# Centralized wage setting in a New Keynesian model

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# Introduction

- wages are bargained collectively in many European countries
  - economy or sector wide collective agreements in Belgium,Finland, Austria, Denmark,Germany, Norway, Netherlands,Sweden,Spain...
- unions or union confederations large enough to have an effect on aggregate wage
- usually DSGE models assume small, atomistic unions that take aggregate variables as given, Erceg, Henderson and Levin (2000)
- not much quantitative tools and empirical evidence for the debate on wage setting institutions and reforms in terms of dynamics

# Introduction

- does centralized wage setting change dynamics (responses to shocks) in a baseline New Keynesian model?
  - is the degree of wage setting centralization irrelevant for monetary policy?
  - centralized wage setting = large agents that internalize the aggregate effects of their actions, can this bring something useful?

# Literature

- Erceg, Henderson and Levin (2000)
- strategic monetary policy with non-atomistic wage setters: static models (Iversen and Soskice (2000), Cukierman and Lippi (1999) and Lippi (2003)), Gnocchi (2009)
- the role wages in a New Keynesian models, Galí (2013), Galí and Billi (2019)

# Literature

Erceg, Henderson and Levin (2000)
"Household unions"

- maximize utility taking into account
  - budget constraint
  - own labour demand $L(i) = \left(\frac{W(i)}{W}\right)^{-\epsilon_w} L$
- take aggregate wage and other aggregate variables as given
- if wages are flexible: $\frac{W_t}{P_t} = \frac{\epsilon_w}{\epsilon_w - 1} \frac{-U_L}{U_C}$
- Calvo-type sticky wages: each union has constant probability to reset its wage on each period

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# Literature

Lippi(2003):"Strategic monetary policy with non-atomistic wage setters"

- static model
- n identical unions each having mass of 1/n
- union maximizes the utility of its members
- anticipating that its wage demand has an effect on the aggregate wage and inflation and central banks reaction
- strictness of inflation targeting impacts employment when $1 < n < \infty$, sign depends on the parameter values
- no effects when $n = 1$ or $n = \infty$

# Literature

Gnocchi(2009, JMCB):"Non-atomistic wage setters and monetary policy in NK framework"

- approach similar to Lippi (2003)
- wages are flexible
- unions set $\frac{W_t}{P_t} = \frac{\eta}{\eta - 1}\frac{U_L}{U_C}$ ,where $\eta \approx \eta_t = \frac{\partial log(L_t(i))}{\partial log(W_t(i))} = F(\epsilon_w, \frac{\partial log(W_t)}{\partial log(W_t(i))}, \frac{\partial log(\Pi_t)}{\partial log(W_t)}, \frac{\partial log(L_t)}{\partial log(\Pi_t)}),$
- with non-atomistic unions steady state becomes efficient when the CB targets price stability
- the dynamics of the economy are the same regardless of the number of the unions

# This paper

- set up unions' wage setting as a planner's problem similarly as in optimal monetary policy literature (e.g. Woodford (2006), Schmitt-Grohe and Uribe (2008))
  - unions maximizes explicitly the welfare of households they represent subject to model constraints
  - allows for more general models

# Model

basic NK model with centralized wage setting

- monopolist competition and Calvo sticky prices in the intermediate goods market
- no capital, $Y_t = A_t L_t^{(1-\alpha)}$,
- households maximize utility choosing the amount of consumption and supply labour according to firms' labour demand given the wage set by union

$$U(C_t, L_t, Z_t) \equiv Z_t \left( \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{L_t^{1+\varphi}}{1+\varphi} \right) \tag{1}$$

$$P_t C_t + B_{t+1}/R_t = B_t + W_t L_t + T_t + D_t \tag{2}$$

- central bank follows Taylor-type rule, $R_t = \beta^{-1} \Pi_t^{\phi_\pi} \tilde{Y}_t^{\phi_y}$

# Union's problem, one union economy

$$
\begin{aligned}
\max_{d_t} E_0 \sum_{t=0}^{\infty} \beta^t \Big\{ & U(C_t, L_t, Z_t) \\
& + \lambda_t^1 (U_{C,t} R_t^{-1} - \beta U_{C,t+1} \Pi_{t+1}^{-1}) \\
& + \lambda_t^2 \left[ K_t - \frac{\epsilon - 1}{\epsilon} F_t \left( \frac{1 - \theta \Pi_t^{\epsilon - 1}}{1 - \theta} \right)^{1/(1-\epsilon)} \right] \\
& + \lambda_t^3 (K_t - C_t \frac{W_t}{P_t A_t} / MPL_t - \theta \beta \frac{U_{C,t+1}}{U_{C,t}} \{\Pi_{t+1}^{\epsilon} K_{t+1}\}) \\
& + \lambda_t^4 (F_t - C_t - \theta \beta E_t \frac{U_{C,t+1}}{U_{C,t}} \{\Pi_{t+1}^{(\epsilon-1)} F_{t+1}\}) \\
& + \lambda_t^5 (C_t \Delta_t - A_t L_t^{(1-\alpha)}) \\
& + \lambda_t^6 (\Delta_t - (1 - \theta) \left( \frac{1 - \theta \Pi_t^{\epsilon - 1}}{1 - \theta} \right)^{\frac{\epsilon}{\epsilon - 1}} - \theta \Pi_t^{\epsilon} \Delta_{t-1}) \\
& + \lambda_t^7 (R_t - \beta^{-1} \Pi_t^{\phi_\pi} \tilde{Y}_t^{\phi_y}) \\
& + \lambda_t^8 (\Pi_t - \frac{P_t}{P_{t-1}}) \Big\}
\end{aligned} \tag{3}
$$

$d_t = [C_t, P,_t\, R_t, \Pi_t, \Delta_t, L_t, K_t, F_t, Y_t, W_t]$

# Union's problem in LQ, one union economy

$$\max_{\pi_t,\tilde{y}_t,i_t} E_0 \sum_{t=0}^{\infty} \beta^t \Big\{ -\frac{1}{2}[\frac{\epsilon}{\lambda}\pi_t^2 + (\sigma + \frac{\varphi+\alpha}{1-\alpha})\tilde{y}_t^2]$$
$$+\gamma_t^1(\tilde{y}_t + \frac{1}{\sigma}(i_t - \pi_{t+1} - r_t^n) - \tilde{y}_{t+1})$$
$$+\gamma_t^2(i_t - \rho - \phi_y\tilde{y}_t - \phi_\pi\pi_t)\Big\}$$

where $r_t^n = \rho + \sigma\psi E_t\{\Delta a_{t+1}\} + E_t\{\Delta z_{t+1}\}$

Nominal wage, $w_t$, given by

$$\pi = \beta E_t\{\pi_{t+1}\} + \lambda(w_t - p_t - mpl_t) \tag{4}$$

# Model with $n$ unions

- households supply differentiated labour which is aggregated as

$$L_t \equiv \left( \int_0^1 L_t(j)^{\frac{\epsilon_w - 1}{\epsilon_w}} dj \right)^{\frac{\epsilon_w}{\epsilon_w - 1}} \tag{5}$$

- households are represented by $n = 1, 2, ..$ unions, each unions share is $\omega = 1/n$
- labour demand for members of union *

$$L_t^* = \left( \frac{W_t^*}{W_t} \right)^{-\epsilon_w} L_t \tag{6}$$

$$W_t = \left( \omega (W_t^*)^{(1-\epsilon_w)} + (1-\omega)(W_t^{**})^{(1-\epsilon_w)} \right)^{1/(1-\epsilon_w)} \tag{7}$$

- wage of other unions, $W_t^{**}$ taken as given

# Model with $n$ unions

$$\omega = 1/n$$

$$\begin{aligned}
W_t &= [\omega W_t^{*(1-\epsilon_w)} + (1-\omega) W_t^{**(1-\epsilon_w)}]^{(1/(1-\epsilon_w))} \\
L_t^* &= (W_t^*/W_t)^{-\epsilon_w} L_t \\
L_t^{**} &= (W_t^{**}/W_t)^{-\epsilon_w} L_t \\
P_t C_t^* + B_{t+1}^*/R_t &= B_t^* + W_t^* L_t^* + T_t + D_t \\
P_t C_t^{**} + B_{t+1}^{**}/R_t &= B_t^{**} + W_t^{**} L_t^{**} + T_t + D_t \\
C_t &= \omega C_t^* + (1-\omega) C_t^{**} \\
U_{C^{**},t} R_t^{-1} &= \beta U_{C^{**},t+1} \Pi_{t+1}^{-1}
\end{aligned}$$

# Parameters

$$\beta = 0.99, \sigma = 1, \varphi = 2, \theta = 3/4, \ \epsilon = 6, \ \epsilon_w = 6, \ \alpha = 0.25$$
$$\phi_\pi = 1.1, \phi_y = 0.1, \rho_a = 0.9, \rho_z = 0.6$$

# Results

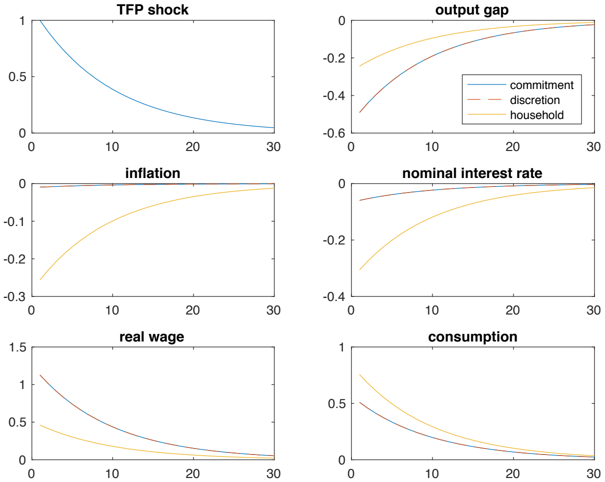
- steady state
- TFP shocks
- demand shocks

# Steady state

| n | real wage | employment | consumption | utility |
|---|---|---|---|---|
| 1 | 0,640 | 0,909 | 0,931 | -0,322 |
| 2 | 0,651 | 0,849 | 0,885 | -0,327 |
| 3 | 0,654 | 0,833 | 0,872 | -0,330 |
| 4 | 0,656 | 0,826 | 0,866 | -0,331 |
| 5 | 0,657 | 0,821 | 0,863 | -0,332 |
| 6 | 0,657 | 0,818 | 0,860 | -0,333 |
| 7 | 0,658 | 0,816 | 0,859 | -0,334 |
| 8 | 0,658 | 0,815 | 0,858 | -0,334 |
| 9 | 0,658 | 0,814 | 0,857 | -0,334 |
| 10 | 0,658 | 0,813 | 0,856 | -0,335 |
| 20 | 0,659 | 0,809 | 0,853 | -0,336 |
| household | 0,660 | 0,805 | 0,850 | -0,337 |

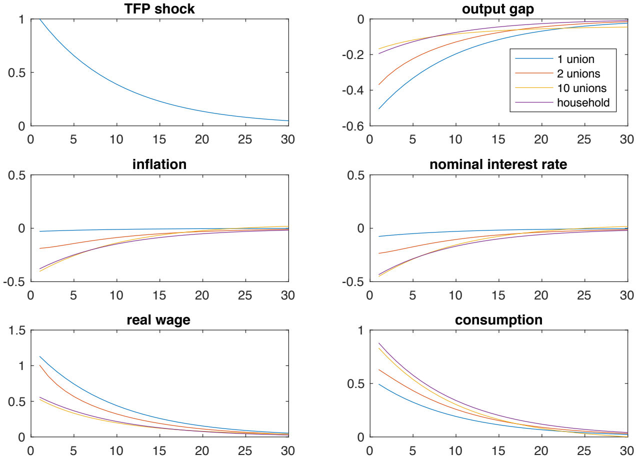
household level: $n = \infty$

# TFP shock, one union

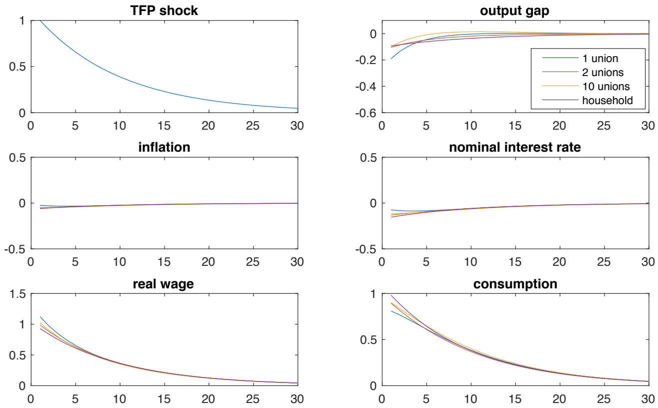



welfare losses: union: 0.03; household level 0.11
about the same difference as with $\phi_\pi = 1.1, \phi_\pi = 2.1$

# TFP shock, many unions



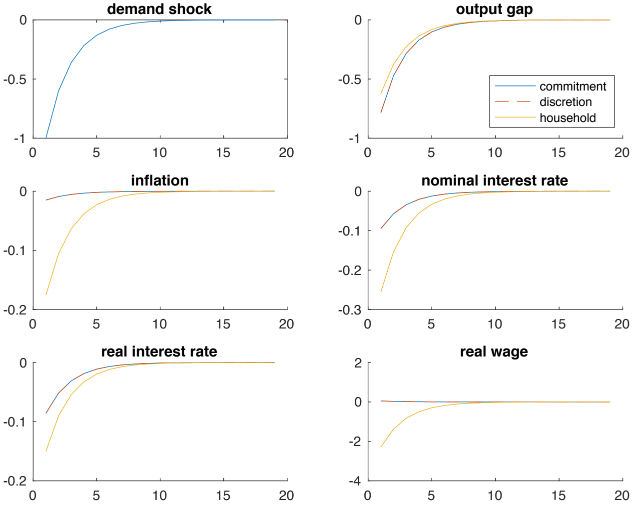
# TFP shock, $\phi_\pi = 2.1$



# TFP shock, results

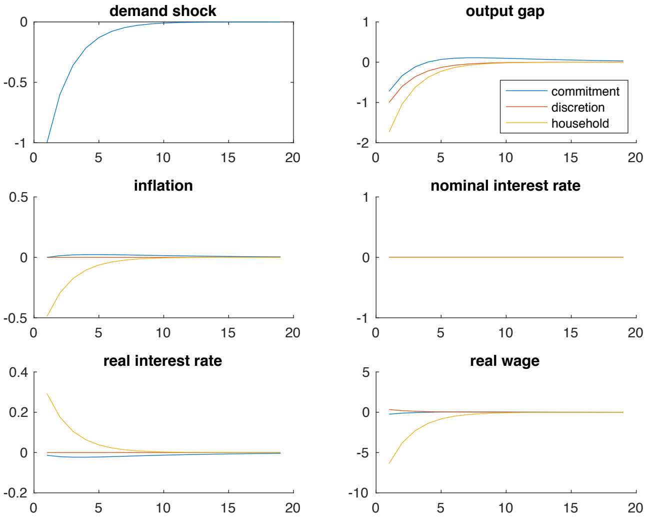
- results different from Gnocchi(2009)
- wage setting centralization matters for the dynamics, the more the less responsive is monetary policy
- inflation - output gap relation changes
- monetary policy should put more weight on output gap stabilization
- or implement very strict inflation targeting

# Demand shock




welfare losses: union: 0.02; household 0.06

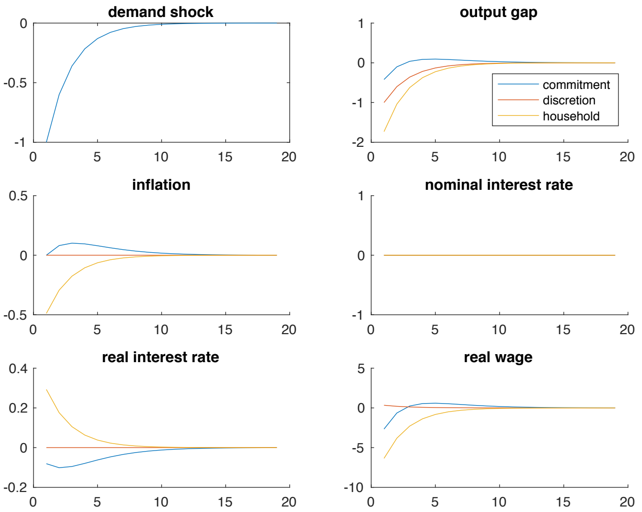
# Demand shock, ZLB



# Demand shock, ZLB, less inflation averse union

- union minimizes $(\frac{\epsilon}{\lambda}\pi_t^2 + (\sigma + \frac{\varphi+\alpha}{1-\alpha})\tilde{y}_t^2)$
- $209.71\pi_t^2 + 4\tilde{y}_t$
- experiment with $209.71/10\pi_t^2 + 4\tilde{y}_t$

# Demand shock, ZLB, less inflation averse union

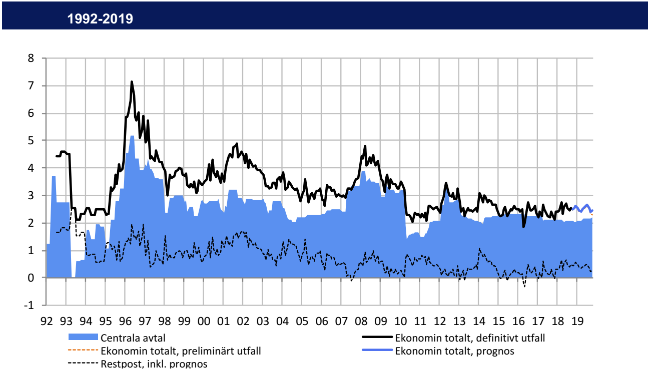


# Demand shock, results

- household level wage setting leads to deflationary dynamics
- results in line with Galí and Billi (2019), wage flexibility does not lead to efficient adjustment to domestic demand shocks
- it the economy is at the ZLB and if union is able to commit to future wages, it can decrease the real interesest rate
- if commitment is essential, is it possible to maintain benefits of collective wage bargaining when allowing for opening clauses?

ECB Monthly bulletin August 2012:
"Regarding competitiveness, given the low level of competition further significant reductions in unit labour costs and excess profit margins are particularly urgent, especially in countries where unemployment is very high. To achieve this, first, flexibility in the wage determination process has to be strengthened, for example, where relevant, by relaxing employment protection legislation, abolishing wage indexation schemes, lowering minimum wages and permitting wage bargaining at the firm level".

# Multi-period wages




GDP growth: 3.5% 2007, -0.6% 2008, -5% 2009

# Multi-period wages

- Calvo-type wage rigidity different from wage rigidity typical for an economy with collective bargaining
- Björklund, Carlsson & Skans (2019) , Faia & Pezone (2018): fixed wages matter for monetary policy transmission

- to get two-period wages, define $\pi_{t,1}, \pi_{t,2}, \tilde{y}_{t,1}, \tilde{y}_{t,2}, ...w_t$

# Two-period wages

$$
\begin{aligned}
\max_{\pi_{t,1},\tilde{y}_{t,1},i_{t,1},\pi_{t,2},\tilde{y}_{t,2},i_{t,2},w_t} E_0 \sum_{t=0}^{\infty} \beta^{2t} \Big\{ & -\frac{1}{2}\big[\frac{\epsilon}{\lambda}\pi_{t,1}^2 + (\sigma + \frac{\varphi+\alpha}{1-\alpha})\tilde{y}_{t,1}^2\big] \\
& -\frac{1}{2}\beta\big[\frac{\epsilon}{\lambda}\pi_{t,2}^2 + (\sigma + \frac{\varphi+\alpha}{1-\alpha})\tilde{y}_{t,2}\big] \\
& +\gamma_{t,1}^1(\tilde{y}_{t,1} + \frac{1}{\sigma}(i_{t,1} - \pi_{t,2} - r_{t,1}^n) - \tilde{y}_{t,2}) \\
& +\gamma_{t,1}^2(i_{t,1} - \rho - \phi_y \tilde{y}_{t,1} - \phi_\pi \pi_{t,1}) \\
& +\gamma_{t,1}^3(\pi_{t,1} - \beta\pi_{t,2} - \lambda(w_t - p_{t,1} - mpl_{t,1})) \\
& +\gamma_{t,2}^1\beta(\tilde{y}_{t,2} + \frac{1}{\sigma}(i_{t,2} - \pi_{t+1,1} - r_{t,2}^n) - \tilde{y}_{t+1,1}) \\
& +\gamma_{t,2}^2\beta(i_{t,2} - \rho - \phi_y \tilde{y}_{t,2} - \phi_\pi \pi_{t,2}) \\
& +\gamma_{t,2}^3\beta(\pi_{t,2} - \beta\pi_{t+1,1} - \lambda(w_t - p_{t,2} - mpl_{t,2}))\Big\}\Big\}
\end{aligned}
$$

# Two-period wages

...leads to system of equations

$$A_1[x_{t,1} \;\; w_t]' = B_1 E_{t,1}[x_{t,2} \;\; w_t]' \tag{8}$$

$$A_2 E_{t,1}[x_{t,2} \;\; w_t]' = B_2 E_{t,1}[x_{t+1,1} \;\; w_{t+1}]' \tag{9}$$

Can be reduced to

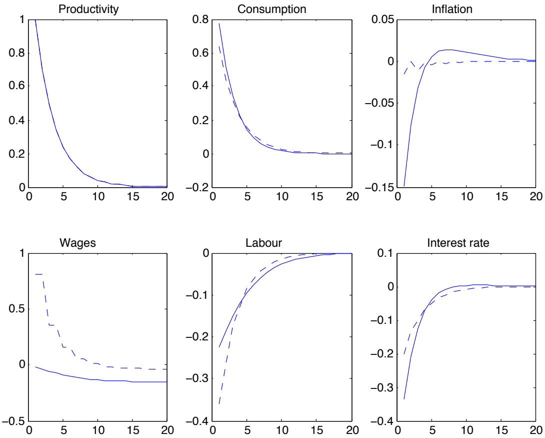
$$A_1[x_{t,1} \;\; w_t]' = B_1 A_2^{-1} B_2 E_{t,1}[x_{t+1,1} \;\; w_{t+1}]' \tag{10}$$

# Two-period wages

compare to Erceg, Henderson and Levin (2000) household unions.

- Calvo-type staggered wage setting
- probability to reset wages on each period is 0.5 - average wage contract length is 2 periods

# Two-period wages




solid line household, dashed line union

- welfare losses: union: 0.04; household level 0.18
- similar magnitude of rigidity, but different outcomes

# Comparison to empirical results

Simulations predict:

1. less volatile inflation
2. higher correlation of labour productivity and real wages

for higher degree of centralization

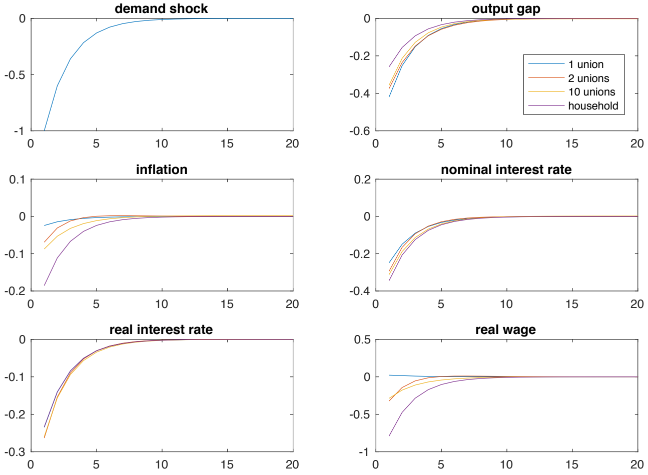
- Bowdler and Nunziata (2007), Rumler and Scharler (2011) agree with 1
- Gnocchi et al (2015), Juvonen(2019) disagree with 2

# Conclusions

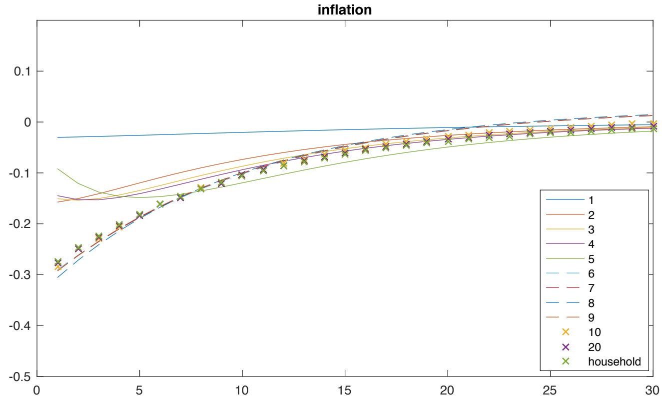
- centralized wage setting modeled as a planner's problem
- wage setting centralization changes the dynamics
  - holds with one and several unions
  - holds with "rigid" wages, macro vs. micro rigidity
  - stabilizes inflation as empirical results suggest
- centralized wage setting decreased welfare losses
  - in this simple model economy
  - not a substitute for monetary policy, wage setting cannot close both gaps
  - commitment to future wages is important in terms of real interest dynamics at the ZLB
- in NK model welfare costs from price variability are high and this influences unions' wage setting
  - illustrates that when the economic environment features imperfections wage setting by large agents can reduce welfare losses

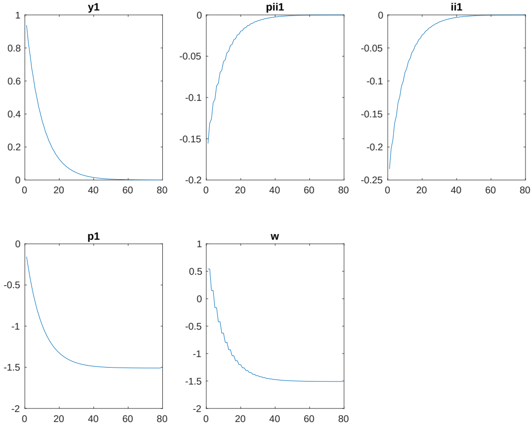
Thanks!

# Demand shock, many unions



# TFP shock,inflation, many unions




y1
1
0.8
0.6
0.4
0.2
0
0 20 40 60 80
pii1
0
-0.05
-0.1
-0.15
-0.2
0 20 40 60 80
ii1
0
-0.05
-0.1
-0.15
-0.2
-0.25
0 20 40 60 80
p1
0
-0.5
-1
-1.5
-2
0 20 40 60 80
w
1
0.5
0
-0.5
-1
-1.5
-2
0 20 40 60 80