Real Keynesian Models and Sticky Prices

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Introduction : Demand Shocks

- In many (most) macro models, "demand" shocks (optimism, positive sentiment, good news, possibly lax credit,...) are expansionary because of of sticky prices.
- (much smaller) literature which suggest that sticky prices may not be necessary for demand shocks to be expansionary. $\rightsquigarrow$ *Real Keynesian* models
  - × Angeletos-La'O, Angeletos-Lian, Angeletos-Collard-Dellas,
  - × Guerrieri-Lorenzoni, Lorenzoni,
  - × Beaudry-Portier, Beaudry-Galizia-Portier,
  - × ... etc
- Question addressed in this paper: should we care?

Introduction: The Question

- Suppose one accepts the evidence that nominal prices are sticky, so that demand is non-neutral,
- Is it important to have another channel through which demand shocks would be expansionary even absent of sticky prices?
- In particular, is it important for
    1. our understanding of how monetary shocks affect the economy?
    2. our understanding the conduct of monetary policy?
- It is.

Introduction: Two Contributions

- Contributions
    1. Propose a new class of simple extensions of the *New Keynesian* model (a *Real Keynesian* model) that has very different implications for monetary policy **when prices are sticky**.
    2. Show that it is empirically relevant

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Roadmap

1. Theory
2. Empirical Relevance
3. Zero Lower Bound and Missing Deflation

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The Real Structure of the Simplest NK Model

- No technology shock $c_t = \ell_t$
- Model with sticky prices:

$$\begin{aligned} \ell_t &= E_t \ell_{t+1} - \alpha_r (i_t - E_t \pi_{t+1}) + d_t && \text{Euler Equation (EE)} \\ \pi_t &= \beta E_t \pi_{t+1} + \kappa \, mc_t && \text{Phillips Curve (PC)} \end{aligned}$$

- Marginal cost is assumed to depend on labor market tightness (real wage) $\rightsquigarrow$ $mc_t = \gamma_\ell \ell_t$
- When prices are fully flexible:

$$\begin{aligned} \ell_t &= E_t \ell_{t+1} - \alpha_r r_t + d_t && \text{Euler Equation (EE)} \\ mc_t &= 0 = \gamma_\ell \ell_t && \text{Aggregate Supply (AS)} \end{aligned}$$

The Real Structure of the Simplest NK Model

Flex price NK model :

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

$$0 = \gamma_\ell \ell_t \quad \text{(AS)}$$

The Real Structure of the Simplest NK Model

i.i.d. case :

$$\ell_t = \qquad - \alpha_r r_t + d_t \quad \text{(EE)}$$
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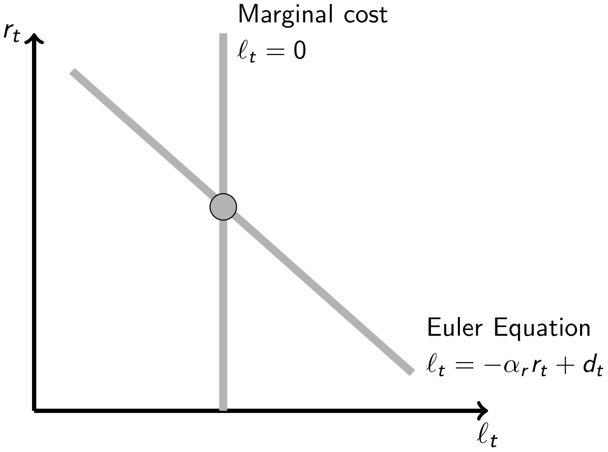

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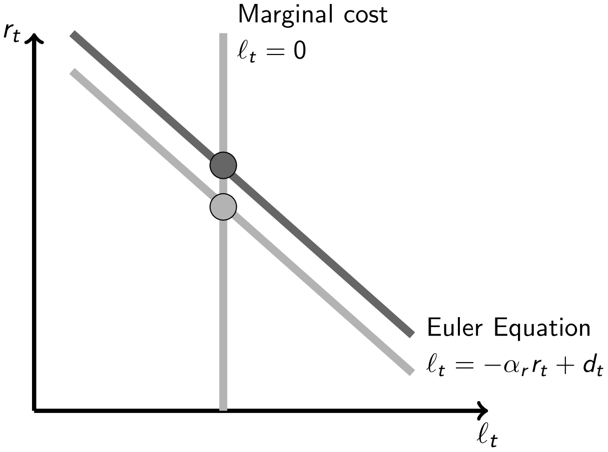

The Real structure of the Simplest NK Model

- Let's have a more general model in which AS is not infinitely sloped.
- Assume now that marginal cost also depend on the real interest rate r (*cost channel*)

$$mc_t = \gamma_\ell \ell_t + \gamma_r r_t$$

The Real structure of the Simplest NK Model

i.i.d. case :

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$$

- Assume $\gamma_r = 0$

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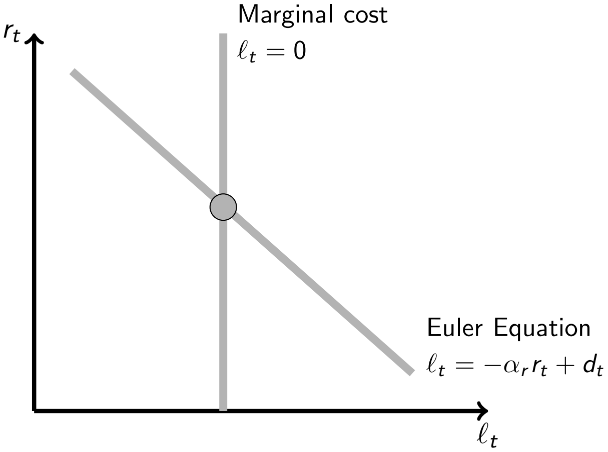

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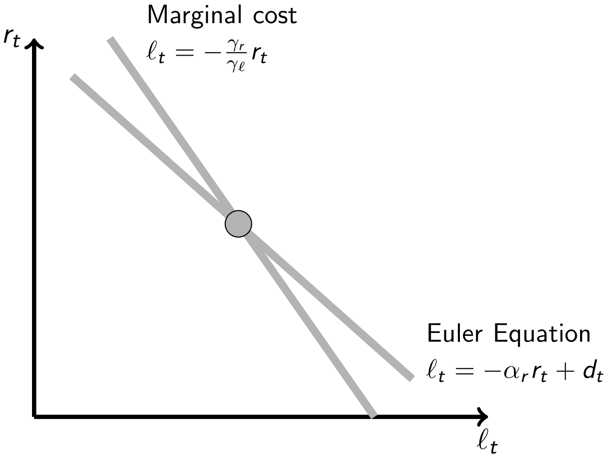
- Assume γ_r is small (compared to γ_ℓ)



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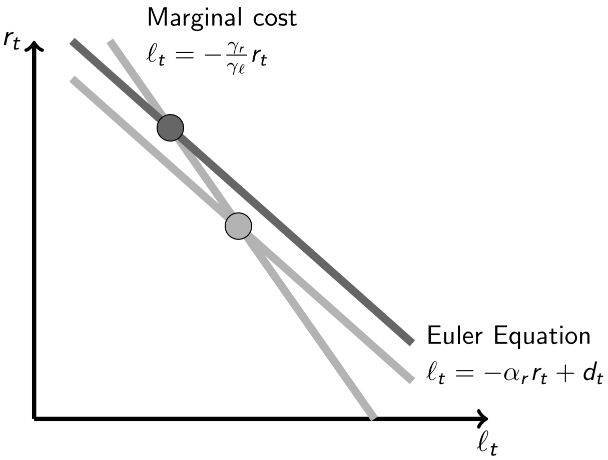

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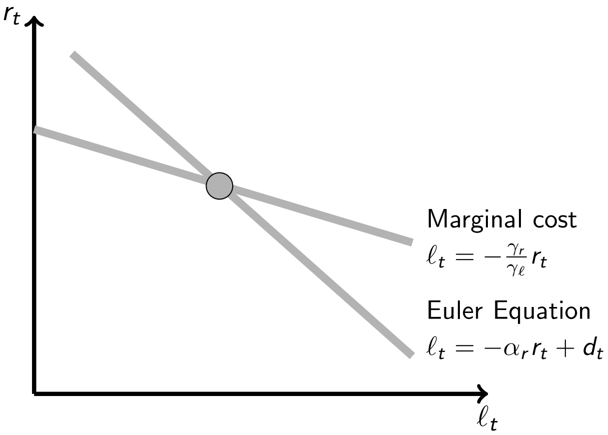

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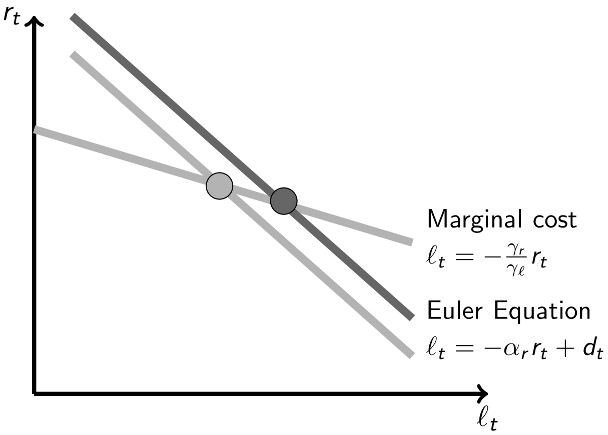

Towards An Extended Model

- Importance of the cost channel: $\frac{\gamma_r}{\gamma_\ell} \lessgtr \alpha_r$
- In the *i.i.d.* case, the model is *Real Keynesian* if $\frac{\gamma_r}{\gamma_\ell} > \alpha_r$
- Need to go beyond the *i.i.d.* case
- $\rightsquigarrow$ Expectations in the Euler equation will matter

Extended Sticky Price 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, with psychological cost of defaulting $\rightsquigarrow$ positively sloped cost of funds $\rightsquigarrow$ *discounted EE*
  - × $\gamma_r \geq 0$: Firms need to borrow to pay for intermediate inputs before production $\rightsquigarrow$ *cost channel*
- 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

Extended Flex Price Linearized Model

- Under which condition is demand expansionary with flex prices when shocks are persistent?

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

$$0 = \gamma_\ell \ell_t + \gamma_r r_t \qquad \text{Marginal cost (AS)}$$

The RK condition

Result 1

With flex. prices, positive demand shocks (both current and expected future) of any persistence have a positive effect on ℓ if and only if

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

The RK condition

Result 1

With flex. prices, positive demand shocks (both current and expected future) of any persistence have a positive effect on ℓ if and only if

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

The Model With Sticky Prices (From now on)

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

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

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Theorem 1

For any Taylor rule $i_t = \widetilde{\phi}_\pi \pi_t + \widetilde{\phi}_\ell \ell_t + \widetilde{\nu}_t$ that gives determinacy, there exists a policy rule $i_t = E_t \pi_{t+1} + \phi_\ell \ell_t + \nu_t$ that produces the same allocations.

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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i.i.d. case :

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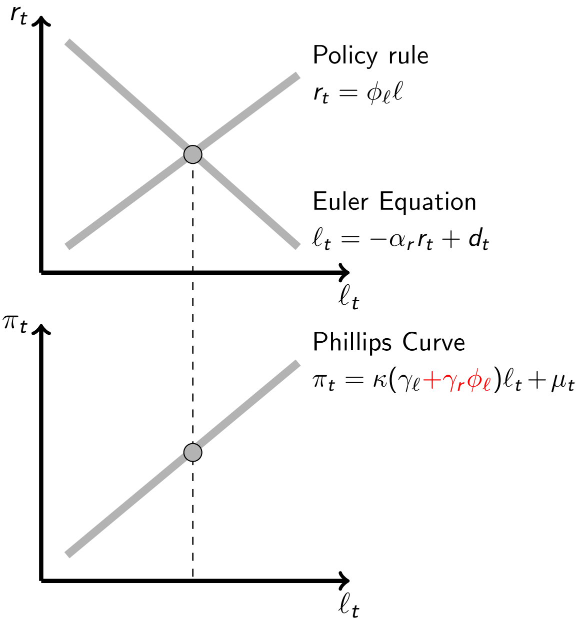

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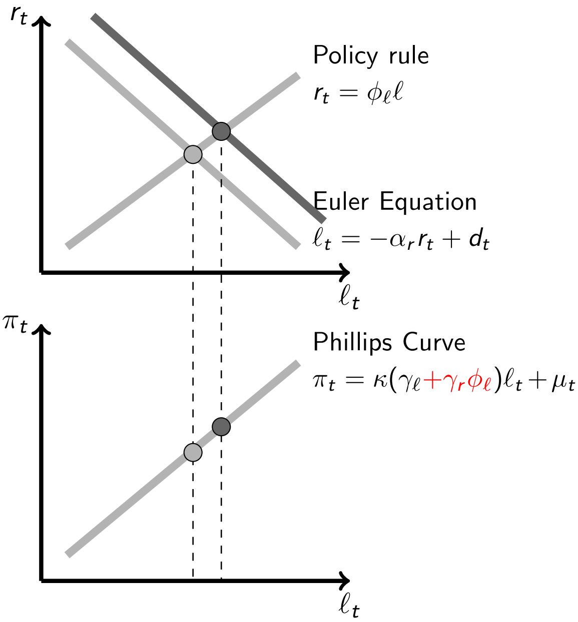

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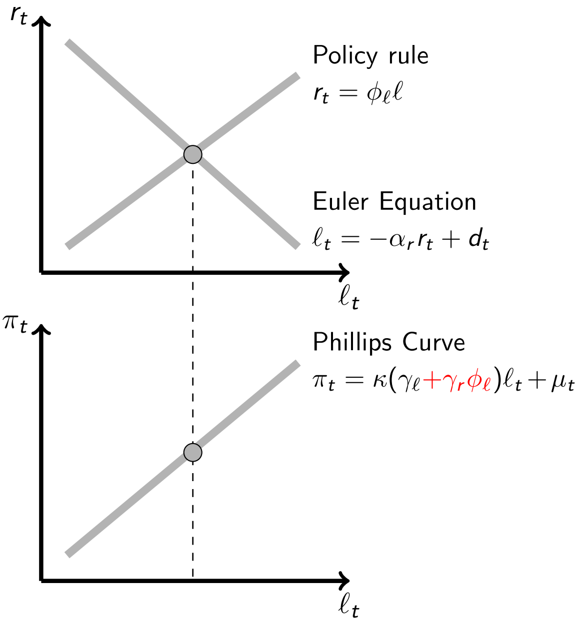

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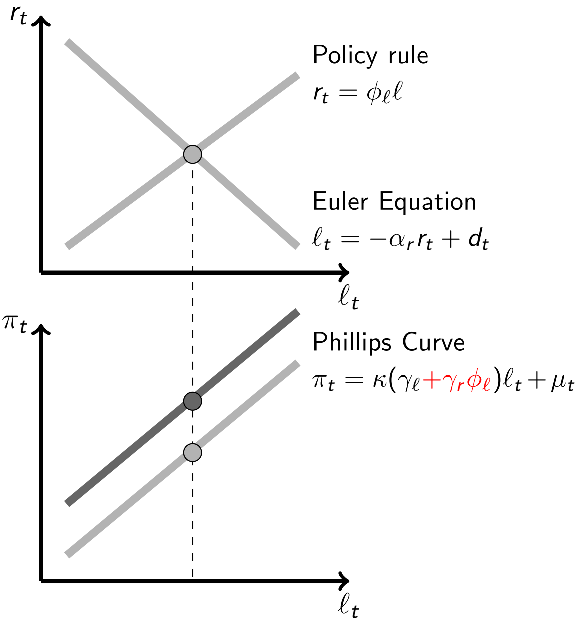

RK Matters for Monetary Policy and Monetary Shocks

- 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.

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 cannot 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
- "*Congressman Wright Patman effect*" (1970) : raising interest rates to fight inflation is like "throwing gasoline on fire"

Roadmap

1. Theory
2. Empirical Relevance
3. Zero Lower Bound and Missing Deflation

Empirical Relevance
Phillips Curve Only

- Estimate a Phillips Curve with cost channel (1969Q1-2006Q4)

$$\pi_t = (1 - a_1)\pi_{t-1} + a_1 E_t[\pi_{t+1}] + a_2(i_t - \pi_{t+1}) + a_3\ell_t + f(t) + u_t$$

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$\ell_t = UNgap$	(1)Core CPI with Trend			(2) Core CPI w/o Trend		
	OLS	OLS	IV	OLS	OLS	IV
a_1	0.49***	0.57***	0.70***	0.49***	0.56***	0.62***
	(0.087)	(0.103)	(0.087)	(0.084)	(0.093)	(0.080)
a_2		0.21**	0.31***		0.16*	0.15**
		(0.101)	(0.111)		(0.081)	(0.075)
a_3	-0.09	-0.03	0.25	-0.05	-0.07	0.11
	(0.105)	(0.119)	(0.189)	(0.095)	(0.093)	(0.214)
Observations	152	152	152	152	152	152
K-P LM Test			29.951			16.341
(idp)			(0.038)			(0.569)
J Test			12.944			16.559
(jp)			(0.740)			(0.485)
C-D Test			2.212			0.846
Time trend	Yes	Yes	Yes	No	No	No

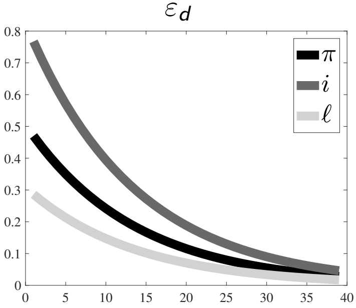
Empirical Relevance
Full Information

- Here we estimate the full model by ML
- 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.

Max Likelihood Estimation, Full Sample

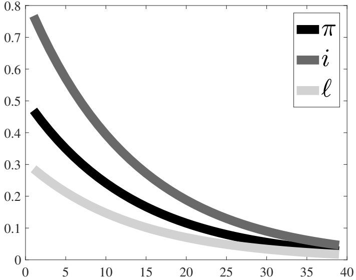


ε_μ

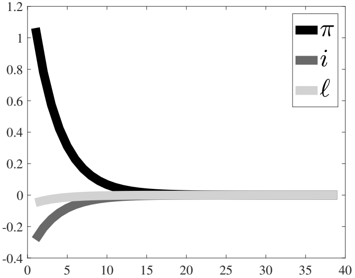
ε_ν

Max Likelihood Estimation, Full Sample

ε_d

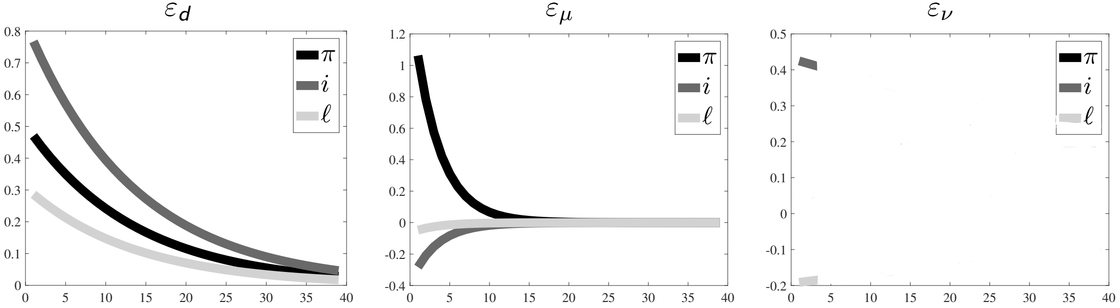


ε_μ



ε_ν

Max Likelihood Estimation, Full Sample



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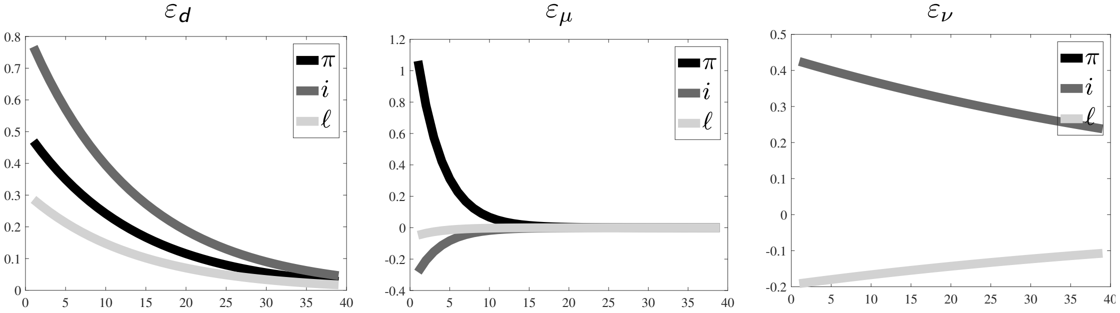

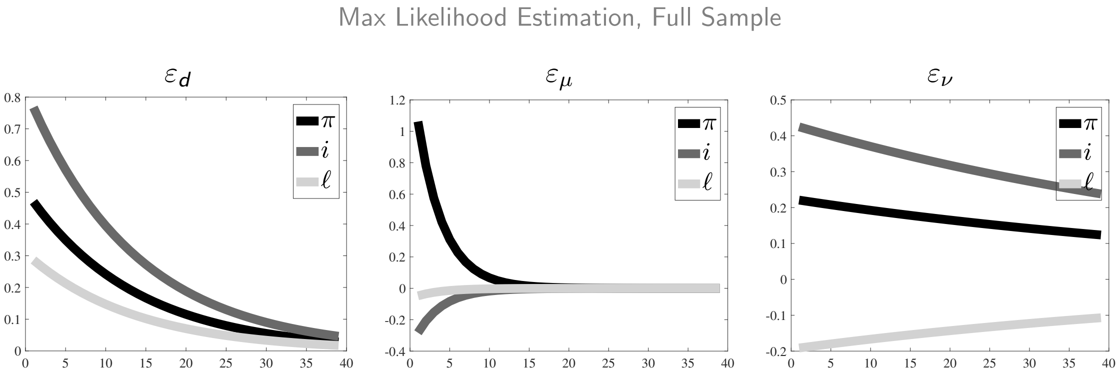
Max Likelihood Estimation, Full Sample
ε_d
ε_μ
ε_ν
π
i
ℓ
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1.2
1
-0.2
-0.4
-0.1
0 5 10 15 20 25 30 35 40

Robustness

- Results are robust across the 3 following 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)
- Results robust when allowing the model to have endogenous propagation
- Results robust when allowing the model to have more shocks

Roadmap

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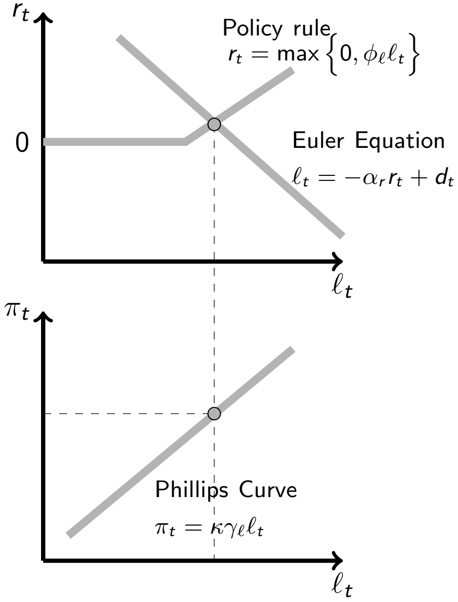
Low Variance of Inflation at the ZLB

		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 ZLN.
- It should have increased in the NK configuration (*under the assumption that demand shocks drove the economy*)
- But this is consistent with the RK configuration

Zero Lower Bound and Missing Deflation



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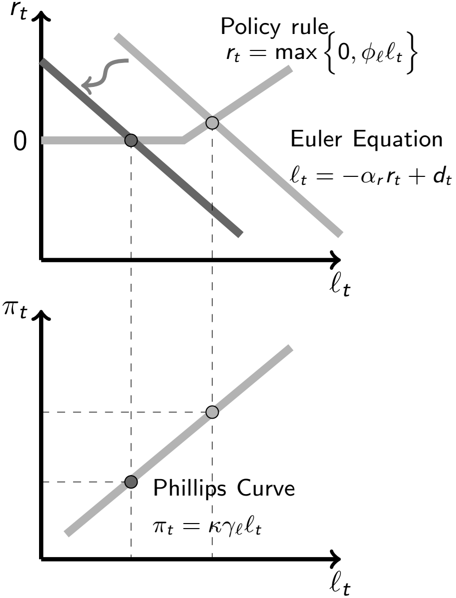

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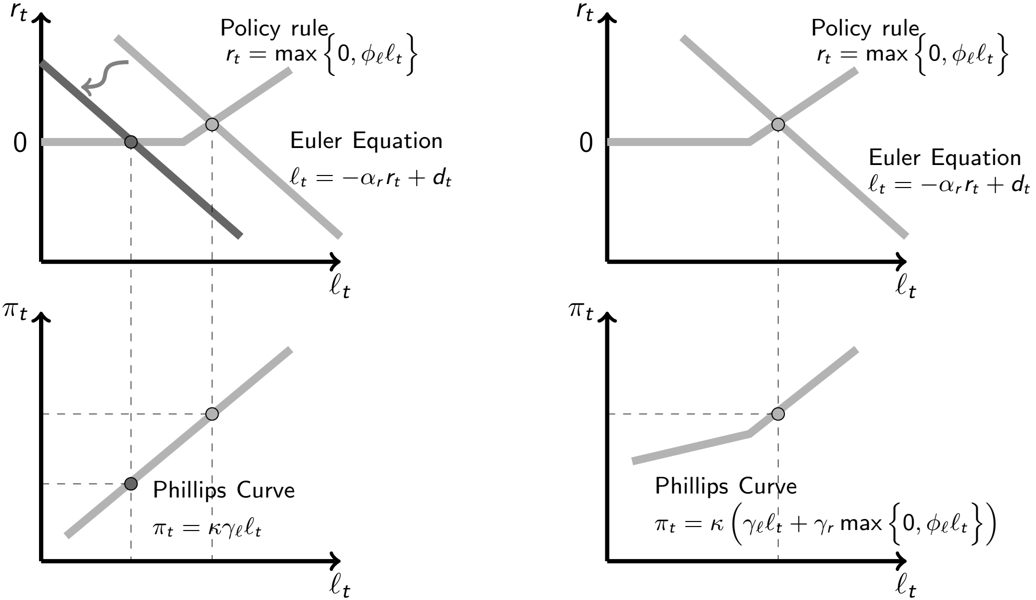

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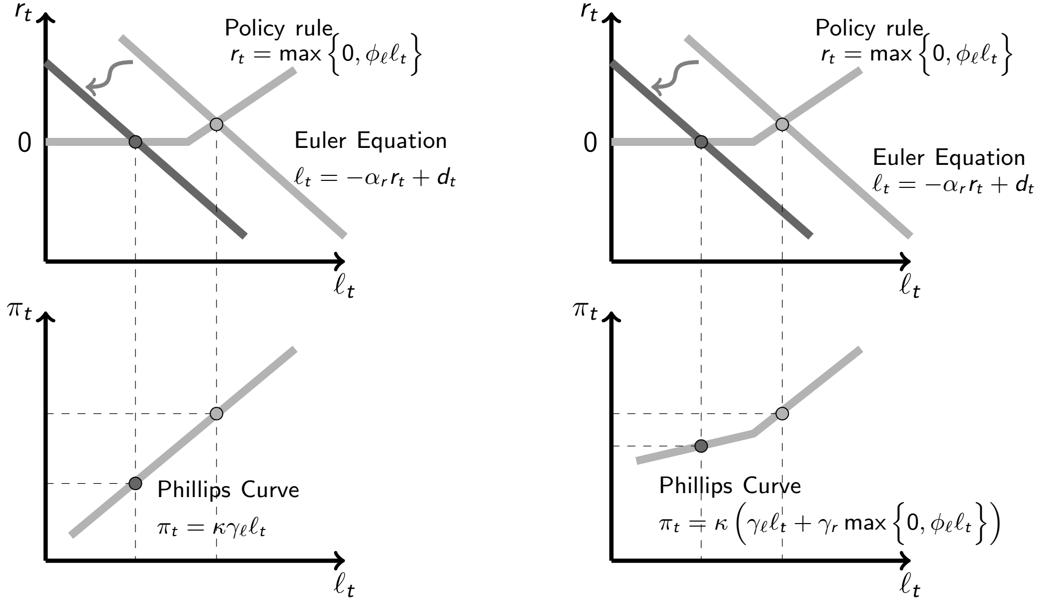
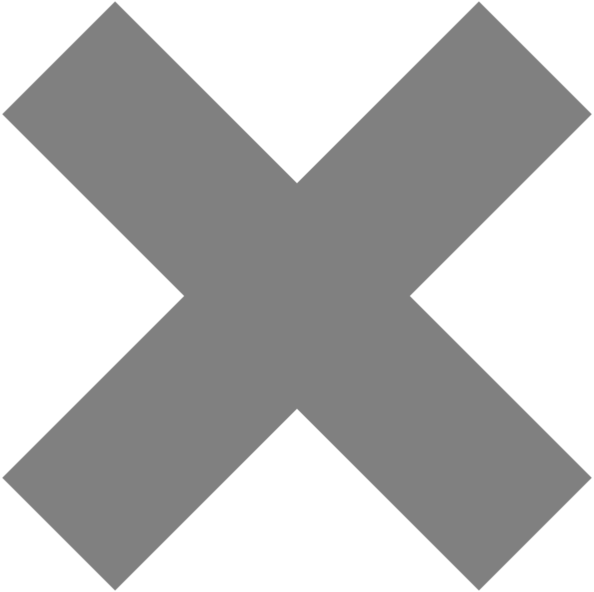


The ZLB Trap

- 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:
  - × Initial negative demand shock $\rightsquigarrow$
  - × Low activity and low inflation $\rightsquigarrow$
  - × Monetary expansion stimulus $\rightsquigarrow$
  - × Lower i and lower inflation $\rightsquigarrow$
  - × More monetary expansion $\rightsquigarrow$
  - × 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 Phillips Curve with cost channel
- Data favours *Real Keynesian* configuration
- Main reason is that monetary shocks are persistent and they have neo-Fisherian effect

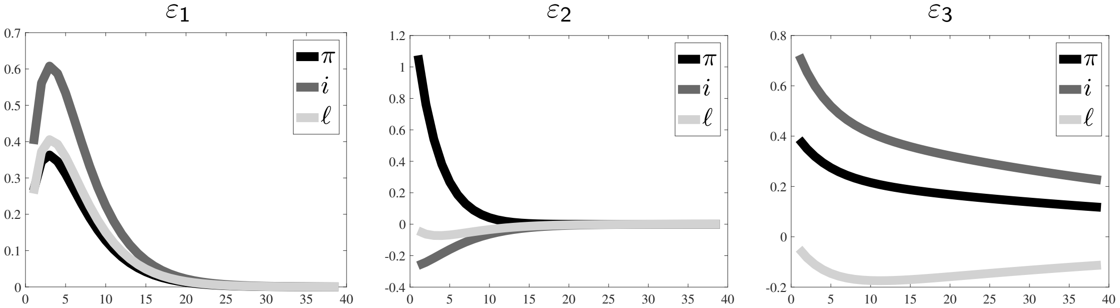


Introducing more endogenous dynamics

- 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.

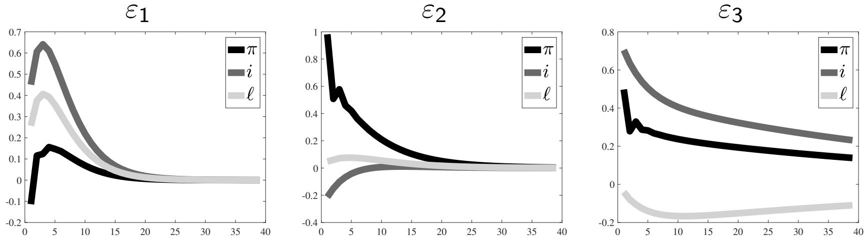
$$
\begin{aligned}
Y_t &= AY_{t-1} + BS_t \\
S_t &= RS_{t-1} + \varepsilon_t
\end{aligned}
$$

Full Sample, "Habit Persistence"

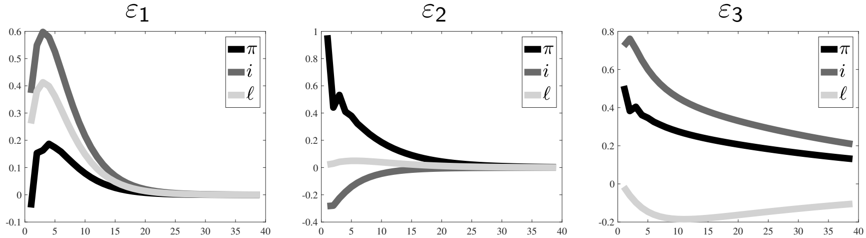


Other configurations, Full sample

"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