Monetary Policy and Unemployment: A New Keynesian Perspective

Jordi Galí

CREI, UPF and Barcelona GSE

April 2015

Introducing unemployment in the Standard NK model

- New approach developed in my Zeuthen lectures [1]

  - reformulation of the *standard* NK model $\Rightarrow$ unemployment

- Alternative to recent literature: labor market frictions + nominal rigidities

  Walsh, Trigari, Blanchard-Galí, Thomas, Gertler-Sala-Trigari, Faia, Ravenna-Walsh,...

- Applications:

  - An empirical model of wage inflation and unemployment dynamics [2]
  - Unemployment and the measurement of the output gap (ch. 2 in [1])
  - Unemployment and the design of monetary policy (ch.3 in [1])
  - Revisiting the sources of fluctuations in the Smets-Wouters model [3]
  - A structural interpretation of slow recoveries [4]

References

[1] *Unemployment Fluctuations and Stabilization Policies: A New Keynesian Perspective* (2011, MIT Press)
[2] "The Return of the Wage Phillips Curve" *Journal of the European Economic Association*, 2011.
[3] "An Estimated New Keynesian Model with Unemployment," (with F. Smets and R. Wouters), *NBER Macroeconomics Annual* 2011
[4] "Slow Recoveries: A Structural Interpretation," (with F. Smets and R. Wouters), *Journal of Money, Credit and Banking*, 2012.

Households

- Representative household with a continuum of members, indexed by $(j, s) \in [0,1] \times [0,1]$
- Continuum of differentiated labor services, indexed by $j \in [0,1]$
- Disutility from (indivisible) labor: χs^{φ}, for $s \in [0,1]$, where $\varphi \geq 0$
- Full consumption risk sharing within the household
- Household utility: $E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, \{\mathcal{N}_t(j)\}; Z_t)$

$$
\begin{aligned}
U(C_t, \{\mathcal{N}_t(j)\}; Z_t) \quad &\equiv \quad \left(\frac{C_t^{1-\sigma} - 1}{1-\sigma} - \chi \int_0^1 \int_0^{\mathcal{N}_t(j)} s^{\varphi} ds dj \right) Z_t \\
&= \quad \left(\frac{C_t^{1-\sigma} - 1}{1-\sigma} - \chi \int_0^1 \frac{\mathcal{N}_t(j)^{1+\varphi}}{1+\varphi} dj \right) Z_t
\end{aligned}
$$

where $C_t \equiv \left(\int_0^1 C_t(i)^{1-\frac{1}{\epsilon_p}} di \right)^{\frac{\epsilon_p}{\epsilon_p - 1}}$

- Budget constraint

$$\int_0^1 P_t(i)C_t(i)di + Q_t B_t \leq B_{t-1} + \int_0^1 W_t(j)\mathcal{N}_t(j)dj + D_t$$

- Two optimality conditions

$$C_t(i) = \left(\frac{P_t(i)}{P_t}\right)^{-\epsilon_p} C_t$$

where $P_t \equiv \left(\int_0^1 P_t(i)^{1-\epsilon_p} di\right)^{\frac{1}{1-\epsilon_p}}$, implying $\int_0^1 P_t(i)C_t(i)di = P_t C_t$.

$$Q_t = \beta E_t \left\{ \left(\frac{C_{t+1}}{C_t}\right)^{-\sigma} \left(\frac{Z_{t+1}}{Z_t}\right) \left(\frac{P_t}{P_{t+1}}\right) \right\}$$

Wage Setting

- Nominal wage for each labor type reset with probability $1 - \theta_w$ each period
- Average wage dynamics

$$w_t = \theta_w w_{t-1} + (1 - \theta_w) w_t^*$$

- Optimal wage setting rule

$$w_t^* = \mu^w + (1 - \beta\theta_w) \sum_{k=0}^{\infty} (\beta\theta_w)^k E_t \left\{ mrs_{t+k|t} + p_{t+k} \right\}$$

where $\mu^w \equiv \log \frac{\epsilon_w}{\epsilon_w - 1}$ and $mrs_{t+k|t} \equiv \sigma c_{t+k} + \varphi n_{t+k|t} + \xi$

- Wage inflation equation

$$\pi_t^w = \beta E_t\{\pi_{t+1}^w\} - \lambda_w (\mu_t^w - \mu^w)$$

where $\pi_t^w \equiv w_t - w_{t-1}$, $\mu_t^w \equiv w_t - p_t - mrs_t$, and $\lambda_w \equiv \frac{(1-\theta_w)(1-\beta\theta_w)}{\theta_w(1+\epsilon_w\varphi)}$.

Introducing Unemployment

- Participation condition for an individual (j, s):

$$\frac{W_t(j)}{P_t} \geq \chi C_t^{\sigma} s^{\varphi}$$

- Marginal participant, $L_t(j)$, given by:

$$\frac{W_t(j)}{P_t} = \chi C_t^{\sigma} L_t(j)^{\varphi}$$

- Taking logs and integrating over i,

$$w_t - p_t = \sigma c_t + \varphi l_t + \xi$$

where $w_t \simeq \int_0^1 w_t(j)dj$ and $l_t \equiv \int_0^1 l_t(j)dj$ is the model's implied (log) aggregate labor force.

Introducing Unemployment

- Unemployment rate

$$u_t \equiv l_t - n_t$$

- Average wage markup and unemployment

$$\begin{aligned} \mu_t^w &= (w_t - p_t) - (\sigma c_t + \varphi n_t + \xi) \\ &= \varphi u_t \end{aligned}$$

- Under flexible wages:

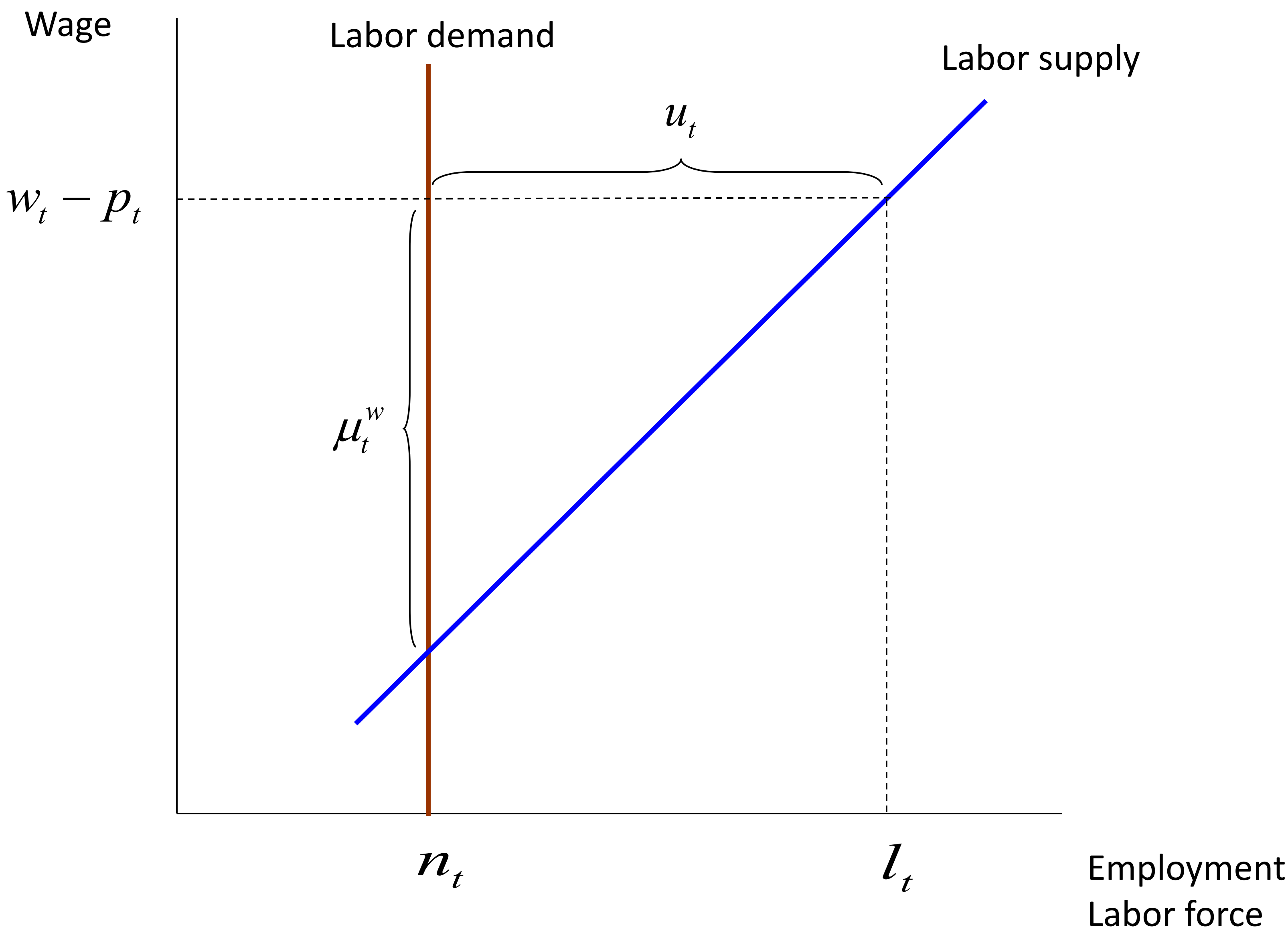
$$\mu^w = \varphi u^n$$

$\Rightarrow u^n$: *natural* rate of unemployment

- The nature of unemployment and its fluctuations
- A New Keynesian Wage Phillips Curve

$$\pi_t^w = \beta E_t\{\pi_{t+1}^w\} - \lambda_w \varphi (u_t - u^n)$$

Figure 7.1 The Wage Markup and the Unemployment Rate



Firms and Price Setting

- Continuum of firms, $i \in [0,1]$, each producing a differentiated good.
- Technology

$$Y_t(i) = A_t N_t(i)^{1-\alpha}$$

where $N_t(i) \equiv \left(\int_0^1 N_t(i,j)^{1-\frac{1}{\epsilon_w}} di \right)^{\frac{\epsilon_w}{\epsilon_w - 1}}$

- The price of each good reset with a probability $1 - \theta_p$ each period
- Average price dynamics

$$p_t = \theta_p p_{t-1} + (1-\theta_p) p_t^*$$

- Opimal price setting rule

$$p_t^* = \mu^p + (1 - \beta\theta_p) \sum_{k=0}^{\infty} (\beta\theta_p)^k E_t\{\psi_{t+k|t}\}$$

Firms and Price Setting

- Implied price inflation equation

$$\pi_t^p = \beta E_t\{\pi_{t+1}^p\} - \lambda_p(\mu_t^p - \mu^p)$$

where

$$\mu_t^p \equiv p_t - \psi_t$$

$$\psi_t \equiv w_t - (a_t - \alpha n_t + \log(1-\alpha))$$

and

$$\lambda_p \equiv \frac{(1-\theta_p)(1-\beta\theta_p)}{\theta_p} \; \frac{1-\alpha}{1-\alpha+\alpha\epsilon_p}.$$

Equilibrium

- Non-Policy block

$$\widetilde{y}_t = -\frac{1}{\sigma}(i_t - E_t\{\pi^p_{t+1}\} - r^n_t) + E_t\{\widetilde{y}_{t+1}\}$$

$$\pi^p_t = \beta E_t\{\pi^p_{t+1}\} + \varkappa_p \widetilde{y}_t + \lambda_p \widetilde{\omega}_t$$

$$\pi^w_t = \beta E_t\{\pi^w_{t+1}\} - \lambda_w \varphi \widehat{u}_t$$

$$\widetilde{\omega}_t \equiv \widetilde{\omega}_{t-1} + \pi^w_t - \pi^p_t - \Delta\omega^n_t$$

$$\begin{aligned} \varphi \widehat{u}_t &= \widehat{\mu}^w_t \\ &= \widetilde{\omega}_t - (\sigma \widetilde{c}_t + \varphi \widetilde{n}_t) \\ &= \widetilde{\omega}_t - \left(\sigma + \frac{\varphi}{1-\alpha}\right)\widetilde{y}_t \end{aligned}$$

- Policy block

Example:

$$i_t = \rho + \phi_p \pi_t^p + \phi_y \widehat{y}_t + v_t$$

- Natural equilibrium

$$\widehat{y}_t^n = \psi_{ya} a_t$$

$$r_t^n = \rho - \sigma(1-\rho_a)\psi_{ya} a_t + (1-\rho_z) z_t$$

$$\widehat{\omega}_t^n = \psi_{wa} a_t$$

with $\psi_{ya} \equiv \frac{1+\varphi}{\sigma(1-\alpha)+\varphi+\alpha}$ and $\psi_{wa} \equiv \frac{1-\alpha\psi_{ya}}{1-\alpha} > 0$.

- Exogenous $AR(1)$ processes for $\{a_t\}$, $\{z_t\}$, and $\{v_t\}$

- Calibration

Baseline calibration

	Description	*Value*	*Target*
φ	Curvature of labor disutility	5	Frisch elasticity 0.2
α	Index of decrasing returns to labor	1/4	
ϵ_w	Elasticity of substitution (labor)	4.52	$u^n = 0.05$
ϵ_p	Elasticity of substitution (goods)	9	$S = \frac{1-\alpha}{\epsilon_p/(\epsilon_p-1)} = 2/3$
θ_p	Calvo index of price rigidities	3/4	avg. duration $= 4$
θ_w	Calvo index of wage rigidities	3/4	avg. duration $= 4$
ϕ_p	Inflation coefficient in policy rule	1.5	Taylor (1993)
ϕ_y	Output coefficient in policy rule	0.125	Taylor (1993)
β	Discount factor	0.99	
ρ_a	Persistence: technology shocks	0.9	
ρ_z	Persistence: demand shocks	0.5	
ρ_v	Persistence: monetary shocks	0.5	

- Dynamic Effects of Monetary Policy Shocks on Labor Markets

  - Impulse responses
  - Wage rigidities and the volatility and persistence of unemployment

Figure 7.2 Response of Labor Market Variables to a Monetary Policy Shock

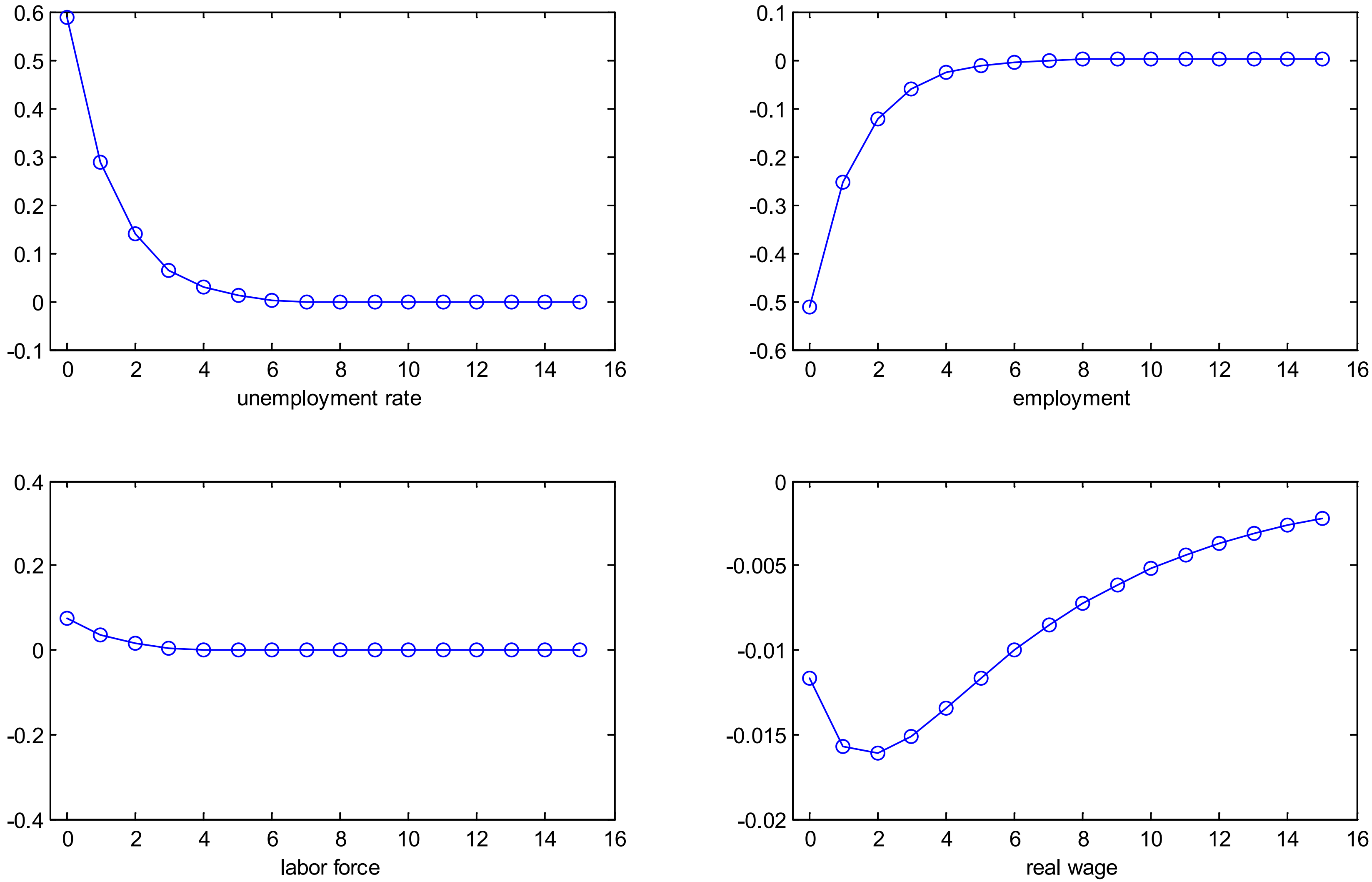


Table 7.1 Wage Rigidities and Unemployment Fluctuations									
	Volatility			Persistence			Cyclicality		
θ_w :	0.1	0.5	0.75	0.1	0.5	0.75	0.1	0.5	0.75
$\rho_v = 0.0$	0.25	0.32	0.33	-0.14	-0.02	-0.01	-0.99	-0.99	-0.99
$\rho_v = 0.5$	0.36	0.60	0.67	0.24	0.44	0.48	-0.96	-0.99	-0.99
$\rho_v = 0.9$	0.31	1.24	2.47	0.51	0.80	0.87	-0.77	-0.98	-0.99

Source: Galí (2015, ch. 7)

- Optimal Monetary Policy Problem

$$\min \frac{1}{2} E_0 \sum_{t=0}^{\infty} \beta^t \left(\left(\sigma + \frac{\varphi + \alpha}{1-\alpha} \right) \widetilde{y}_t^2 + \frac{\epsilon_p}{\lambda_p} (\pi_t^p)^2 + \frac{\epsilon_w (1-\alpha)}{\lambda_w} (\pi_t^w)^2 \right)$$

subject to:

$$\pi_t^p = \beta E_t\{\pi_{t+1}^p\} + \varkappa_p \widetilde{y}_t + \lambda_p \widetilde{\omega}_t$$

$$\pi_t^w = \beta E_t\{\pi_{t+1}^w\} + \varkappa_w \widetilde{y}_t - \lambda_w \widetilde{\omega}_t$$

$$\widetilde{\omega}_t \equiv \widetilde{\omega}_{t-1} + \pi_t^w - \pi_t^p - \Delta\omega_t^n$$

- Optimality conditions

$$\left(\sigma + \frac{\varphi + \alpha}{1-\alpha}\right)\widetilde{y}_t + \varkappa_p \zeta_{1,t} + \varkappa_w \zeta_{2,t} = 0 \tag{1}$$

$$\frac{\epsilon_p}{\lambda_p}\ \pi_t^p - \Delta\zeta_{1,t} + \zeta_{3,t} = 0 \tag{2}$$

$$\frac{\epsilon_w(1-\alpha)}{\lambda_w}\ \pi_t^w - \Delta\zeta_{2,t} - \zeta_{3,t} = 0 \tag{3}$$

$$\lambda_p \zeta_{1,t} - \lambda_w \zeta_{2,t} + \zeta_{3,t} - \beta E_t\{\zeta_{3,t+1}\} = 0 \tag{4}$$

- Impulse responses: Optimal vs. Taylor
- A simple rule with unemployment (vs. optimal policy)

$$i_t = 0.01 + 1.5\pi_t^p - 0.5\widehat{u}_t \tag{5}$$

Figure 7.3 Optimal Policy vs. Taylor Rule: Technology Shocks

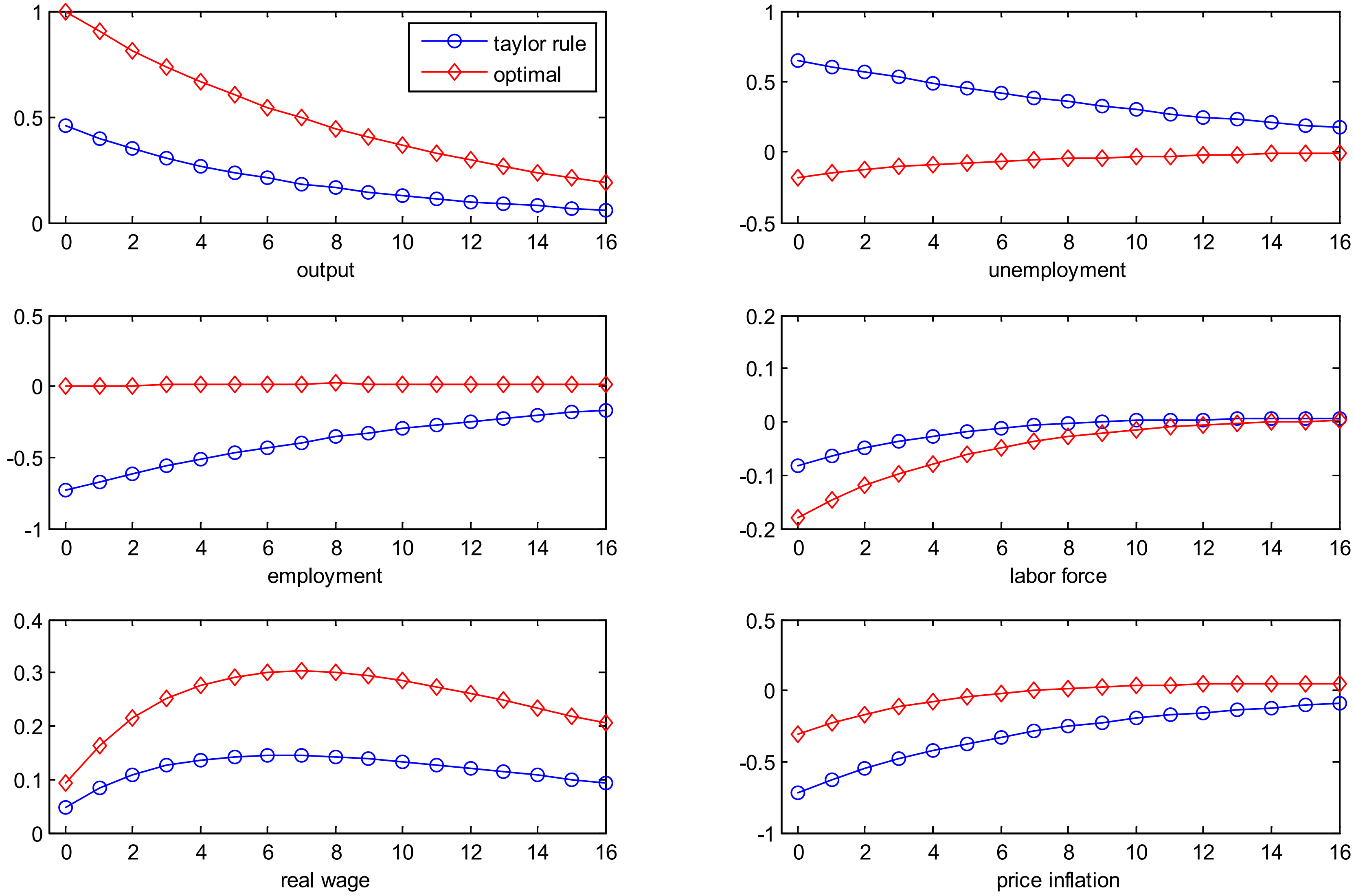


Figure 7.4 Optimal Policy vs. Taylor Rule: Demand Shocks

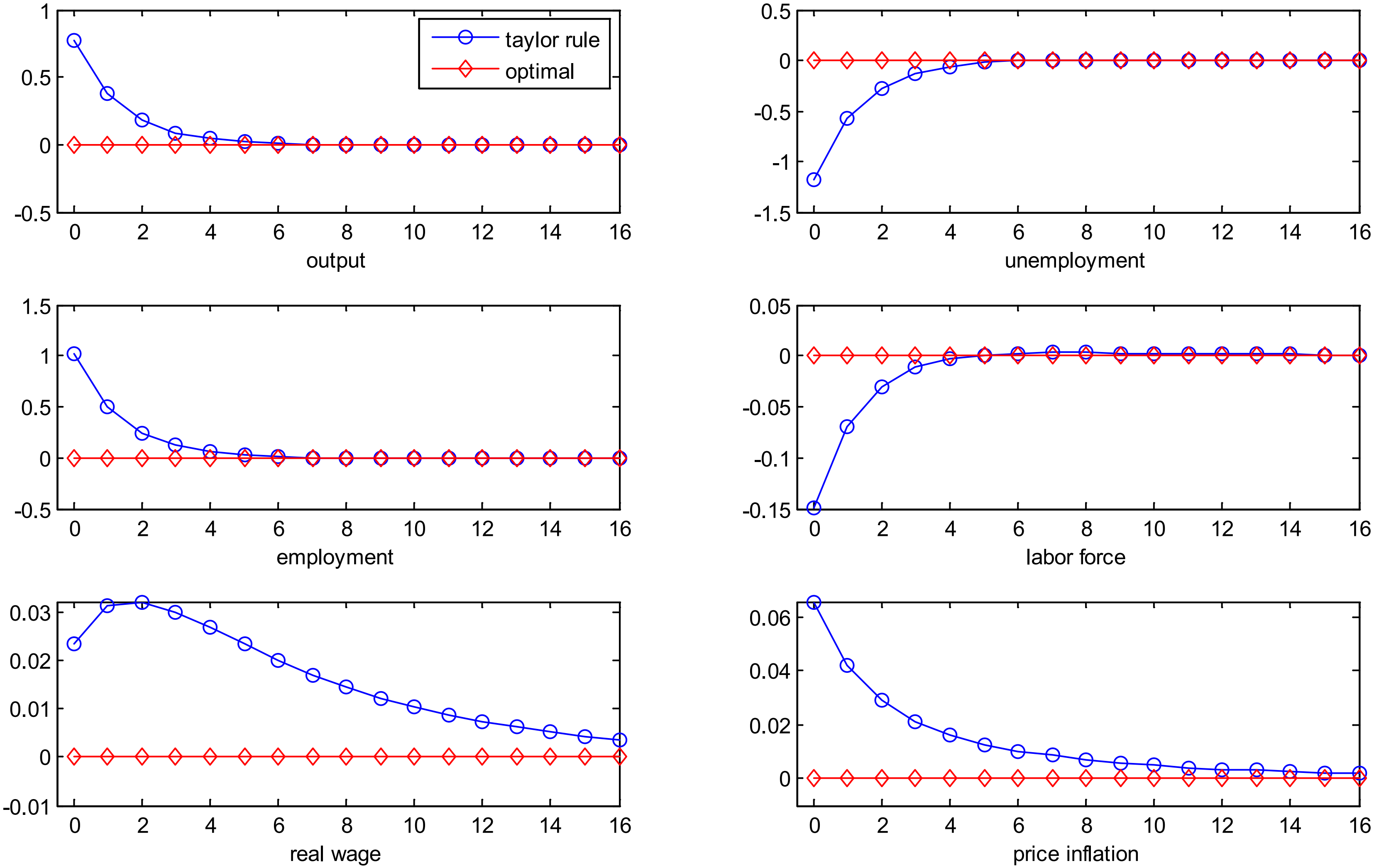


Figure 7.5 Optimal Policy vs. Simple Rule: Technology Shocks

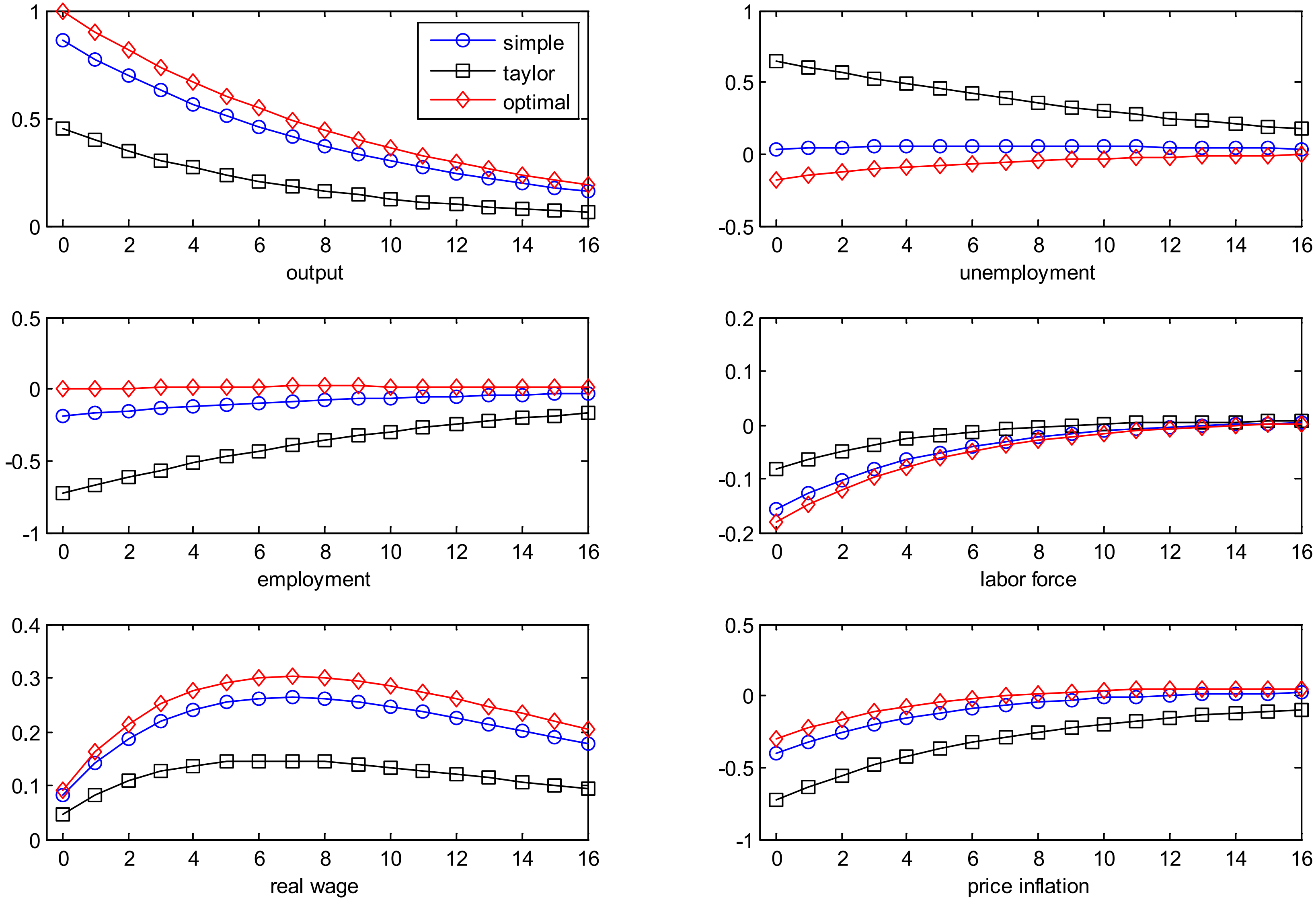


Figure 7.6 Optimal Policy vs. Simple Rule: Demand Shocks