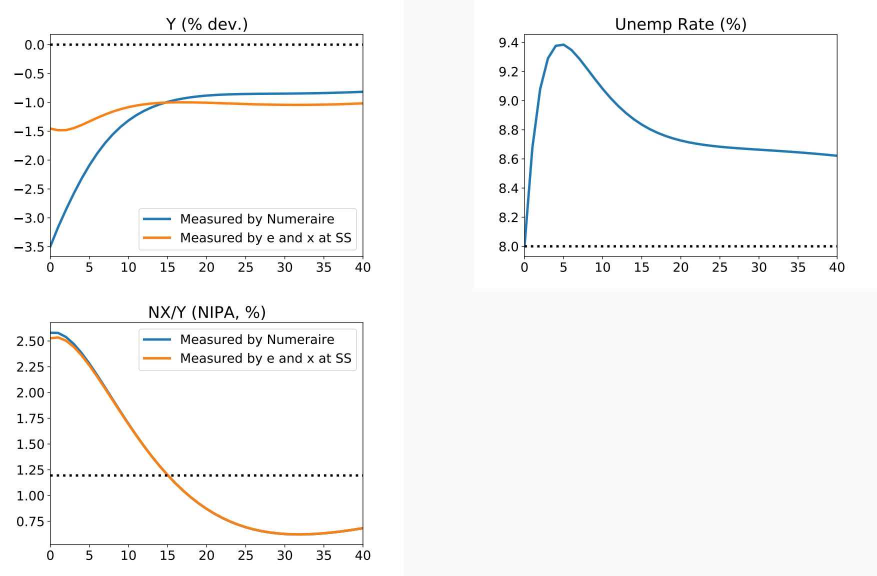



Y (% dev.)
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
−3.5
0
5
10
15
20
25
30
35
40
Measured by Numeraire
Measured by e and x at SS

1- Main Business Cycle Objects






Y (% dev.)
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
−3.5
0 5 10 15 20 25 30 35 40
Measured by Numeraire
Measured by e and x at SS
Unemp Rate (%)
9.4
9.2
9.0
8.8
8.6
8.4
8.2
8.0
0 5 10 15 20 25 30 35 40
NX/Y (NIPA, %)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0 5 10 15 20 25 30 35 40
Measured by Numeraire
Measured by e and x at SS

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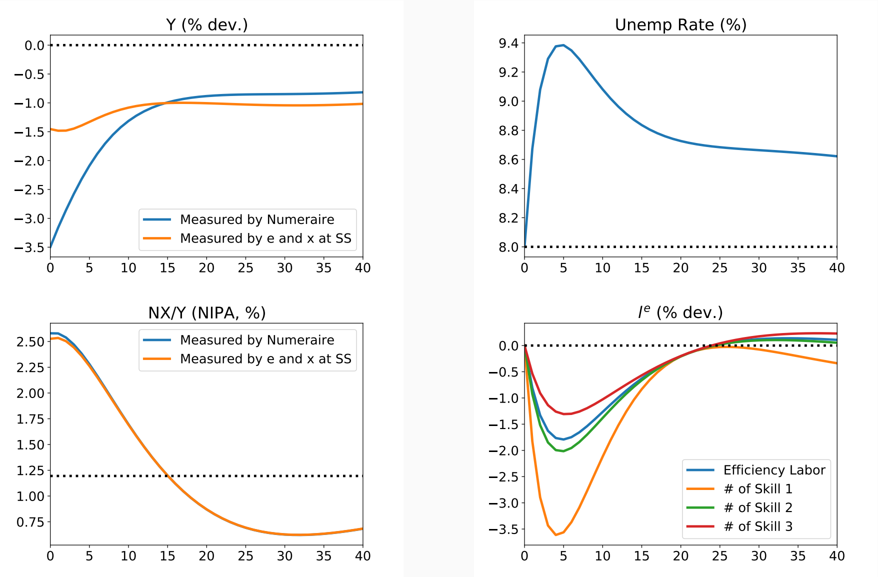
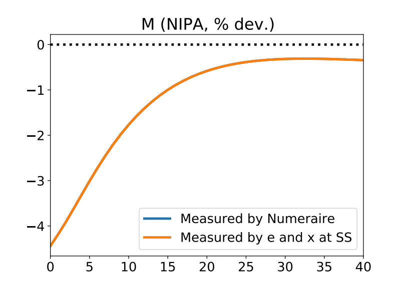
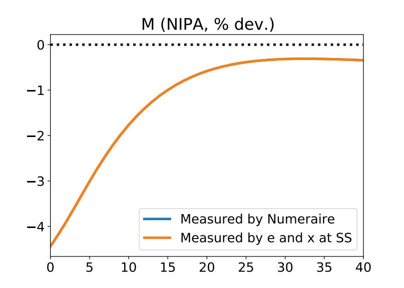
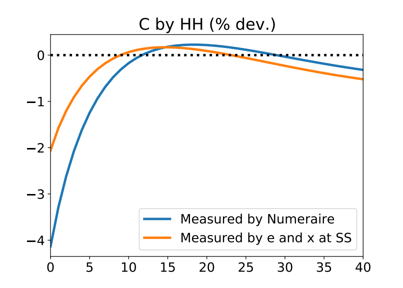
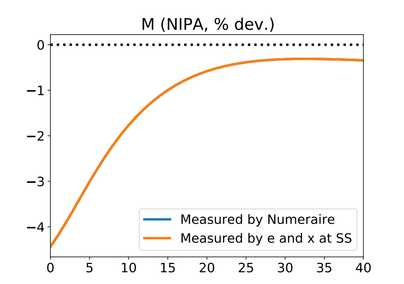
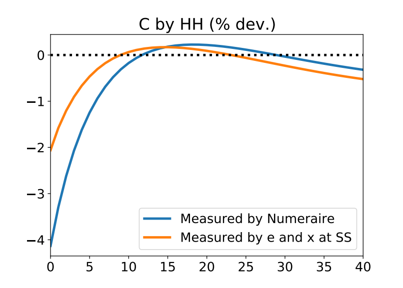


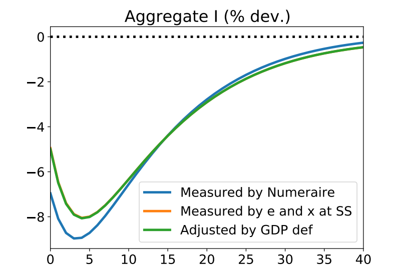

M (NIPA, % dev.)
0
−1
−2
−3
−4
0
5
10
15
20
25
30
35
40
Measured by Numeraire
Measured by e and x at SS


M (NIPA, % dev.)
Measured by Numeraire
Measured by e and x at SS
0
−1
−2
−3
−4
0 5 10 15 20 25 30 35 40

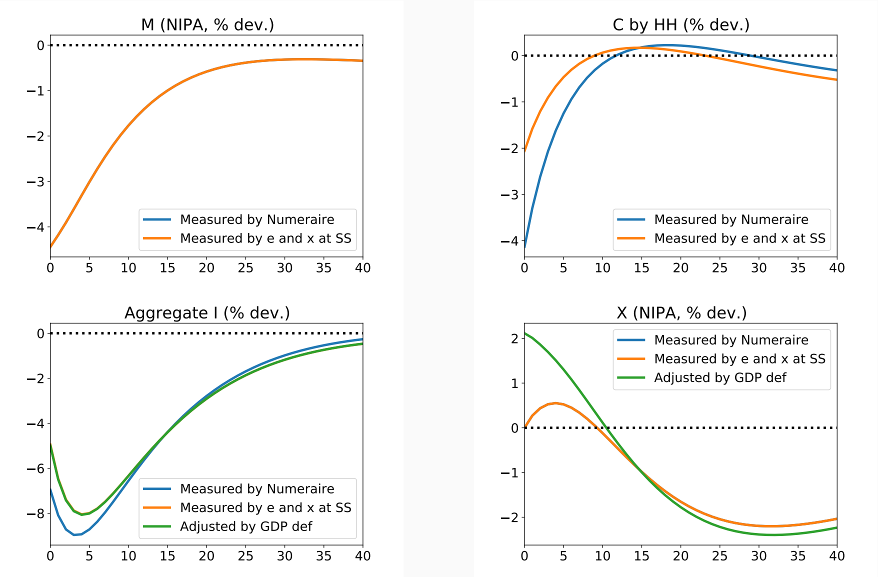

C by HH (% dev.)
Measured by Numeraire
Measured by e and x at SS
0
−1
−2
−3
−4
0 5 10 15 20 25 30 35 40

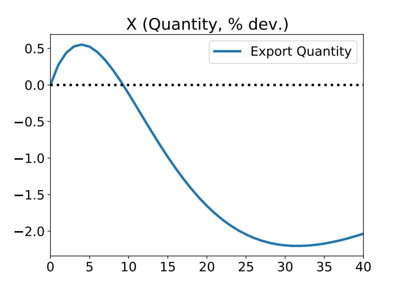

M (NIPA, % dev.)
0
−1
−2
−3
−4
0
5
10
15
20
25
30
35
40
Measured by Numeraire
Measured by e and x at SS

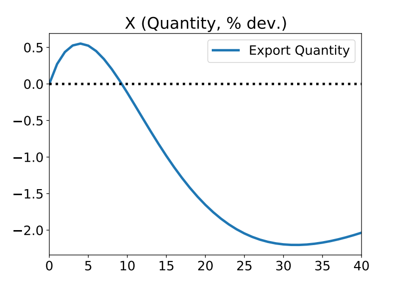

C by HH (% dev.)
0
−1
−2
−3
−4
0
5
10
15
20
25
30
35
40
Measured by Numeraire
Measured by e and x at SS

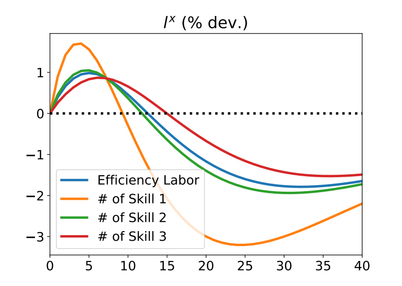

Aggregate I (% dev.)
0
−2
−4
−6
−8
0
5
10
15
20
25
30
35
40
Measured by Numeraire
Measured by e and x at SS
Adjusted by GDP def

1- GDP Components

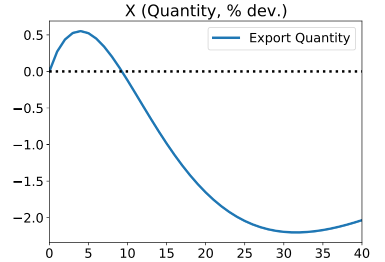


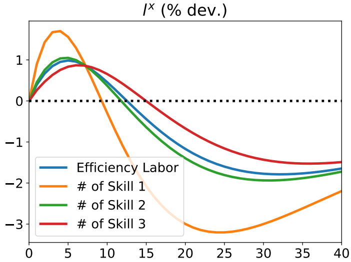

X (Quantity, % dev.)
Export Quantity
0.5
0.0
−0.5
−1.0
−1.5
−2.0
0
5
10
15
20
25
30
35
40

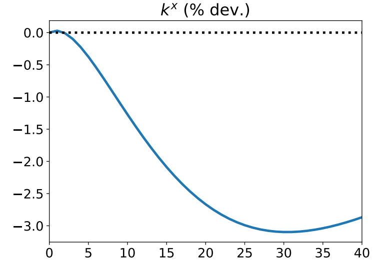

X (Quantity, % dev.)
Export Quantity
0.5
0.0
−0.5
−1.0
−1.5
−2.0
0
5
10
15
20
25
30
35
40

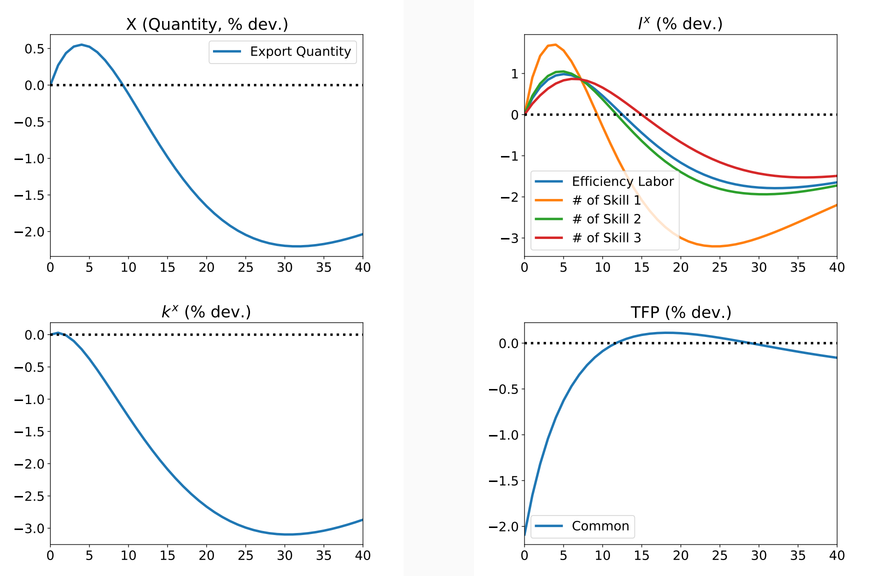

l^x (% dev.)
Efficiency Labor
# of Skill 1
# of Skill 2
# of Skill 3
1
0
−1
−2
−3
0
5
10
15
20
25
30
35
40

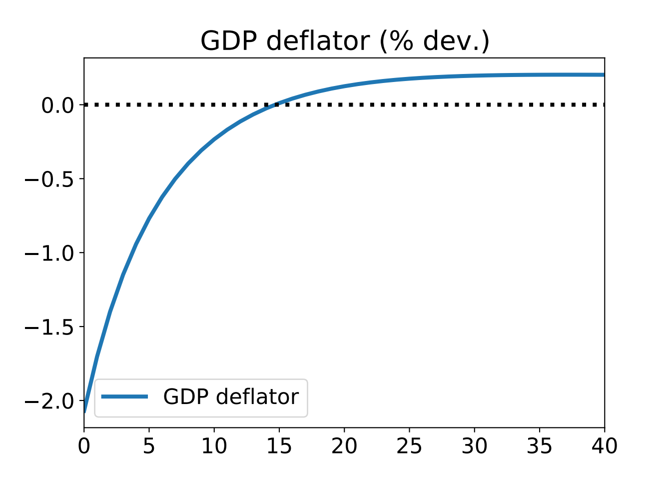
1- Sector

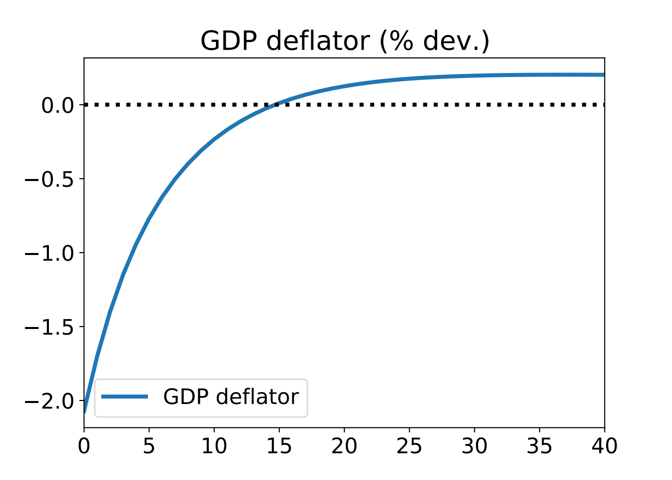

X (Quantity, % dev.)
Export Quantity
0.5
0.0
−0.5
−1.0
−1.5
−2.0
0
5
10
15
20
25
30
35
40

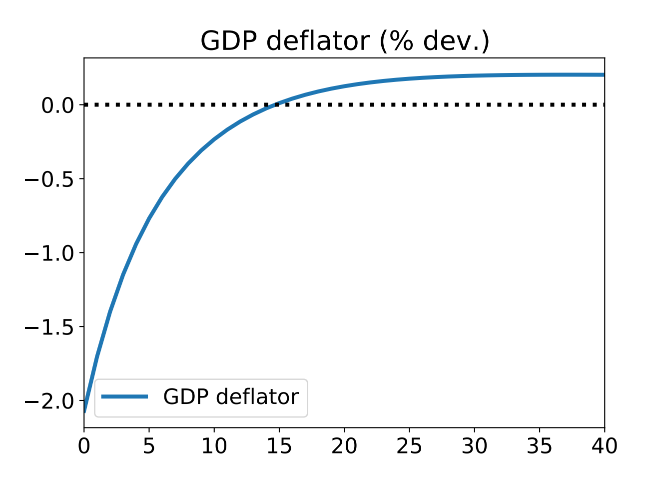

l^x (% dev.)
Efficiency Labor
# of Skill 1
# of Skill 2
# of Skill 3
1
0
−1
−2
−3
0
5
10
15
20
25
30
35
40

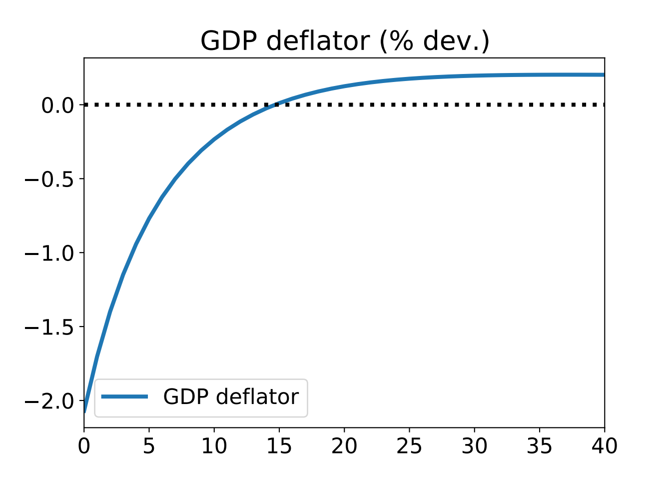

k^x (% dev.)
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
0
5
10
15
20
25
30
35
40


X (Quantity, % dev.)
Export Quantity
I^x (% dev.)
Efficiency Labor
# of Skill 1
# of Skill 2
# of Skill 3
k^x (% dev.)
TFP (% dev.)
Common

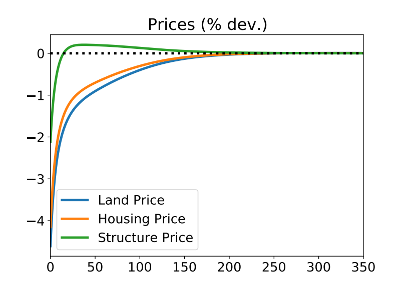

GDP deflator (% dev.)
0.0
−0.5
−1.0
−1.5
−2.0
0
5
10
15
20
25
30
35
40
GDP deflator


GDP deflator (% dev.)
0.0
−0.5
−1.0
−1.5
−2.0
GDP deflator
0
5
10
15
20
25
30
35
40


GDP deflator (% dev.)
0.0
−0.5
−1.0
−1.5
−2.0
0
5
10
15
20
25
30
35
40
GDP deflator


GDP deflator (% dev.)
0.0
−0.5
−1.0
−1.5
−2.0
0
5
10
15
20
25
30
35
40
GDP deflator

1- The Longer View: 87 years



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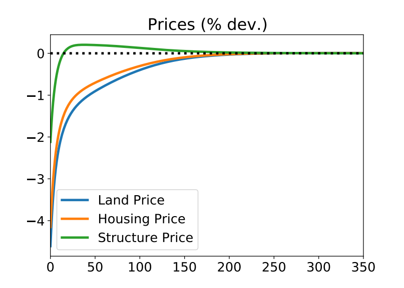
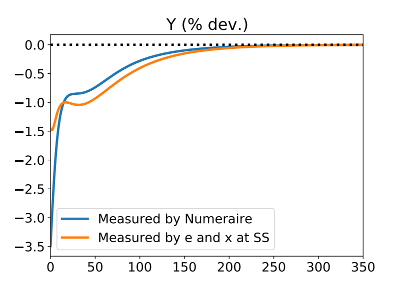
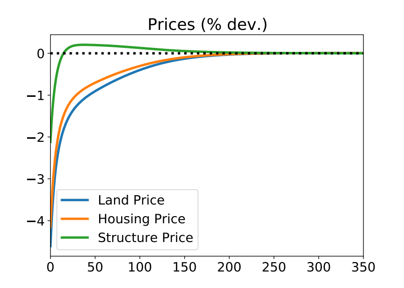
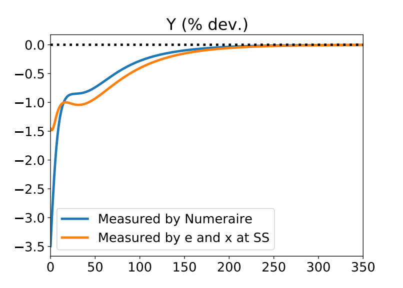
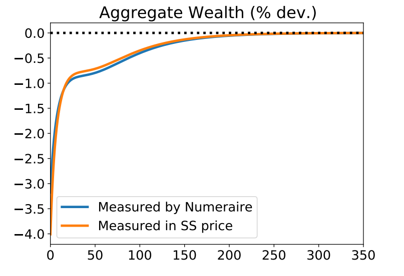





Prices (% dev.)
0
−1
−2
−3
−4
Land Price
Housing Price
Structure Price
0 50 100 150 200 250 300 350


Y (% dev.)
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
−3.5
Measured by Numeraire
Measured by e and x at SS
0 50 100 150 200 250 300 350


Aggregate Wealth (% dev.)
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
−3.5
−4.0
Measured by Numeraire
Measured in SS price
0 50 100 150 200 250 300 350

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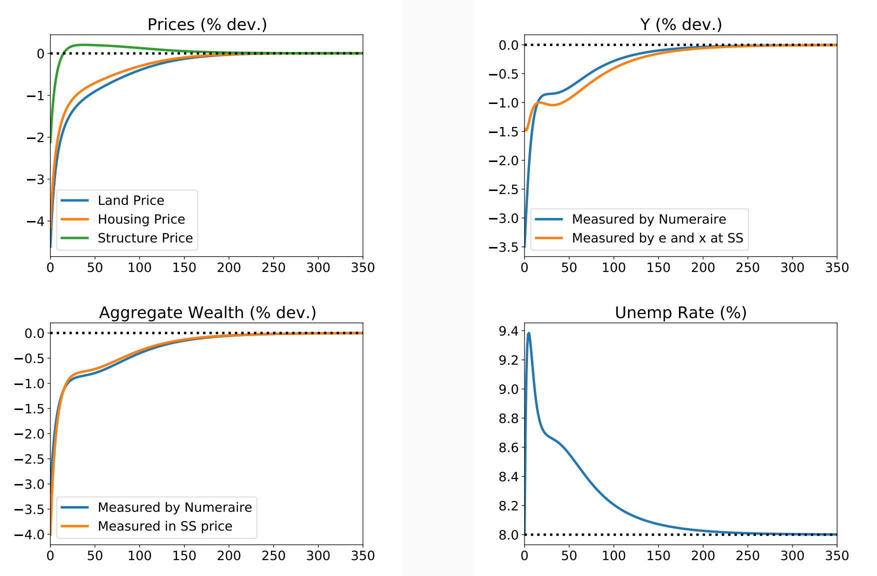

- Sizeable Recession With Large Drop of Wealth

1- Takeaways from a 1% persistent but temporary real interest rate hike

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- 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))

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- A 3% Temporary but persistent Decrease in the Terms of Trade

2th Experiment: Perfect Storm: The Great Recession?

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$$\log w_t - \log w^{ss} = \psi^w \left(\log Y_t - \log Y^{ss}\right)$$

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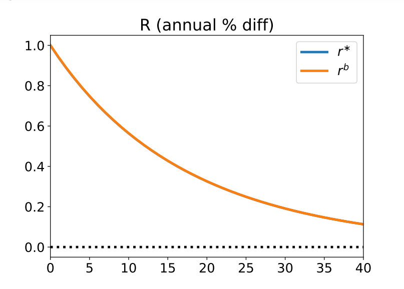
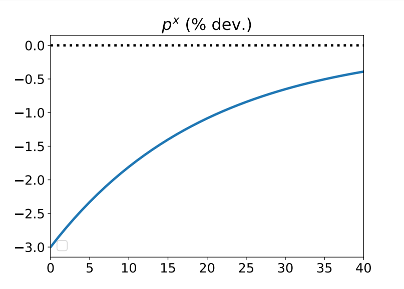
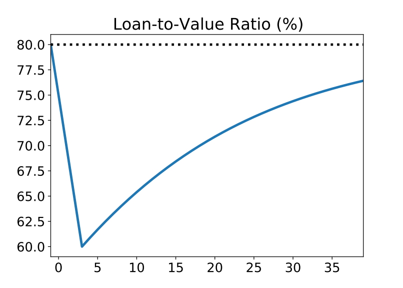
    - Import Elasticty .8

p^x Much more because of devaluation; LTV Does Not







2. Asset Prices & Quantities (Financial and Total Wealth)

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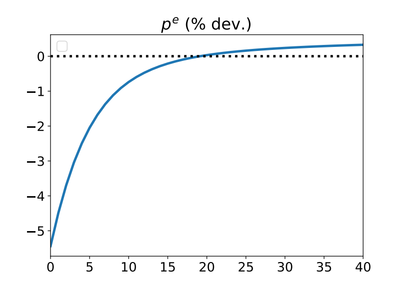
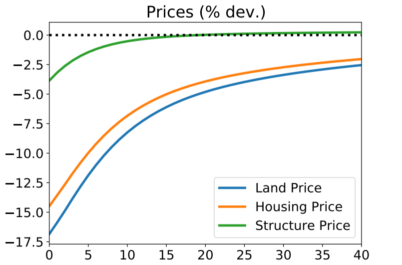
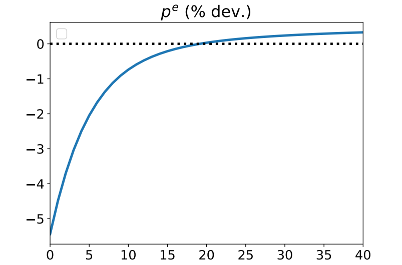
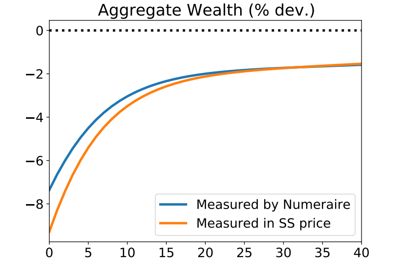
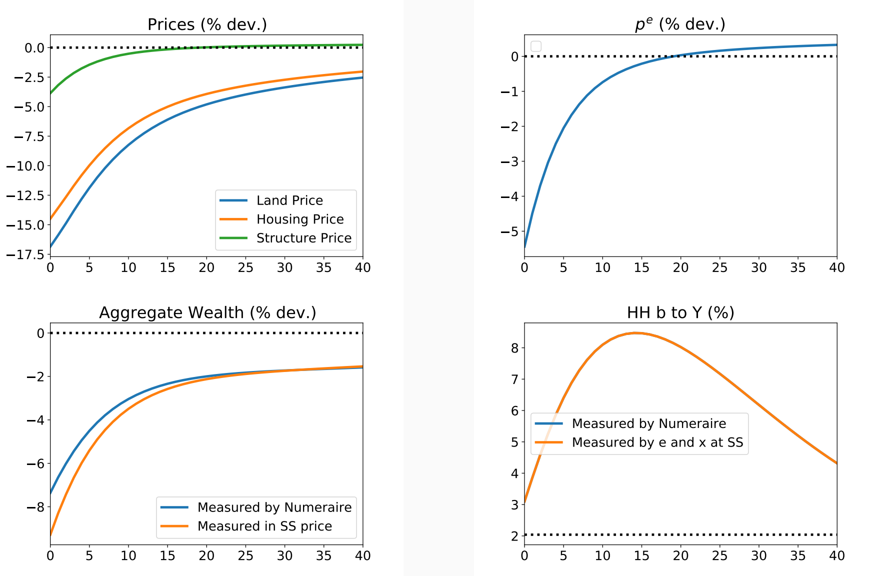


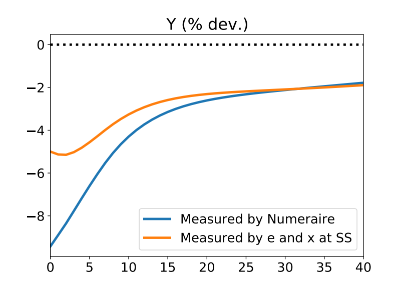

Prices (% dev.)
Land Price
Housing Price
Structure Price
0.0
−2.5
−5.0
−7.5
−10.0
−12.5
−15.0
−17.5
0
5
10
15
20
25
30
35
40

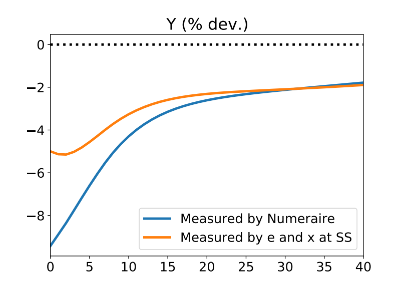

p^e (% dev.)
0
−1
−2
−3
−4
−5
0
5
10
15
20
25
30
35
40

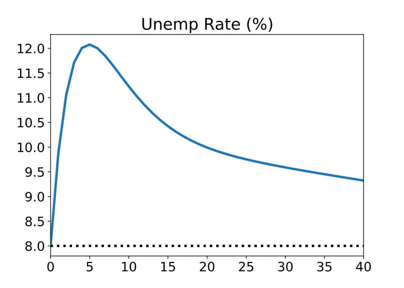

Aggregate Wealth (% dev.)
Measured by Numeraire
Measured in SS price
0
−2
−4
−6
−8
0
5
10
15
20
25
30
35
40

2. Asset Prices & Quantities (Financial and Total Wealth)

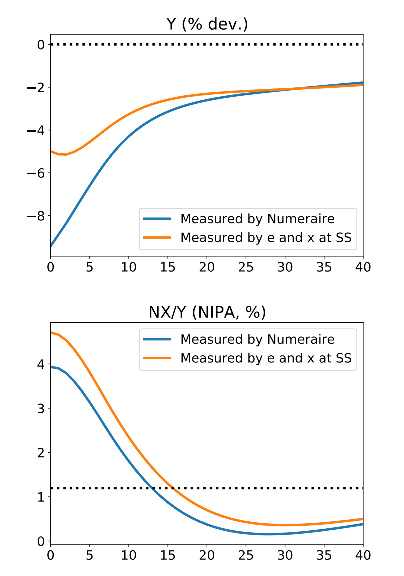


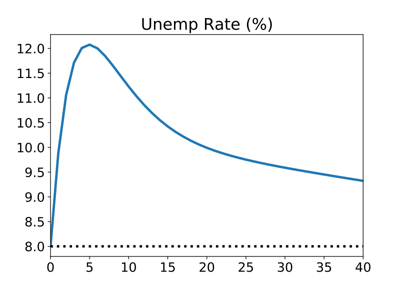

Y (% dev.)
0
−2
−4
−6
−8
0
5
10
15
20
25
30
35
40
Measured by Numeraire
Measured by e and x at SS


Y (% dev.)
0
−2
−4
−6
−8
0 5 10 15 20 25 30 35 40
Measured by Numeraire
Measured by e and x at SS


Unemp Rate (%)
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
0 5 10 15 20 25 30 35 40

2. Main Business Cycle Objects





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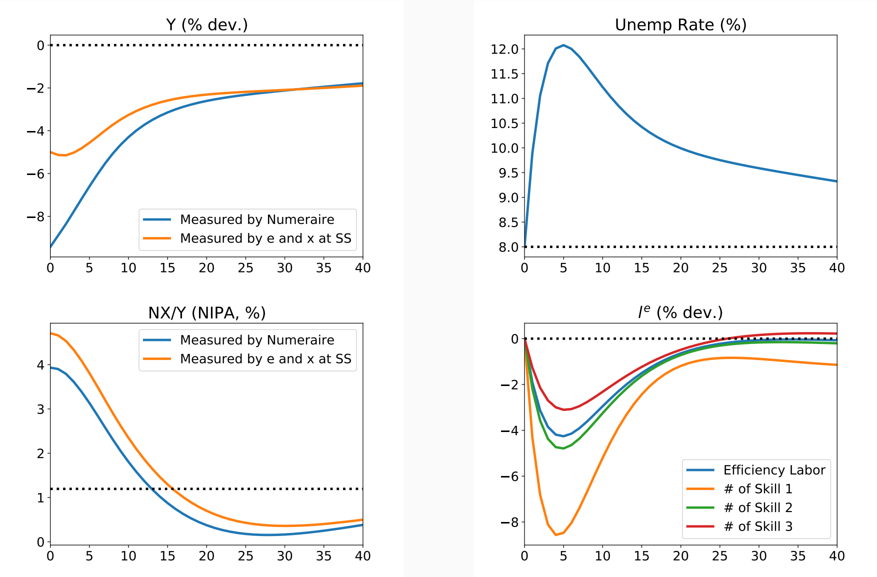
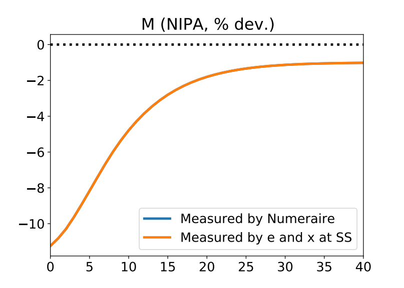
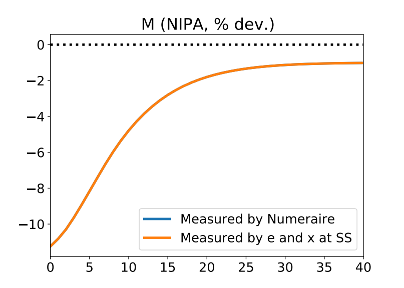
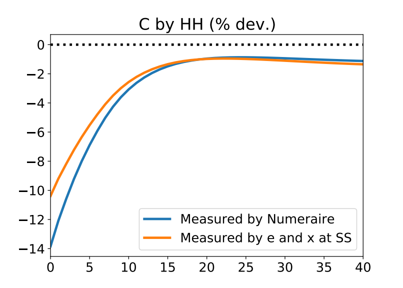
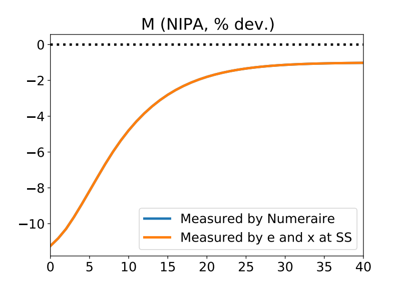


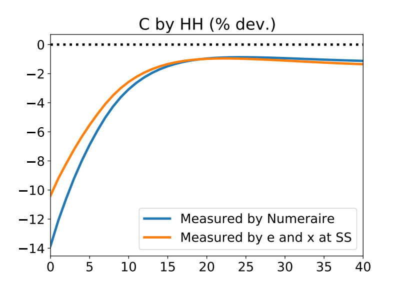

M (NIPA, % dev.)
0
−2
−4
−6
−8
−10
0
5
10
15
20
25
30
35
40
Measured by Numeraire
Measured by e and x at SS

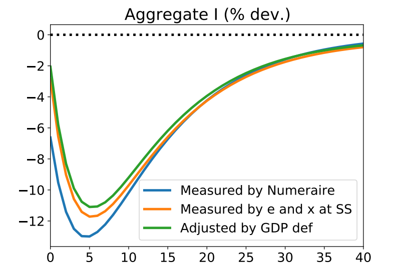
2. GDP Components

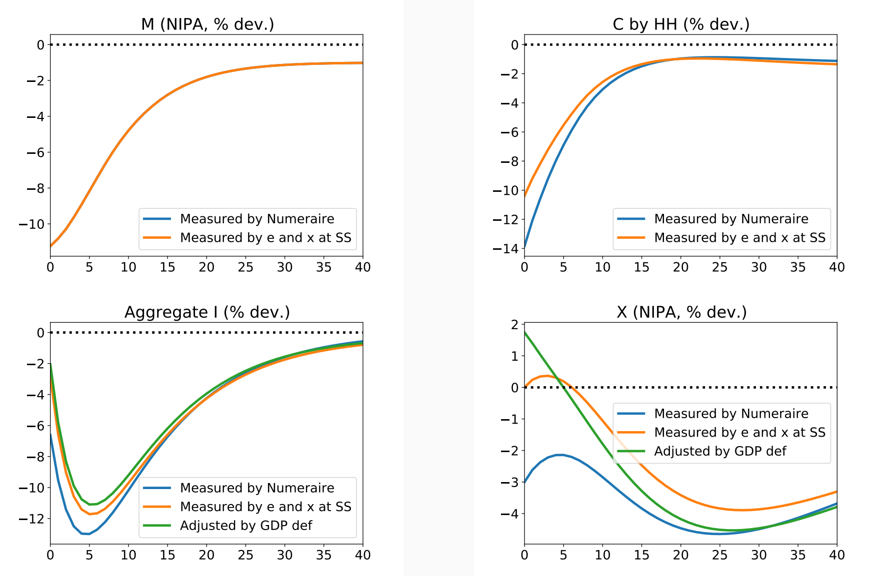





M (NIPA, % dev.)
0
−2
−4
−6
−8
−10
0 5 10 15 20 25 30 35 40
Measured by Numeraire
Measured by e and x at SS


C by HH (% dev.)
0
−2
−4
−6
−8
−10
−12
−14
0 5 10 15 20 25 30 35 40
Measured by Numeraire
Measured by e and x at SS


Aggregate I (% dev.)
0
−2
−4
−6
−8
−10
−12
0 5 10 15 20 25 30 35 40
Measured by Numeraire
Measured by e and x at SS
Adjusted by GDP def


M (NIPA, % dev.)
Measured by Numeraire
Measured by e and x at SS
C by HH (% dev.)
Measured by Numeraire
Measured by e and x at SS
Aggregate I (% dev.)
Measured by Numeraire
Measured by e and x at SS
Adjusted by GDP def
X (NIPA, % dev.)
Measured by Numeraire
Measured by e and x at SS
Adjusted by GDP def

- Everything Larger

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- Very Large Devaluation relative to price decrease

2. Main Takeaways

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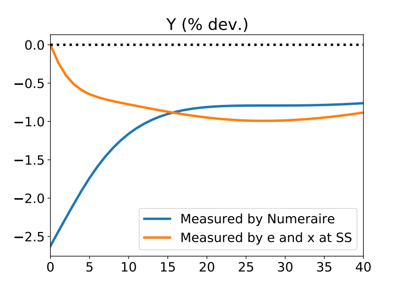
- Humongous reduction of imports: Sizeable Improvement in Balance of Payments.
- Not consistent world wide. Need much larger drop in foreign demand.

3- No Amplification via Expenditure Externality



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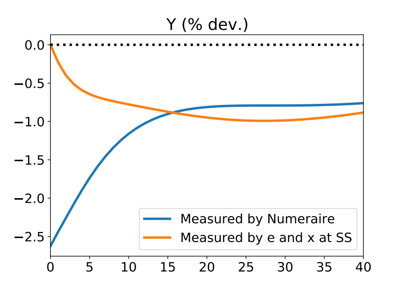
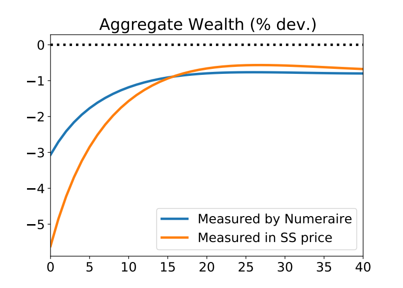
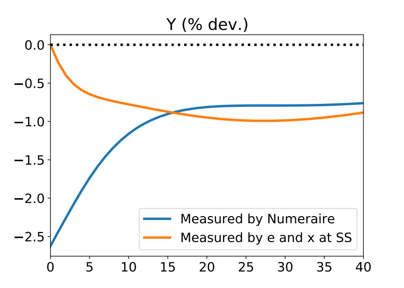
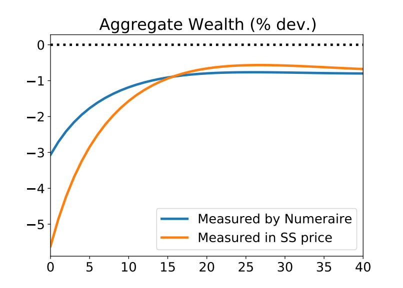
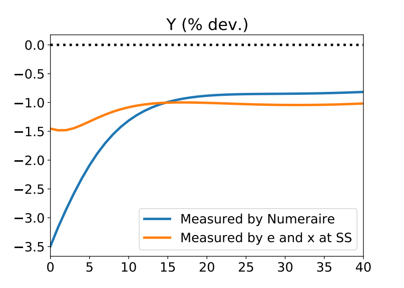








Comparing with Baseline



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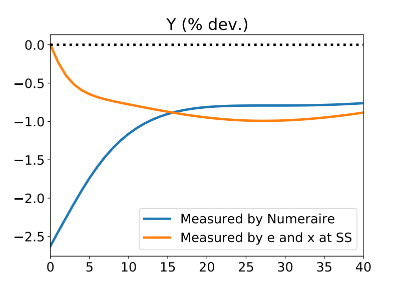

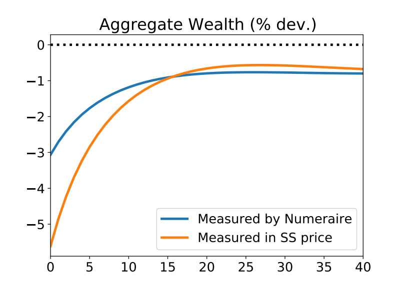

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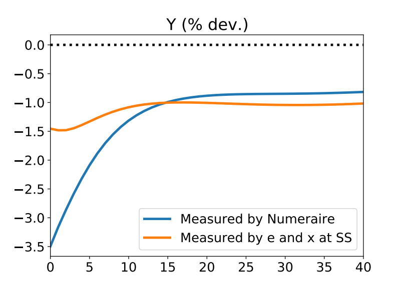
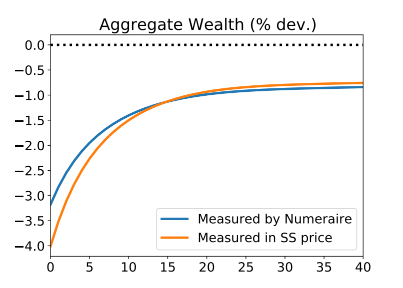




- Elastic Non-tradable price no market clearing on non-tradables, demand determined quantities

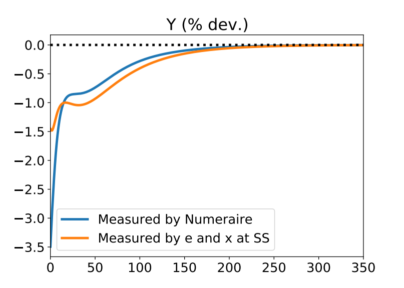
- A Temporary but persistent Increase in Interest Rates
- Elastic Non-tradable price no market clearing on non-tradables, demand determined quantities
- Reduction in Max LTV from 80% to 60%
- With TFP Externality
  - TFP Elasticity wrt expenditures .5
  - Wage Adjustments ($\psi^w = .5$)

$$\log w_t - \log w^{ss} = \psi^w \left(\log Y_t - \log Y^{ss}\right)$$

  - Import Elasticty .8

Comparing with output across horizons between base and partial devaluation

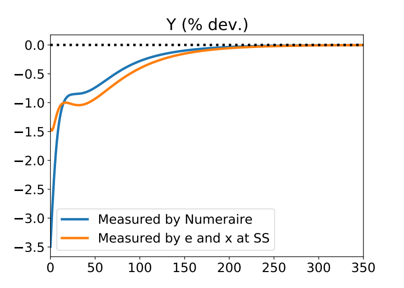
Baseline



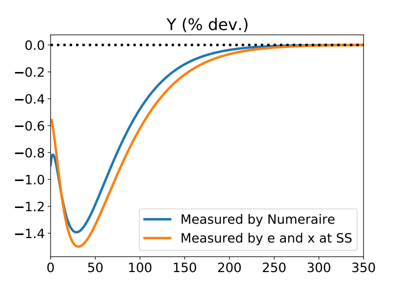
Partial Devaluation

Comparing with output across horizons between base and partial devaluation

Baseline

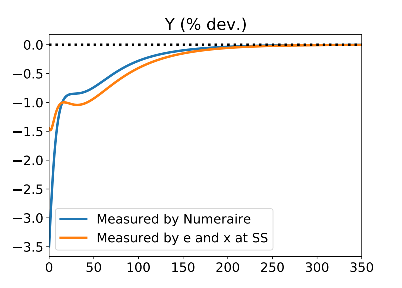


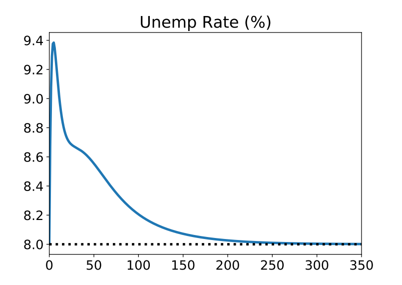
Partial Devaluation



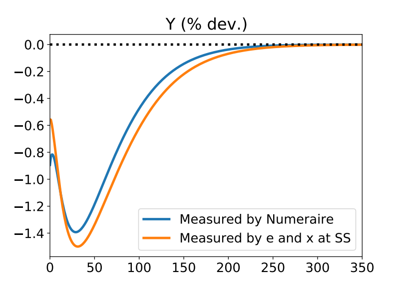
Comparing with output across horizons between base and partial devaluation

Baseline



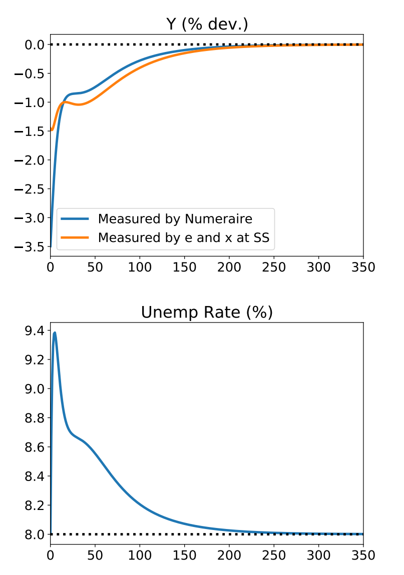


Partial Devaluation

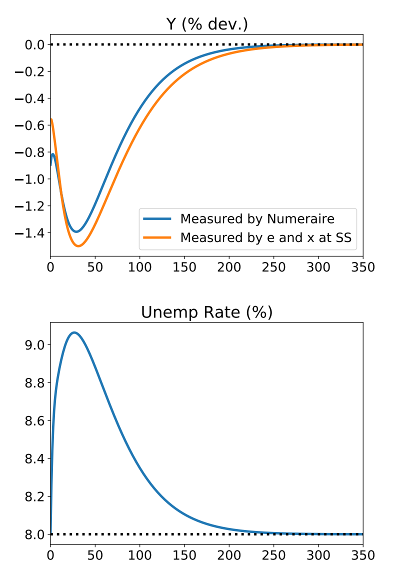


Comparing with output across horizons between base and partial devaluation

Baseline

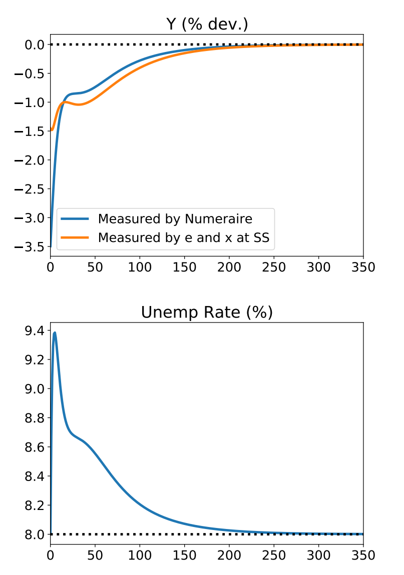


Partial Devaluation

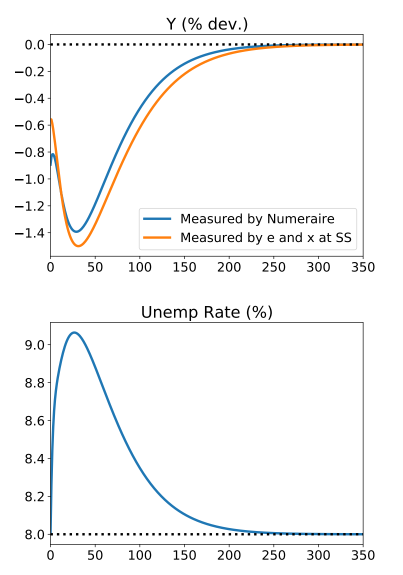


Comparing with output across horizons between base and partial devaluation

Baseline



Partial Devaluation



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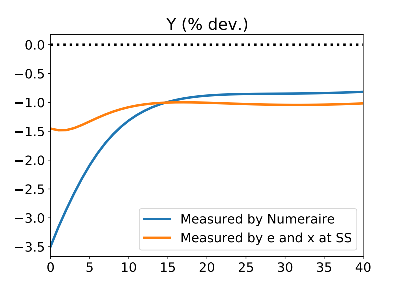
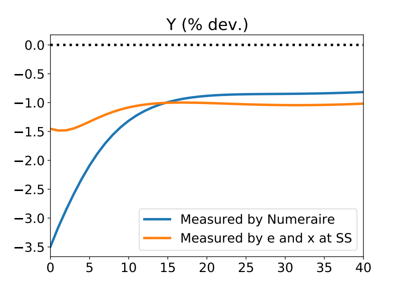


Perfect Storm

Baseline



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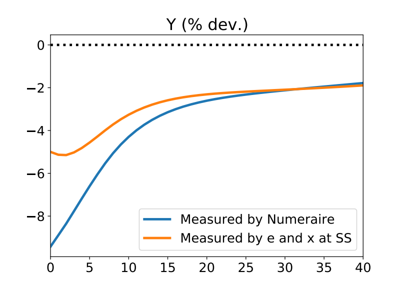
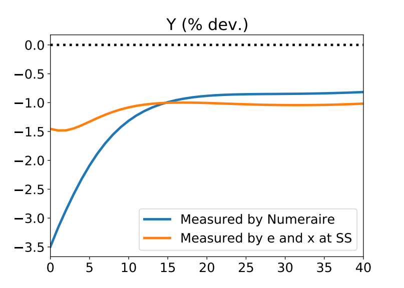


Comparison between all Economies: Output

Baseline



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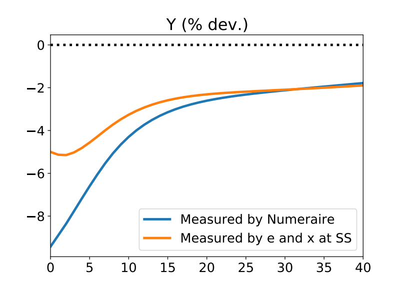
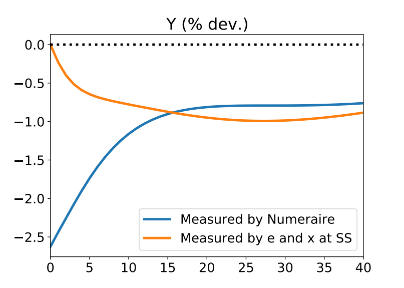


No TFP Externality



Insufficient Devaluation

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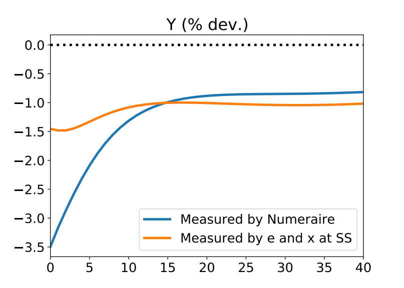

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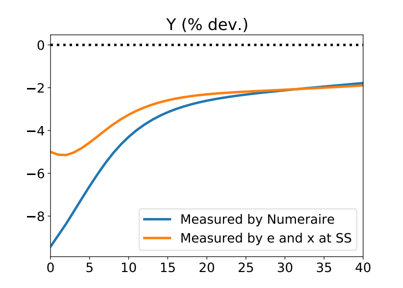

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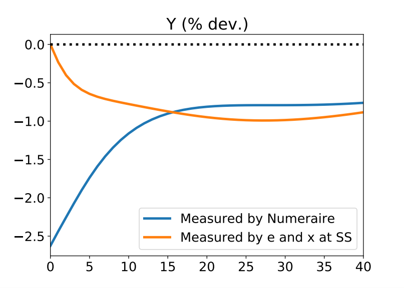

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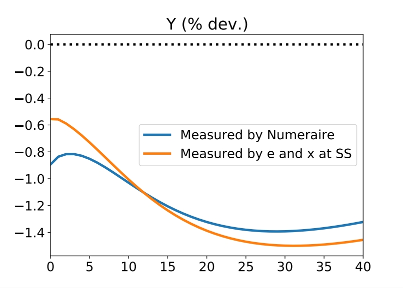

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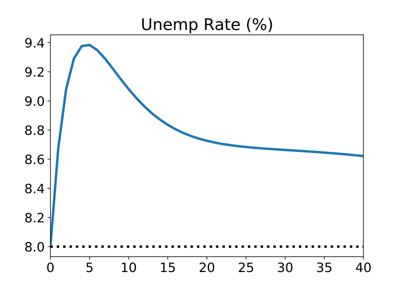

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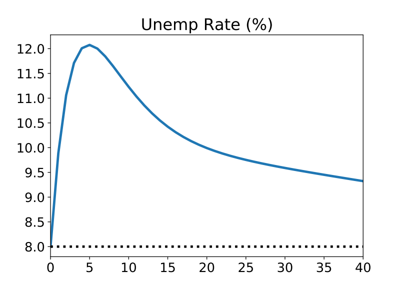

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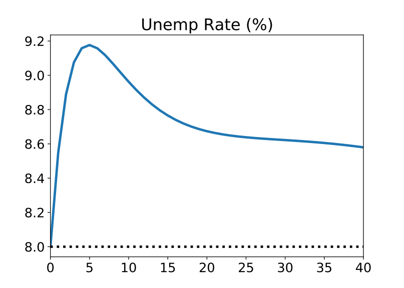

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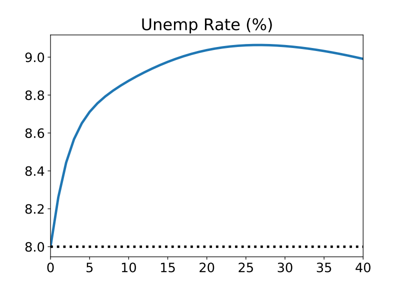

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What we want to have but do not have YET

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- Have a modern New Keynesian structure to model the link between nominal and real interest rates

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- Build more Asset prices and productivity propagation into those models.

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- 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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