Real Keynesian Models and Sticky Prices

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Introduction : Demand Shocks

- In most macro models...
- price stickiness = source of money non neutrality...
- ... and of demand shocks non neutrality
- There are alternative modelling choices for demand non-neutrality:
- Demand driven fluctuations in flex. price environments (Ex: Angeletos-La'O, Angeletos-Lian, Guerrieri-Lorenzoni, Lorenzoni, Beaudry-Portier, Beaudry-Galizia-Portier,... etc $\rightsquigarrow$ *Real Keynesian* models
- Should we care for better understanding the effect of monetary policy?

Introduction: Two Contributions, One Message

Introduction: Two Contributions

- Contributions
  1. Propose a new class of simple extensions of the *New Keynesian* model (the *Real Keynesian* model) that has very different implications for monetary policy
  2. Propose a novel way to identify shocks in SVARs

Introduction: One Message

"The theory of natural output matters to understand the impact of monetary policy on the output gap"

Roadmap

1. Theory & Estimation
2. Dissecting the results using a new SVAR approach
3. Zero Lower Bound and Missing Deflation

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Extended Linearized Model

$$\ell_t = \alpha_\ell E_t \ell_{t+1} - \alpha_r (i_t - E_t \pi_{t+1}) + d_t \qquad \text{Euler Equation (EE)}$$

$$\pi_t = \beta E_t \pi_{t+1} + \kappa\big(\gamma_\ell \ell_t + \gamma_r (i_t - E_t \pi_{t+1})\big) \qquad \text{Phillips Curve (PC)}$$

- Two changes:
  - $\alpha_\ell \leq 1$: Add asymmetric information: some households always repay their debt, some do only if it is in their interest $\rightsquigarrow$ positively sloped cost of funds $\rightsquigarrow$ *discounted EE*
  - $\gamma_r \geq 0$: Firms need to borrow to pay for intermediate inputs before production $\rightsquigarrow$
- Nothing novel, except for putting them together.
- Note: standard NK model: $\alpha_\ell = 1$, $\gamma_r = 0$
- Here only demand shock (news shock, β shock,...)
- To remember: α's for the EE, γ's for the PC

Sticky & Flex Price Versions

- Sticky Prices

$$\ell_t = \alpha_\ell E_t \ell_{t+1} - \alpha_r (i_t - E_t \pi_{t+1}) + d_t \qquad \text{(EE)}$$

$$\pi_t = \beta E_t \pi_{t+1} + \kappa \big(\gamma_\ell \ell_t + \gamma_r (i_t - E_t \pi_{t+1}) \big) \qquad \text{(PC)}$$

- Flex Prices

$$\ell_t = \alpha_\ell E_t \ell_{t+1} - \alpha_r r_t + d_t \qquad \text{(EE)}$$

$$mc_t = \gamma_\ell \ell_t + \gamma_r r_t = 0 \qquad \text{Marginal Cost (MC)}$$

The *i.i.d.* Case

- I will give some graphical interpretation in the specific case where shocks are *i.i.d.*
- In that case, for any variable x : $E_t x_{t+1} = 0$

The RK condition

Result 1

With flex. prices, positive demand shocks (both current and expected future) always maintain a positive effects on ℓ *if and only if*

$$\frac{\gamma_r}{\gamma_\ell} > \frac{\alpha_r}{(1-\alpha_\ell)} \qquad (RK)$$

The RK condition

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general case :

$$\ell_t = \alpha_\ell E_t \ell_{t+1} - \alpha_r r_t + d_t \qquad \text{(EE)}$$

$$\ell_t = -\frac{\gamma_r}{\gamma_\ell} r_t \qquad \text{(MC)}$$

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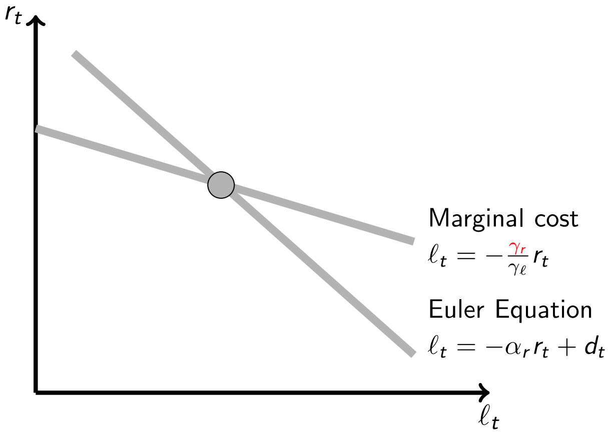

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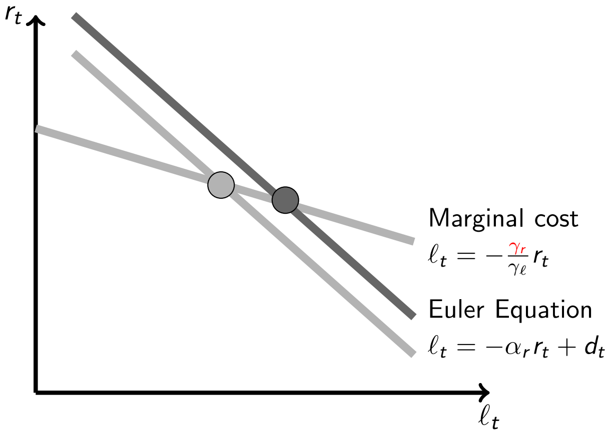

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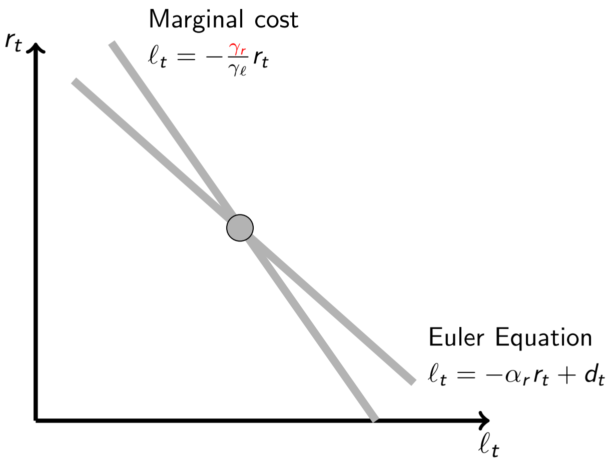

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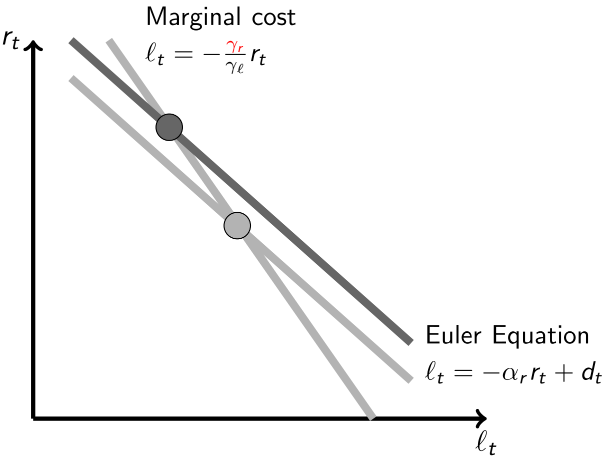

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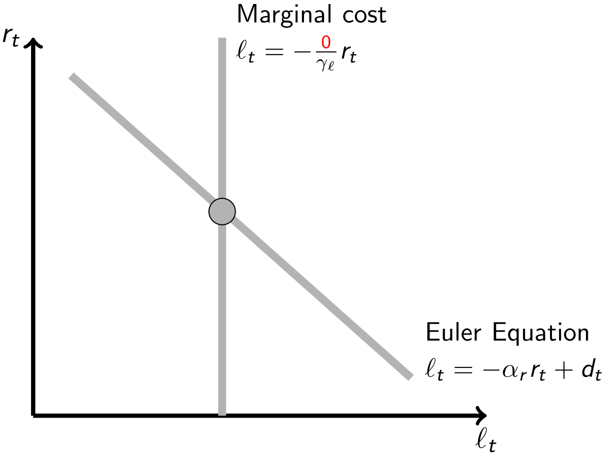

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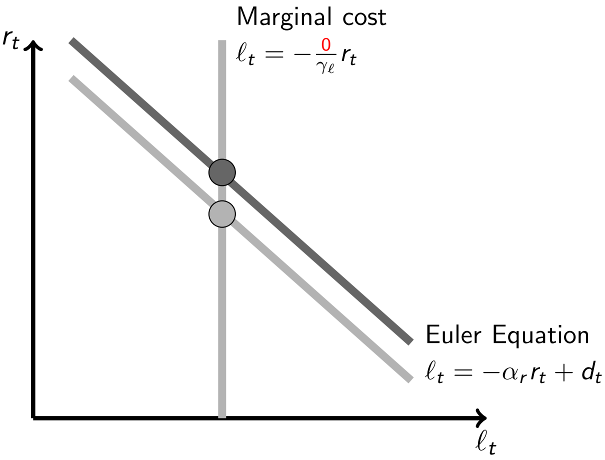

With Sticky Prices

$$\ell_t = \alpha_\ell E_t \ell_{t+1} - \alpha_r (i_t - E_t \pi_{t+1}) + d_t \qquad \text{(EE)}$$

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$$i_t = E_t \pi_{t+1} + \phi_\ell \ell_t + \nu_t \qquad \text{(Policy Rule)}$$

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$$
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$$

Result 2

With policy rule $\phi_\ell > 0$, the economy is determinate for all admissible parameter values.

Irrelevance Result

Result 3

With sticky prices, RK and NK configurations are not qualitatively distinguishable for demand and markup shocks.

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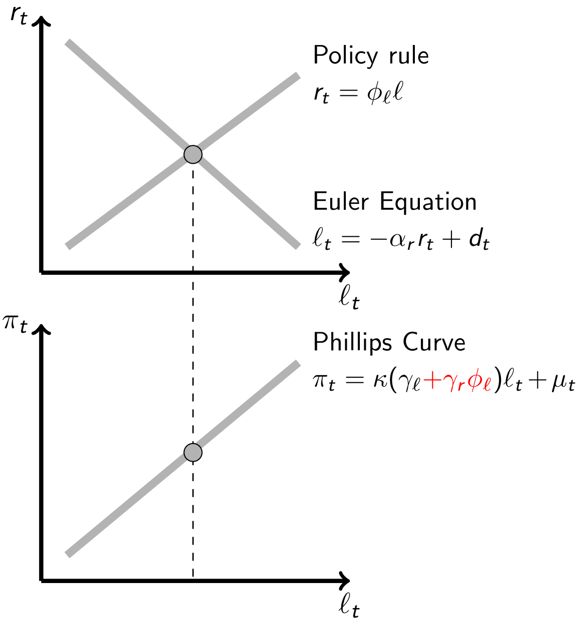

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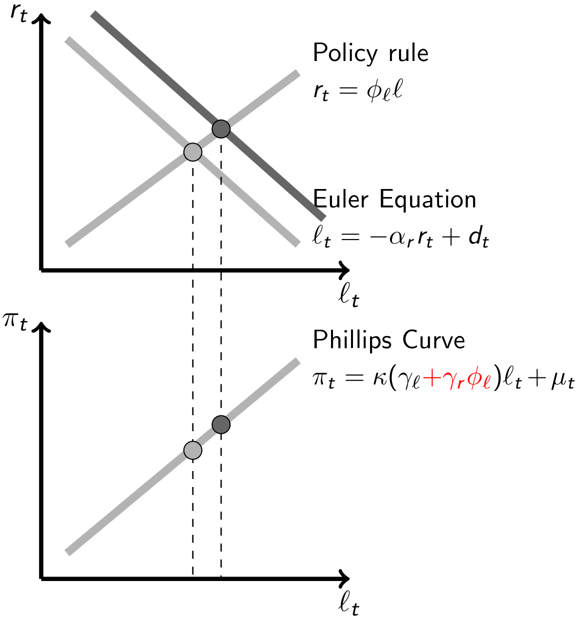

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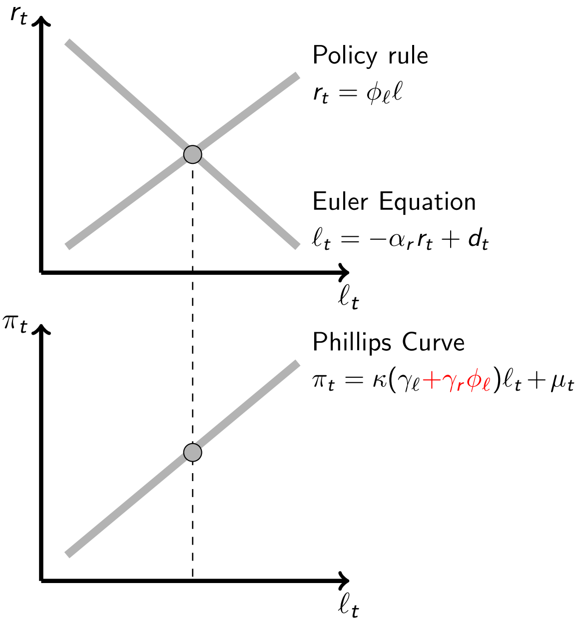

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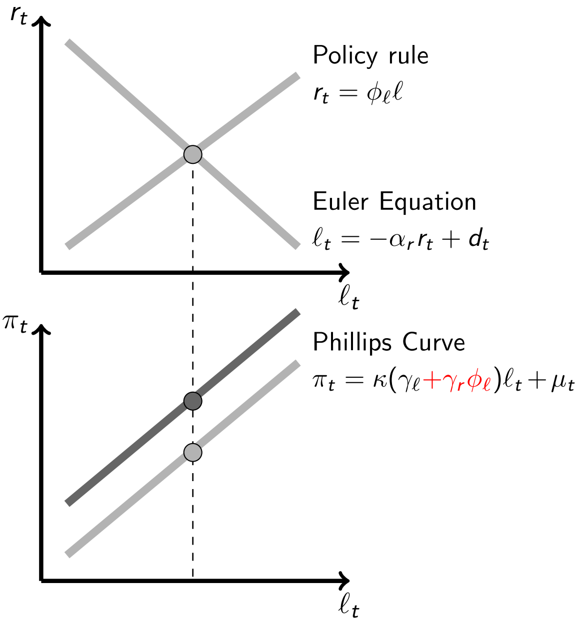


RK Matters for Monetary Policy and Monetary Shocks

- Monetary Policy and Stabilization
- Determinacy under i peg
- Monetary Shocks

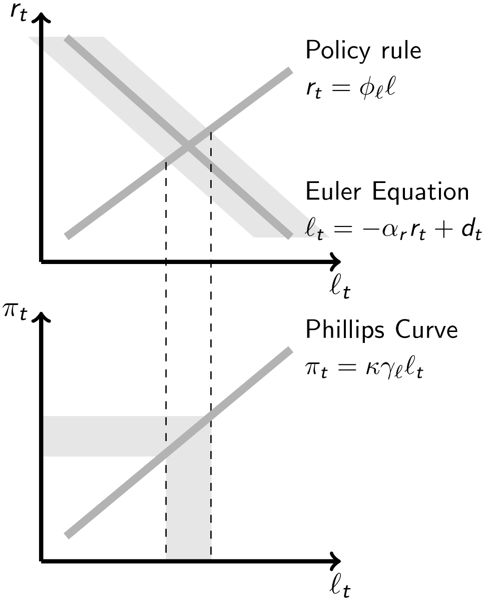
Effects of Stabilization with Demand Shocks

$$i_t = E_t \pi_{t+1} + \phi_\ell \ell_t$$

Result 4

A more aggressive policy (ϕ_ℓ larger) always decreases σ_ℓ^2 at the cost of increasing σ_π^2 iff the RK condition is satisfied.

NK Configuration ($\gamma_r = 0$, $\alpha_\ell = 1$)



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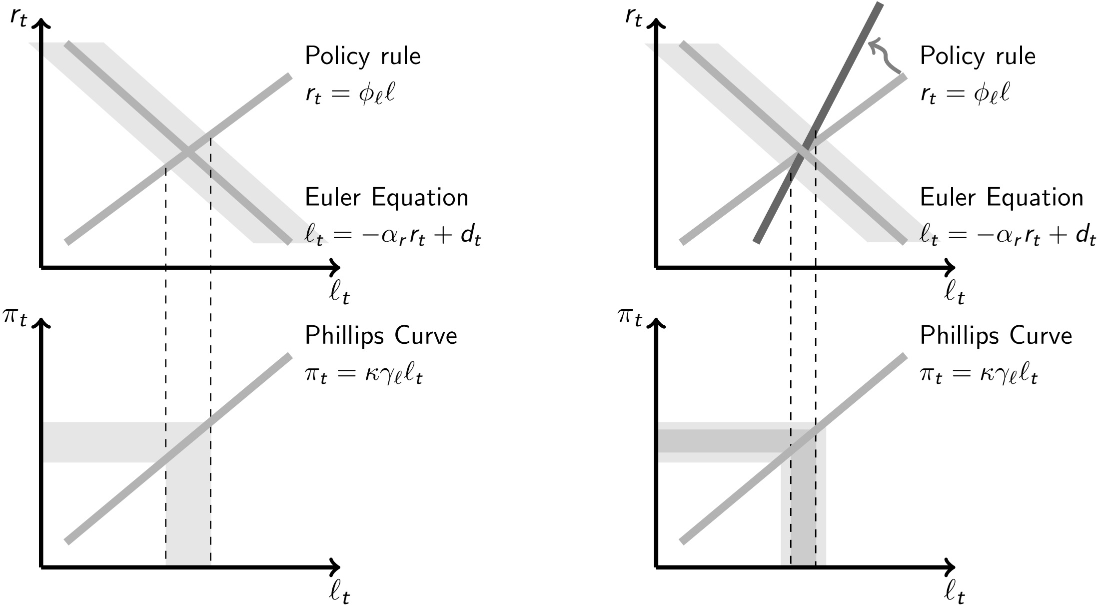
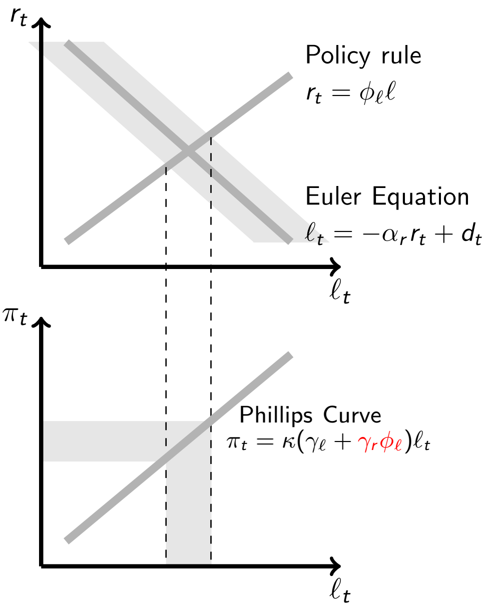


Under RK (γ_r large enough)



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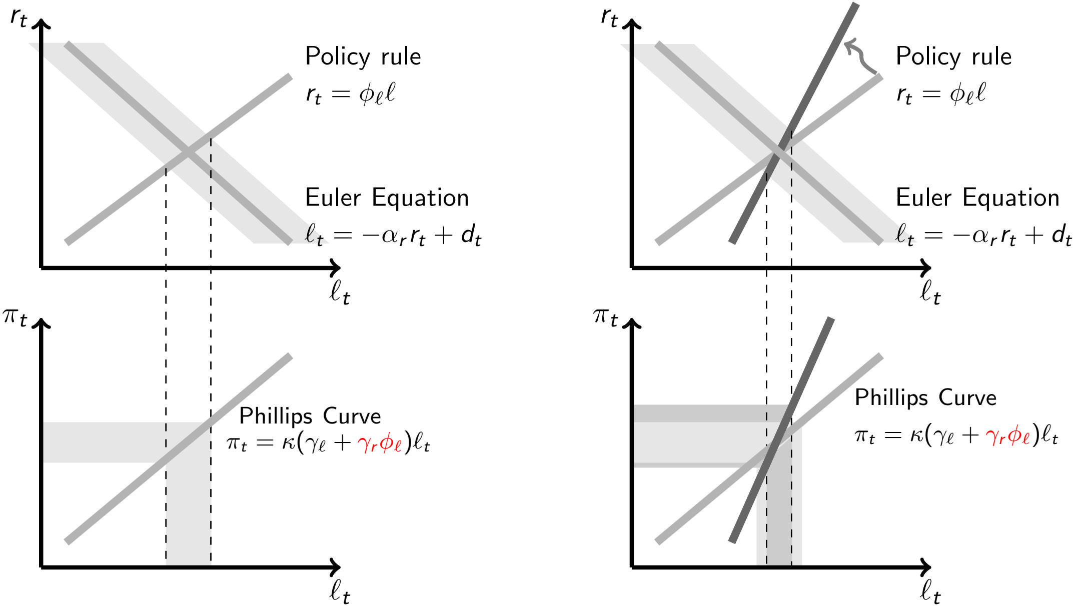


Nominal Interest Rate Peg (ZLB)

- Suppose policy goes from

$$i_t = E_t\pi_{t+1} + \phi_2\ell_t$$

to

$$i_t = 0.$$

Result 5

In the NK configuration,

- × *indeterminacy*
- × *in all equilibria, σ_ℓ^2 and σ_π^2 move together (conditional on demand shocks)*

In the RK configuration,

- × *determinacy*
- × *σ_ℓ^2 increases but σ_π^2 decreases (conditional on demand shocks)*

Monetary Shocks

Result 6

In response to a contractionary monetary shocks,

- *If the shock is not very persistent, then NK and RK canot be distinguished.*
- *If shock is sufficiently persistent,*
  - × *it increases inflation in RK case (neo-Fisherian effect)*
  - × *it decreases inflation in the NK case*

- RK favoured if we observe both (1) persistent monetary shock that (2) do not lead to a fall in inflation

Estimation

- Data:
  - π: GDP deflator,
  - i_t: fed funds rate,
  - ℓ_t: minus unemployment rate.
- Sample:
  - long: 1954:3- 2007:4,
  - post-Volker-deflation sample: 1983:4-2007:4
- Maximum Likelihood estimation

Result 7

Estimation shows that the model is in the Real Keynesian region.

Estimation

Estimated Parameters, 1954Q3-2007Q1, GDP deflator

$$\ell_t = \mathbf{.65} E_t \ell_{t+1} - \mathbf{.33}^\star (i_t - E_t \pi_{t+1}) - \mathbf{.38} \mu_t + d_t \tag{EE}$$

$$\pi_t = \mathbf{.99}^\star \pi_{t+1} + 1^\star (\mathbf{.05} \ell_t + \mathbf{.07} (i_t - E_t \pi_{t+1})) + \mu_t \tag{PC}$$

$$i_t = E_t \pi_{t+1} + \mathbf{.33} d_t - \mathbf{1.06} \mu_t + \nu_t \tag{Policy}$$

- RK condition is satisfied: $\underbrace{.07 \times (1 - .65)}_{.0245} > \underbrace{.05 \times .33}_{.0165}$

Roadmap

1. Theory & Estimation
2. Dissecting the results using a new SVAR approach
3. Zero Lower Bound and Missing Deflation

SVAR representation

- The model solution writes

$$\underbrace{\begin{pmatrix} \pi_t \\ i_t \\ \ell_t \end{pmatrix}}_{Y_t} = A(\Theta) \begin{pmatrix} \pi_{t-1} \\ i_{t-1} \\ \ell_{t-1} \end{pmatrix} + B(\Theta) \underbrace{\begin{pmatrix} d_t \\ \mu_t \\ \nu_t \end{pmatrix}}_{S_t}$$

$$\begin{pmatrix} d_t \\ \mu_t \\ \nu_t \end{pmatrix} = \underbrace{\begin{pmatrix} \rho_d & 0 & 0 \\ 0 & \rho_\mu & 0 \\ 0 & 0 & \rho_\mu \end{pmatrix}}_{R(\Theta)} \begin{pmatrix} d_{t-1} \\ \mu_{t-1} \\ \nu_{t-1} \end{pmatrix} + \underbrace{\begin{pmatrix} \varepsilon_{dt} \\ \varepsilon_{\mu t} \\ \varepsilon_{\nu t} \end{pmatrix}}_{\varepsilon_t}$$

- This is what we use for ML in order to obtain $\widehat{\Theta}$.
- But we can also estimate in two-steps:
  - × First A, B and R,
  - × Second Θ.

Using The Structural Zeros

$$
\begin{aligned}
Y_t &= A(\Theta)Y_{t-1} + B(\Theta)S_t \\
S_t &= R(\Theta)S_{t-1} + \varepsilon_t
\end{aligned}
$$

where Θ are the strutural parameters

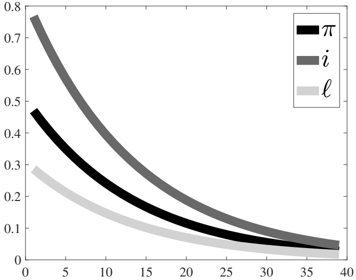
Result 8

- *Under the assumptions that we make for the ML estimation (Y_t observable, lag order is known, S_t are latent variables)*
- *if R is diagonal (at least triangular),*
- *then A, B and R can be identified, and so can be the structural shocks ε*

- This uniquely defines structural shocks and IRF (but no names for the shocks)
- Then a second stage is to find the mapping from A, B and R to structural parameters Θ.

SVAR, Full Sample

ε_1

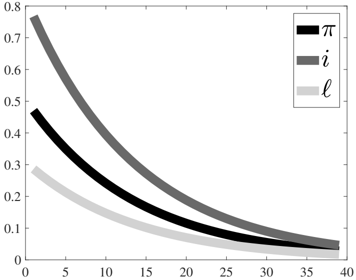


ε_2

ε_3

SVAR, Full Sample

$\varepsilon_1 \rightsquigarrow \varepsilon_d$



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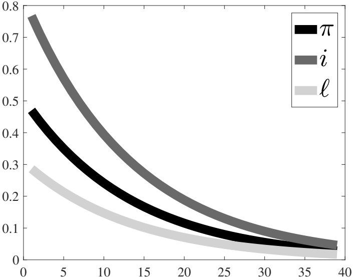
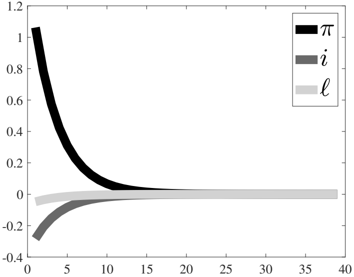


ε_2



ε_3

SVAR, Full Sample

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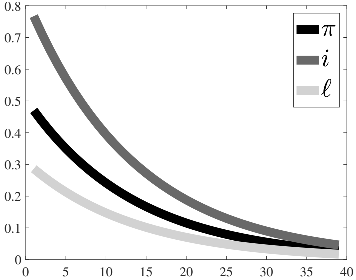
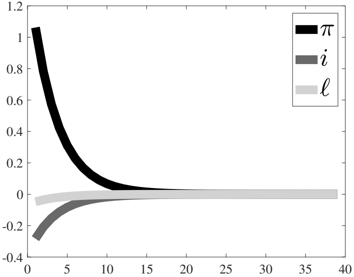
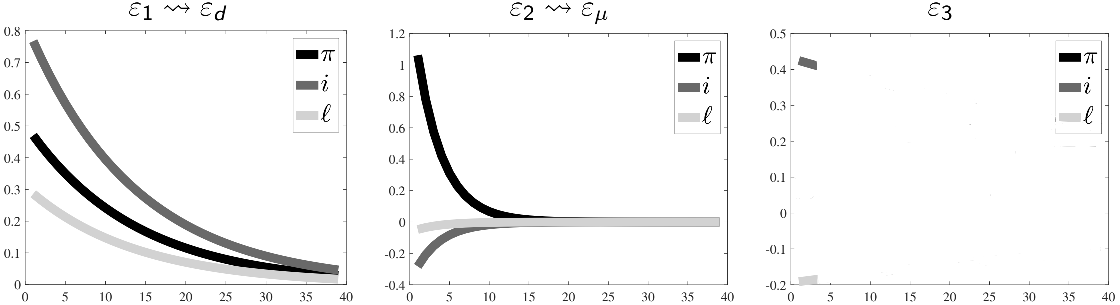


$\varepsilon_2 \rightsquigarrow \varepsilon_\mu$



ε_3

SVAR, Full Sample



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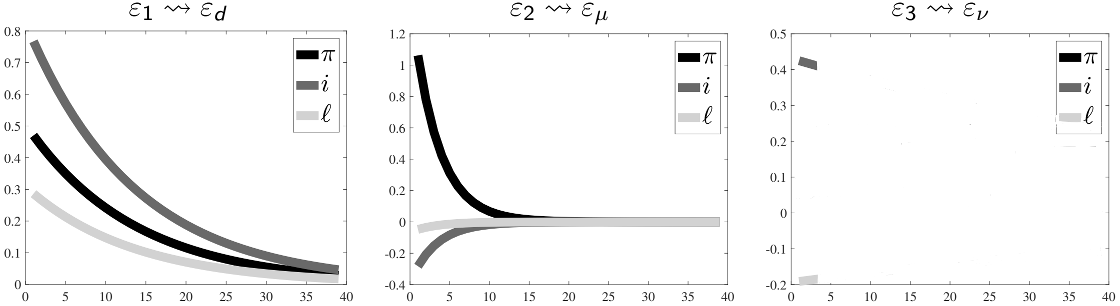

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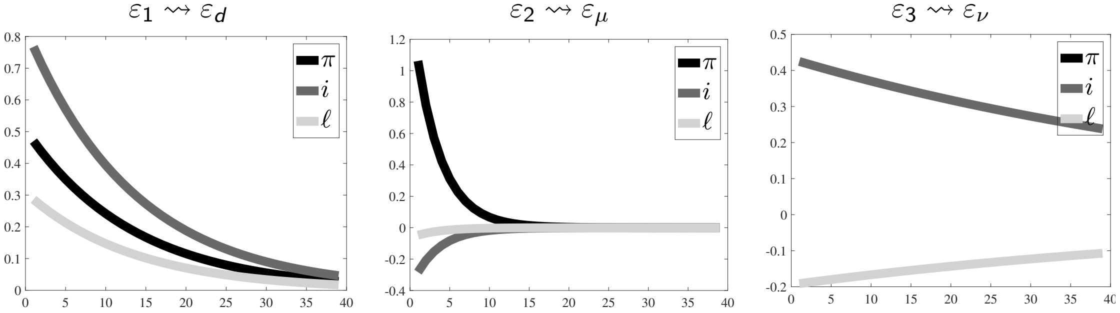

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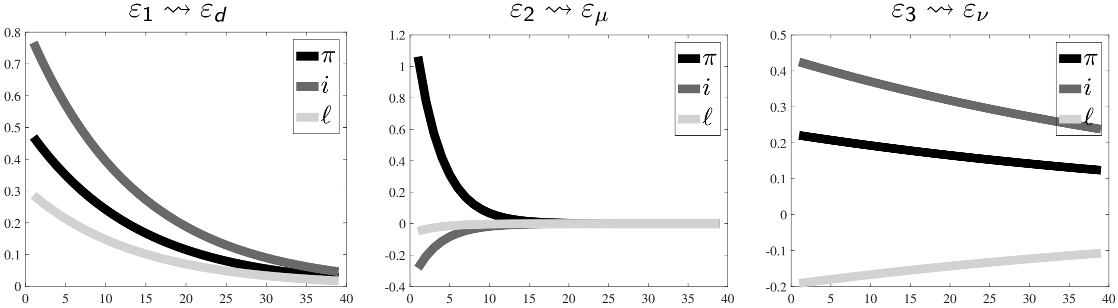

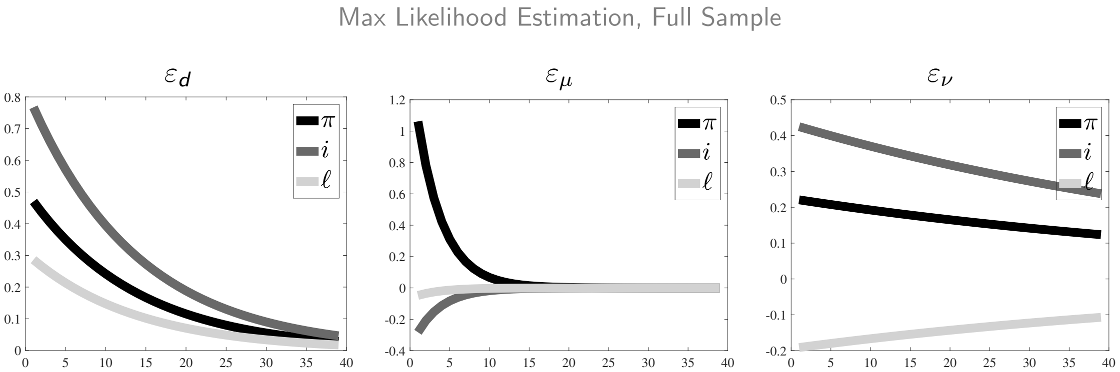
Max Likelihood Estimation, Full Sample
ε_d
ε_μ
ε_ν
π
i
ℓ
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1.2
1
-0.2
-0.4
-0.1
0 5 10 15 20 25 30 35 40

Three Sub-Samples

I. Pre Volker dis-inflation period (1954:3-1979:1)
II. Post Volker dis-inflation period (1983:4-2007:1)
III. Zero Lower Bound period (2009:1-2016:3)

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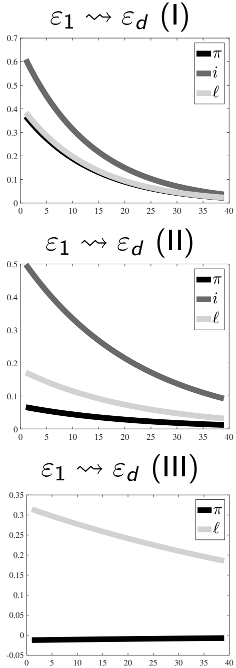

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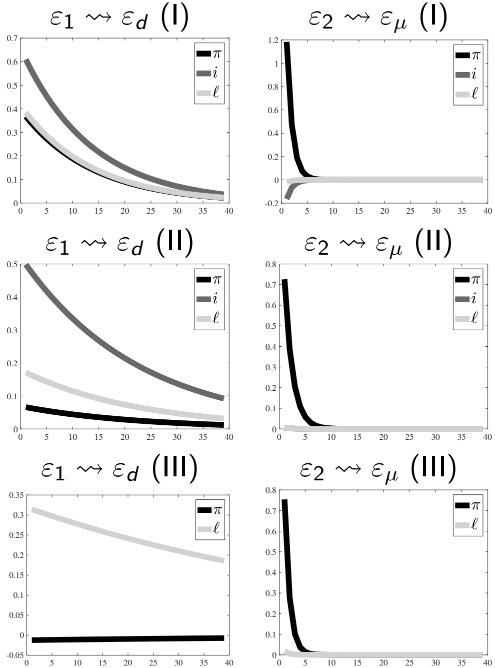

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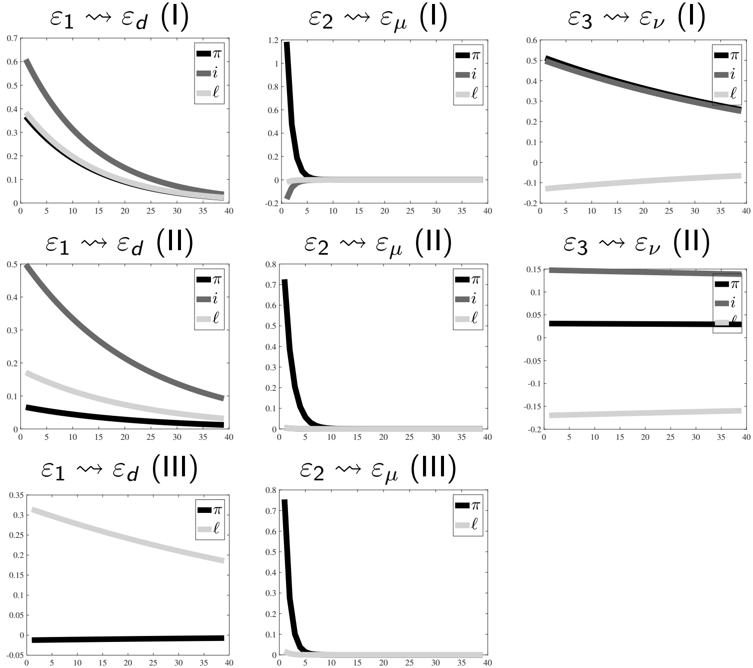

Robustness

1. Are these results robust to allowing the model to have endogenous propagation?
2. Are these results robust to allowing the model to have more shocks?
3. Yes and yes.

Can we obtain more standard effects of monetary shocks?

- Note that the RK model is not inconsistent with VAR evidence that finds temporary monetary shocks.
- But those shocks (as opposed to persistent monetary shocks) do not seem to be relevant in a simple 3-shocks framework.

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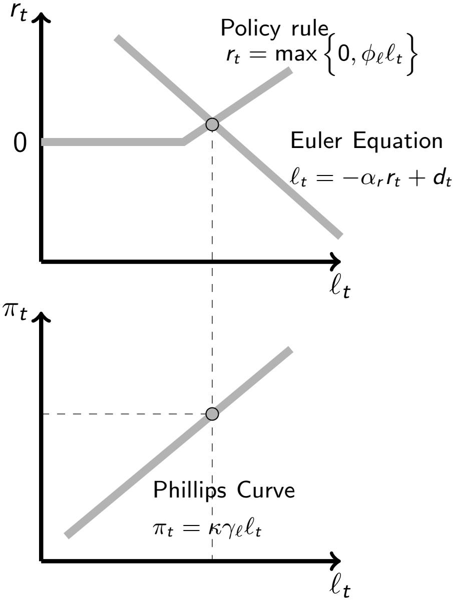
2. Dissecting the results using a new SVAR approach
3. Zero Lower Bound and Missing Deflation

Low Variance of Inflation at the ZLB

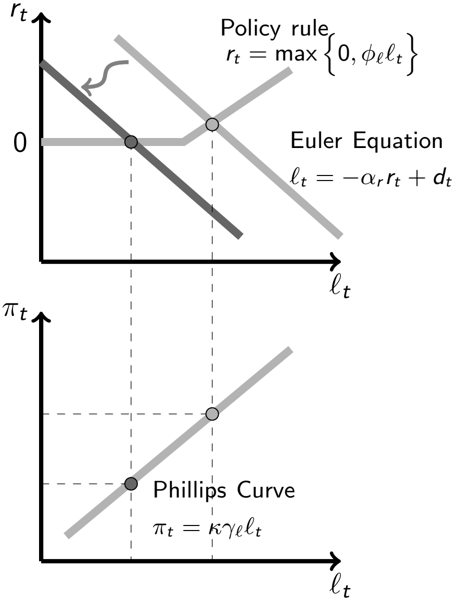
		σ_u	σ_π	σ_i
Post-Volcker	:	1.3	.9	2.5
ZLB	:	1.7	.8	.1

- Observation: the variance of inflation slightly decreased at lower bound.
- It should have increased in the NK configuration
- But this is consistent with the RK configuration

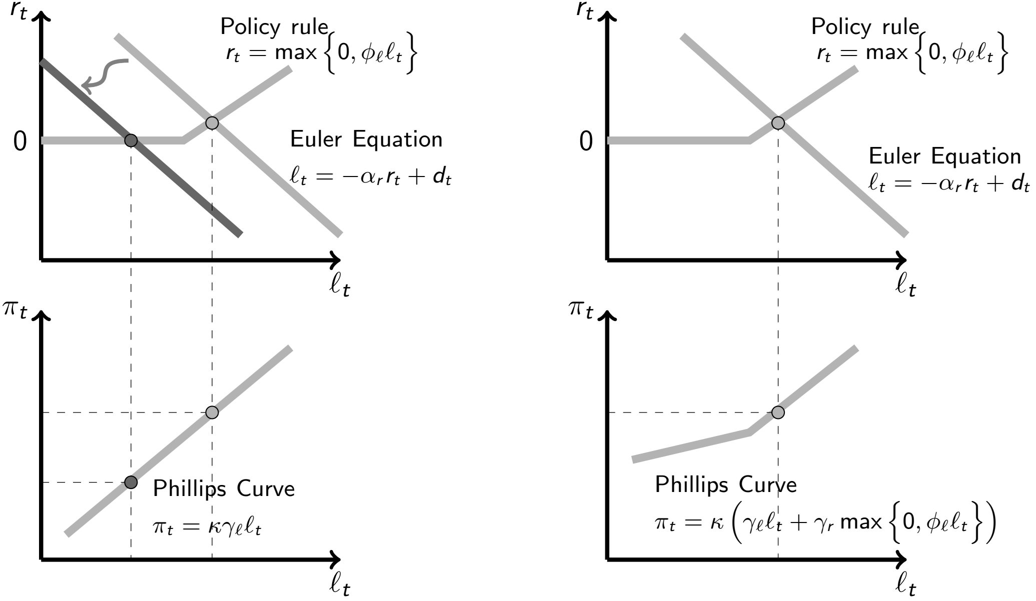
Zero Lower Bound and Missing Deflation



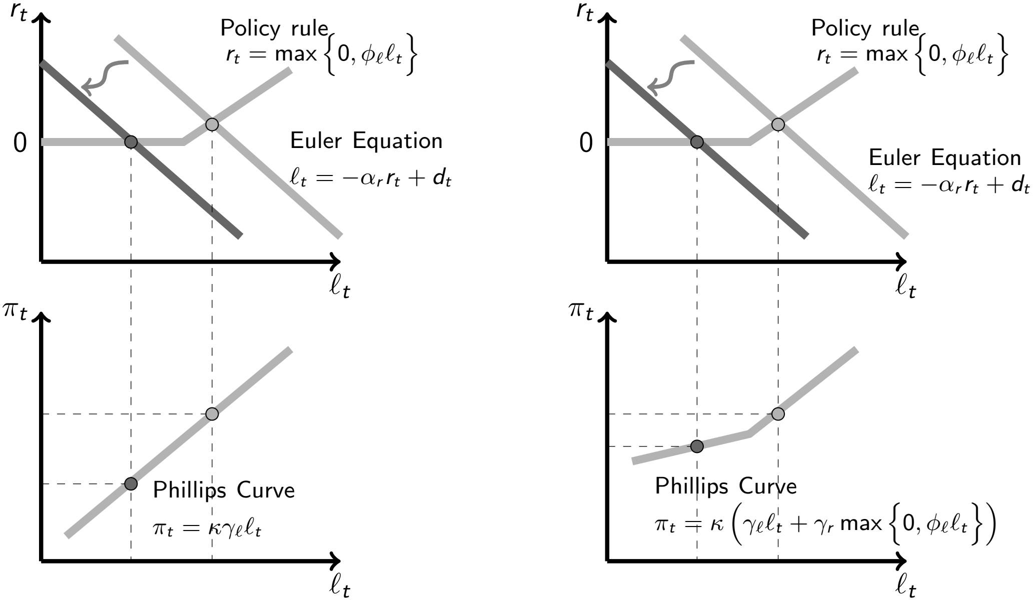
Zero Lower Bound and Missing Deflation



Zero Lower Bound and Missing Deflation



Zero Lower Bound and Missing Deflation

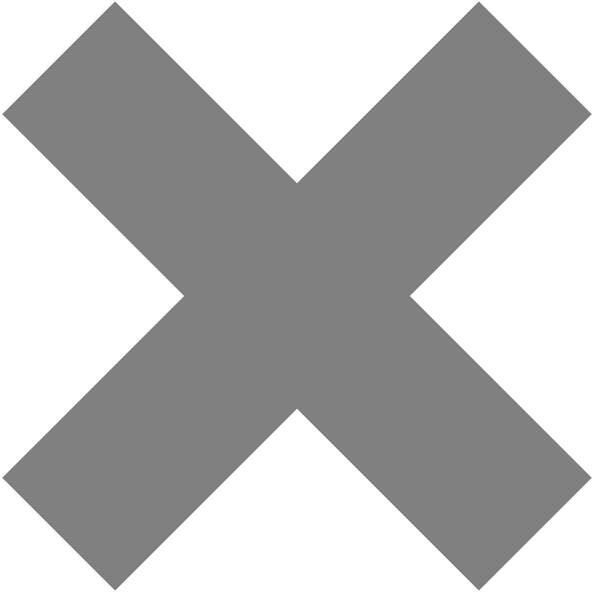


The ZLB Trap

- RK framework suggest that ZLB was quasi inevitable following a persistent fall in demand.
- In RK, both the fall in demand and the response of monetary authorities favours lower inflation:
  - × Low inflation $\rightsquigarrow$
  - × Monetary expansion stimulus $\rightsquigarrow$
  - × Lower i and lower inflation $\rightsquigarrow$
  - × More monetary expansion
  - × Even lower i and inflation $\rightsquigarrow$
  - × Hit the zero lower bound.

Summary

- When demand matters with flexible prices (*Real Keynesian* models), adding sticky prices affect the way we think of monetary policy:
  - × trade-off between stabilising inflation and output when facing demand shocks
  - × Determinacy at the ZLB
  - × Variance of inflation and output moving in opposite direction at the ZLB
- Data favours *Real Keynesian* configuration
- Main reason is that monetary shocks are persistent and they have neo-Fisherian effect

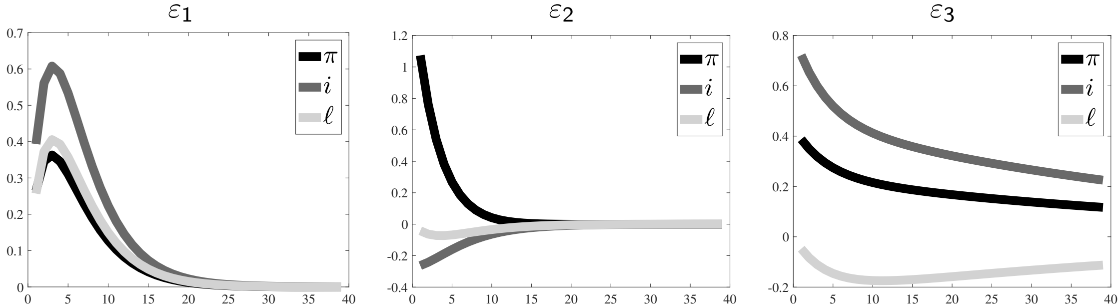


Introducing more endogenous dynamics

- Let us think of richer dynamics
  - Habit persistence
  - Hybrid New Phillips curve
  - Gradual adjustment of i
- It amounts to constraining more or less columns of A to be zero.

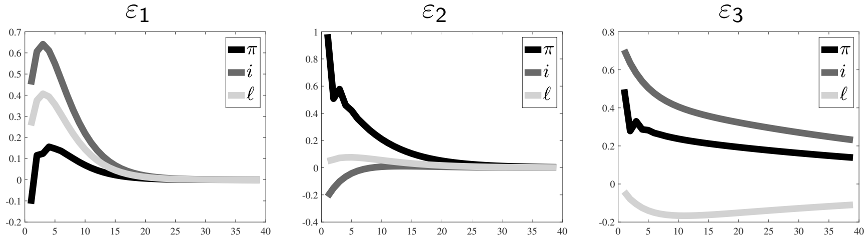
$$
\begin{aligned}
Y_t &= AY_{t-1} + BS_t \\
S_t &= RS_{t-1} + \varepsilon_t
\end{aligned}
$$

Full Sample, “Habit Persistence”

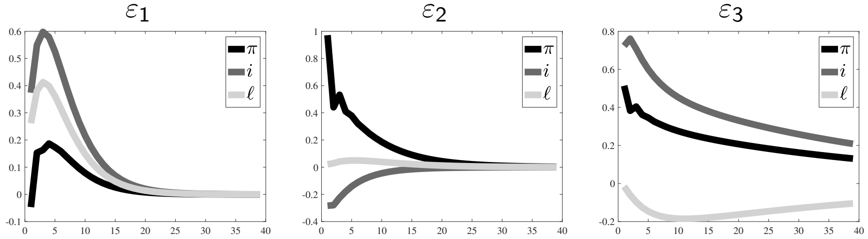


Other configurations, Full sample

“Habit persistence, and hybrid New Phillips curve”



“Habit persistence, gradual adjustment of i and hybrid New Phillips curve”

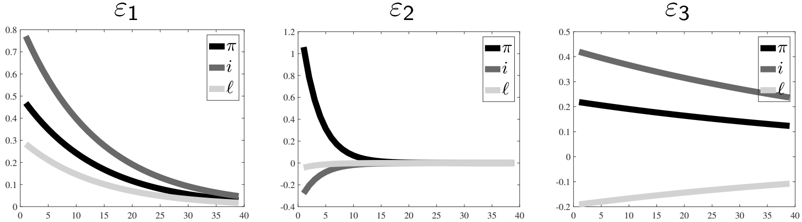


Allowing for more shocks

- Enrich the analysis by:
  - × Allowing for explicit oil shocks
  - × Allowing for TFP shocks
  - × Allowing for natural rate of employment shocks
- We find very consistent results

Real growth (Δy) as the Fourth Variable

"Fully Forward", Full sample



"Habit persistence", Full sample