Unemployment Fluctuations and Stabilization Policies: A New Keynesian Perspective

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Households

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

$$
\begin{aligned}
U_t(C_t, \{N_t(i)\}, \chi_t) &\equiv \log C_t - \chi_t \int_0^1 \int_0^{N_t(i)} j^{\varphi} dj di \\
&= \log C_t - \chi_t \int_0^1 \frac{N_t(i)^{1+\varphi}}{1+\varphi} di
\end{aligned}
$$

where $C_t \equiv \left(\int_0^1 C_t(z)^{1-\frac{1}{\epsilon_p}} dz \right)^{\frac{\epsilon_p}{\epsilon_p - 1}}$ and $\chi_t \equiv \exp\{\xi_t\}$ is a labor supply shifter.

- Budget constraint

$$\int_0^1 P_t(z)C_t(z)dz + Q_t B_t \leq B_{t-1} + \int_0^1 W_t(i)N_t(i)di + \Pi_t$$

- Two optimality conditions

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

where $P_t \equiv \left(\int_0^1 P_t(z)^{1-\epsilon_p} dz\right)^{\frac{1}{1-\epsilon_p}}$ and

$$Q_t = \beta E_t \left\{ \frac{C_t}{C_{t+1}} \frac{P_t}{P_{t+1}} \right\}$$

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 $mrs_{t+k|t} \equiv c_{t+k} + \varphi \; n_{t+k|t} + \xi_{t+k}$.

- 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 (i, j):

$$\left(\frac{1}{C_t}\right)\left(\frac{W_t(i)}{P_t}\right) \geq \chi_t j^{\varphi}$$

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

$$\frac{W_t(i)}{P_t} = \chi_t C_t L_t(i)^{\varphi}$$

- Taking logs and integrating over i,

$$w_t - p_t = c_t + \varphi l_t + \xi_t$$

where $l_t \equiv \int_0^1 l_t(i)\, di$ 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

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

- Under flexible wages:

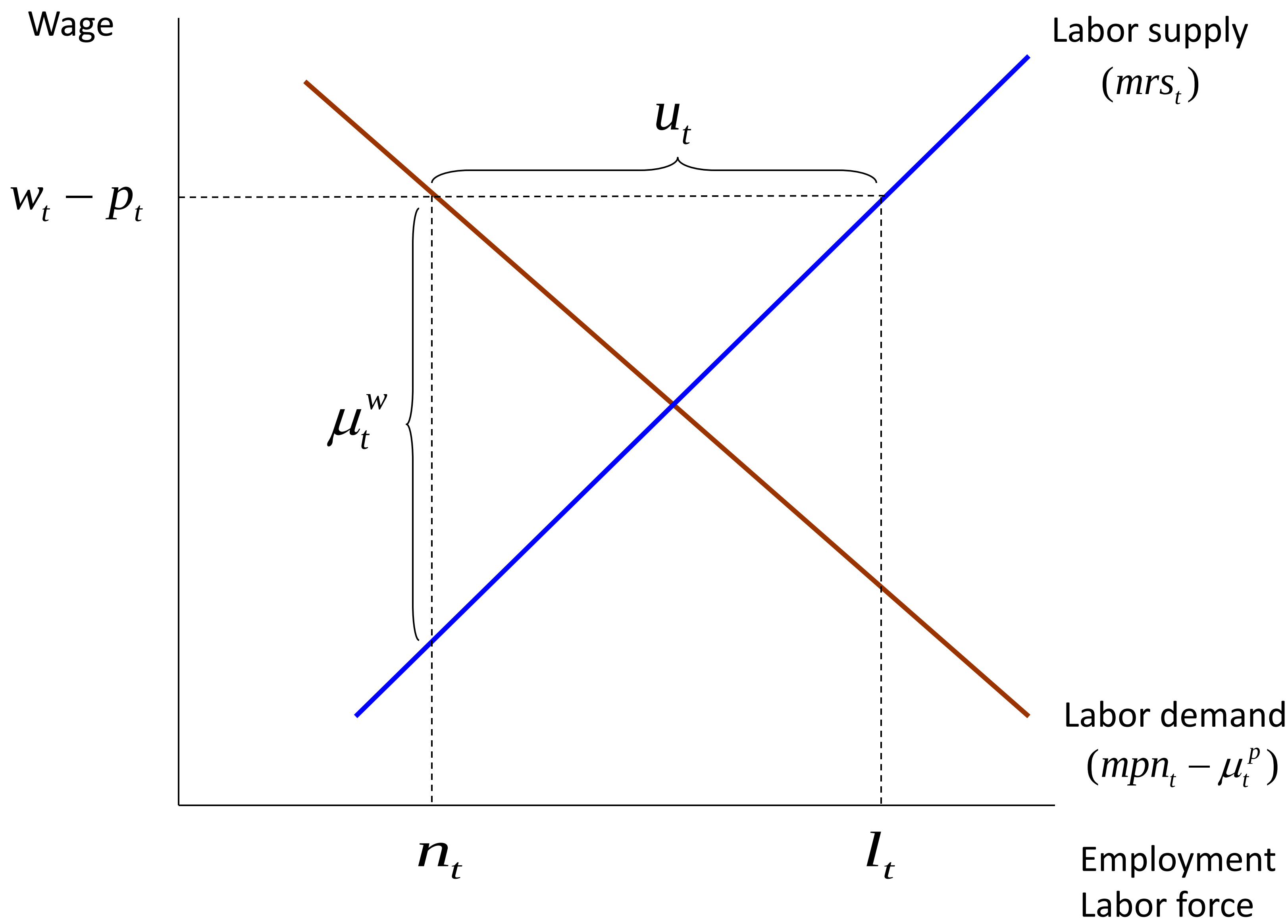
$$\mu^w = \varphi u^n$$

$\Rightarrow u^n$: *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 2.1: The Wage Markup and the Unemployment Rate



Firms and Price Setting

- Continuum of firms, $z \in [0,1]$, each producing a differentiated good.
- Technology
$$Y_t(z) = A_t N_t(z)^{1-\alpha}$$
where $N_t(z) \equiv \left(\int_0^1 N_t(i,z)^{1-\frac{1}{\epsilon_w}} di \right)^{\frac{\epsilon_w}{\epsilon_w - 1}}$
- 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

$$\widetilde{y}_t = E_t\{\widetilde{y}_{t+1}\} - (i_t - E_t\{\pi_{t+1}\} - r_t^n)$$

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

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

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

where $\widetilde{y}_t \equiv y_t - y_t^n$, $\omega_t \equiv w_t - p_t$ and $\widetilde{\omega}_t \equiv \omega_t - \omega_t^n$

- Policy block

$$i_t = \rho + \phi_\pi \pi_t^p + \phi_y y_t + v_t$$

- Natural equilibrium

$$\omega_t^n = a_t + \left(\frac{\alpha}{1+\varphi}\right)\xi_t$$

$$y_t^n = a_t - \left(\frac{1-\alpha}{1+\varphi}\right)\xi_t$$

$$r_t^n = \rho + E_t\{\Delta a_{t+1}\} - \left(\frac{1-\alpha}{1+\varphi}\right)E_t\{\Delta\xi_{t+1}\}$$

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

$$\begin{aligned} u_t - u^n &= \frac{1}{\varphi}(\mu_t^w - \mu^w) \\ &= \frac{1}{\varphi}\widetilde{\omega}_t - \left(\frac{1}{\varphi} + \frac{1}{1-\alpha}\right)\widetilde{y}_t \end{aligned}$$

Nominal Wage Rigidities and Unemployment Fluctuations: Simulations

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_p	Calvo index of price 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_i	Persistence exogenous processes	0.9	

Nominal Wage Rigidities and Unemployment Fluctuations: Simulations

- Impulse responses and conditional second moments
- The role of wage rigidities as a source of unemployment volatility and persistence

Figure 2.2: Dynamic Responses to a Technology Shock

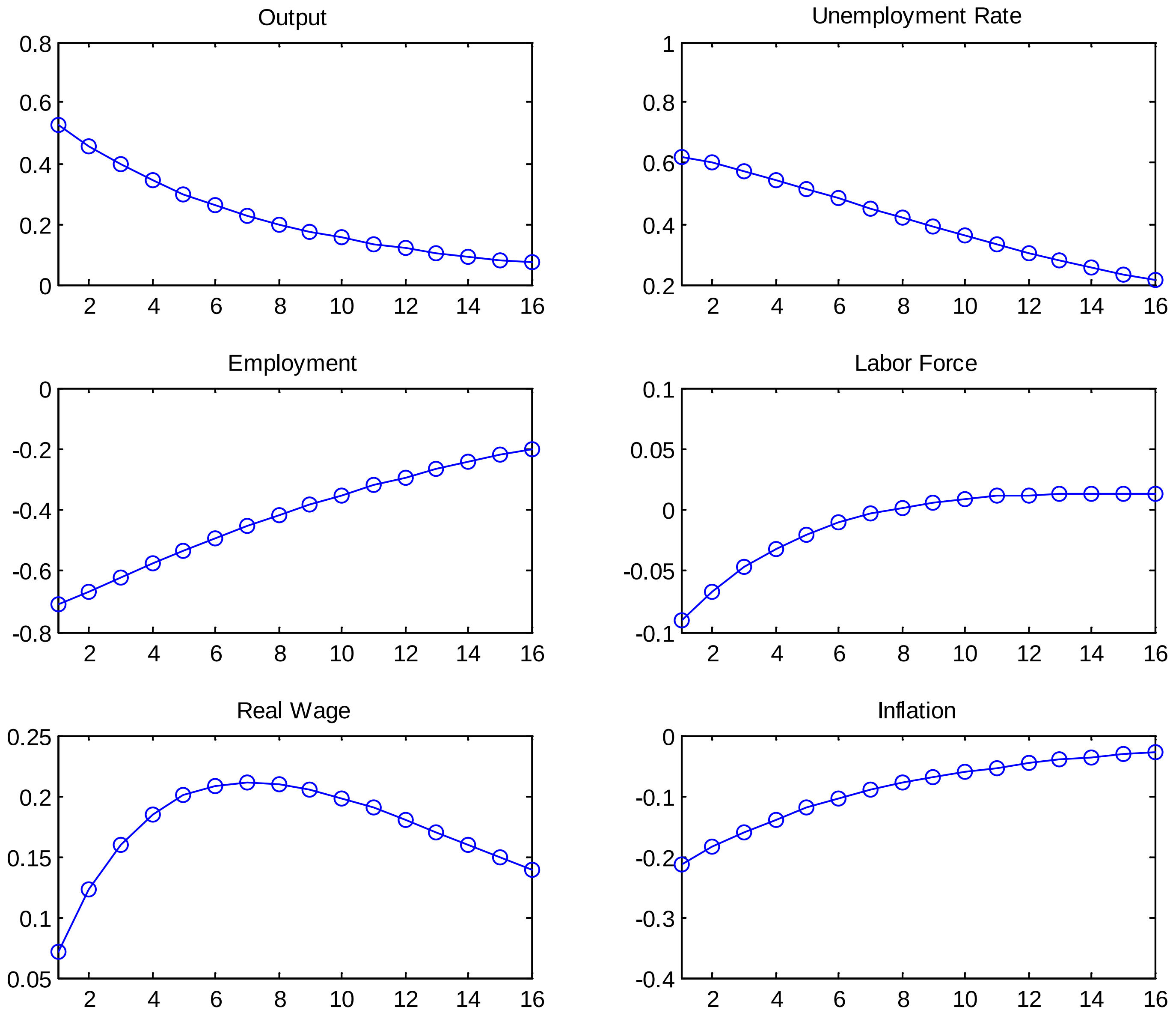


Figure 2.3: Dynamic Responses to a Monetary Shock

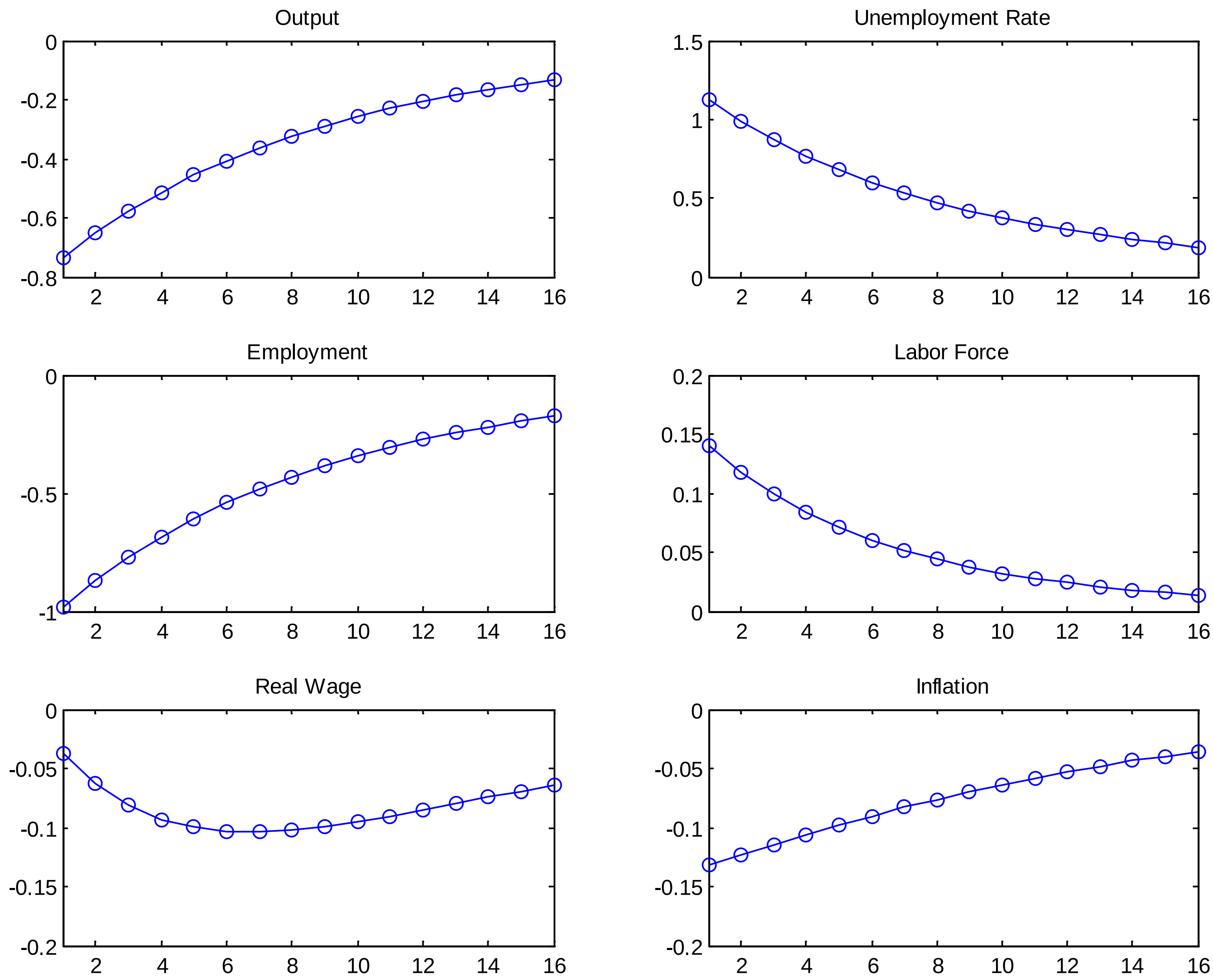


Figure 2.4: Dynamic Responses to a Labor Supply Shock

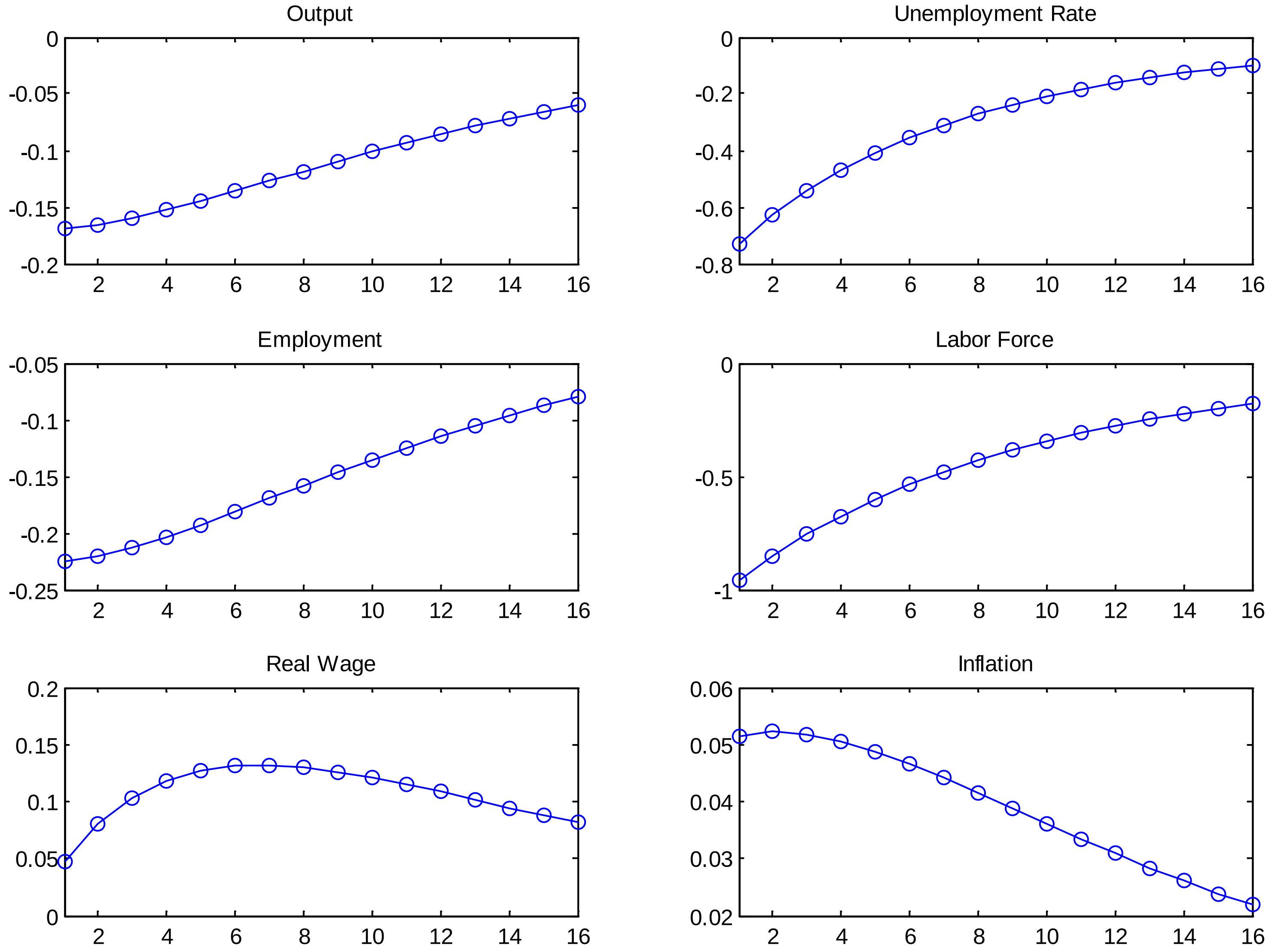


Table 2. Second Moments: Model vs. Data										
	U.S.		*Euro area*		*Technology*		*Monetary*		*Labor Supply*	
	$\frac{\sigma(x)}{\sigma(y)}$	$\rho(x,y)$	$\frac{\sigma(x)}{\sigma(y)}$	$\rho(x,y)$	$\frac{\sigma(x)}{\sigma(y)}$	$\rho(x,y)$	$\frac{\sigma(x)}{\sigma(y)}$	$\rho(x,y)$	$\frac{\sigma(x)}{\sigma(y)}$	$\rho(x,y)$
Unemployment	0.48	−0.88	0.41	−0.68	1.30	0.96	1.68	−0.99	4.42	0.95
Employment	0.63	0.81	0.62	0.78	1.44	−0.98	1.49	0.99	1.49	0.99
Labor force	0.23	0.28	0.32	0.56	0.17	−0.92	0.17	−0.98	5.87	0.97
Real Wage	0.58	0.13	0.68	0.27	0.38	0.53	0.15	0.57	0.87	−0.75
Inflation	0.33	0.35	0.38	0.34	0.40	−0.99	0.20	0.99	0.31	−0.99

Table 3. 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
$\rho_v = 0.0$	0.18	0.22	0.23	−0.16	−0.08	−0.07	−0.99	−1.0	−1.0
$\rho_v = 0.5$	0.24	0.39	0.42	0.20	0.34	0.37	−0.98	−0.99	−1.0
$\rho_v = 0.9$	0.15	0.54	1.0	0.40	0.62	0.68	−0.92	−0.99	−1.0

Monetary Policy Design in the New Keynesian Model: Some Background

- The basic New Keynesian model (flexible wages)

  - Optimal policy: strict price inflation targeting
  - Intuition

- The New Keynesian model with sticky prices and wages (EHL model)

  - Erceg-Henderson-Levin, Woodford, Galí
  - Efficient allocation: unattainable
  - Optimal policy: balance between stabilization of output gap, price inflation and wage inflation

But no analysis of unemployment or its possible role in policy...

Monetary Policy Design in the New Keynesian Model: The Role of Unemployment

- Implications of the optimal policy for unemployment fluctuations
- Potential gains from adding the unemployment rate to simple interest rate rules

Exercise motivated by three observations:
- existing literature: near-optimality of stabilization of the output gap
- previous lecture: strong relation between the output gap and the unemployment rate
- advantage of unemployment: observability

Optimal Monetary Policy

- The central bank's problem

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

subject to:

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

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

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

where $\omega_t^n = a_t + \left(\frac{\alpha}{1+\varphi} \right) \xi_t$

Optimal Monetary Policy

- Optimality conditions

$$\left(\frac{1+\varphi}{1-\alpha}\right) x_t + \kappa_p \xi_{1,t} + \kappa_w \xi_{2,t} = 0$$

$$\frac{\epsilon_p}{\lambda_p} \pi_t^p - \Delta \xi_{1,t} + \xi_{3,t} = 0 \quad (1)$$

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

$$\lambda_p \xi_{1,t} - \lambda_w \xi_{2,t} + \xi_{3,t} - \beta E_t \{\xi_{3,t+1}\} = 0 \quad (3)$$

- Impulse Responses and Conditional Second Moments: Optimal policy vs. Taylor rule

Figure 8a . Dynamic Responses to a Technology Shock: Optimal vs. Taylor

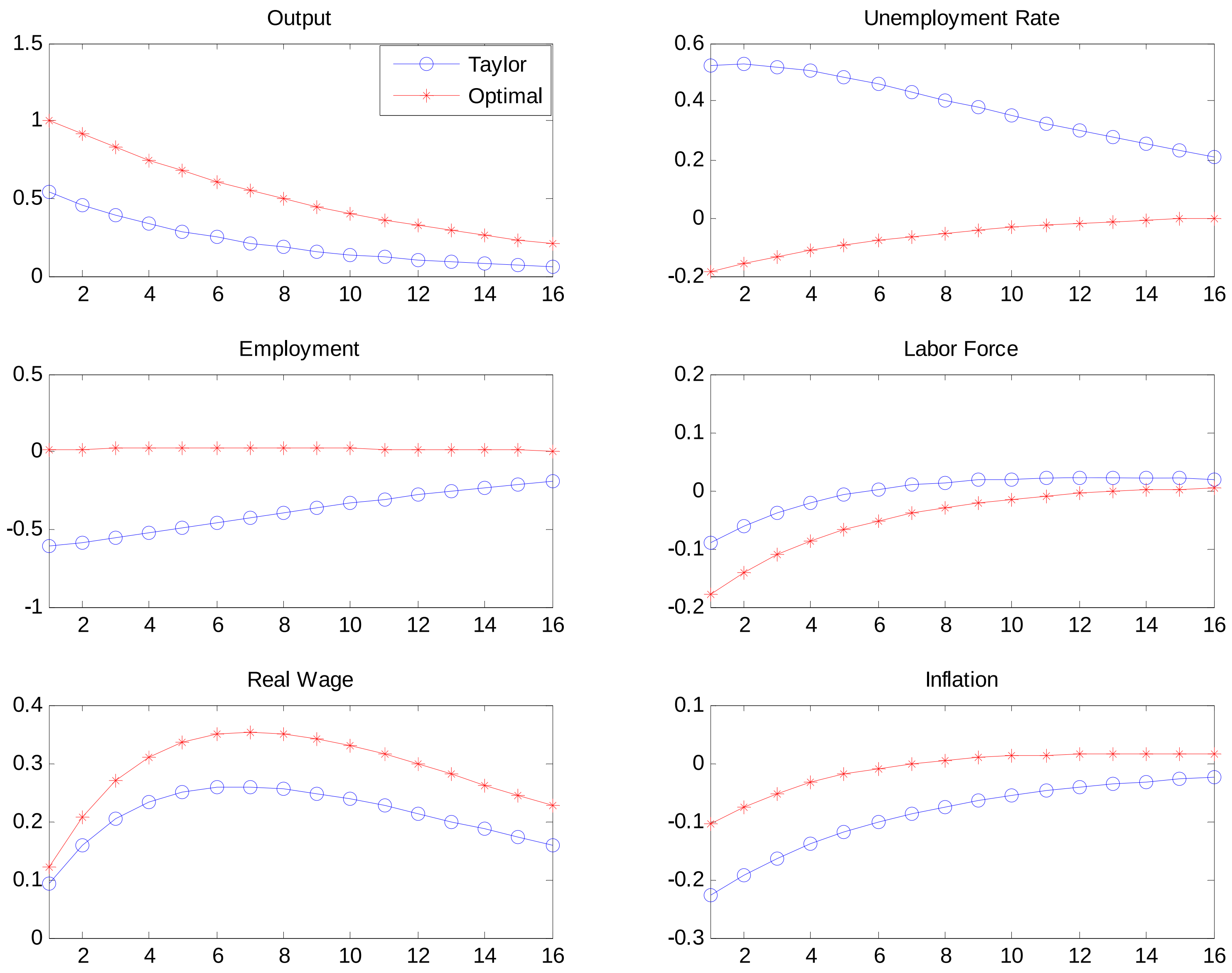
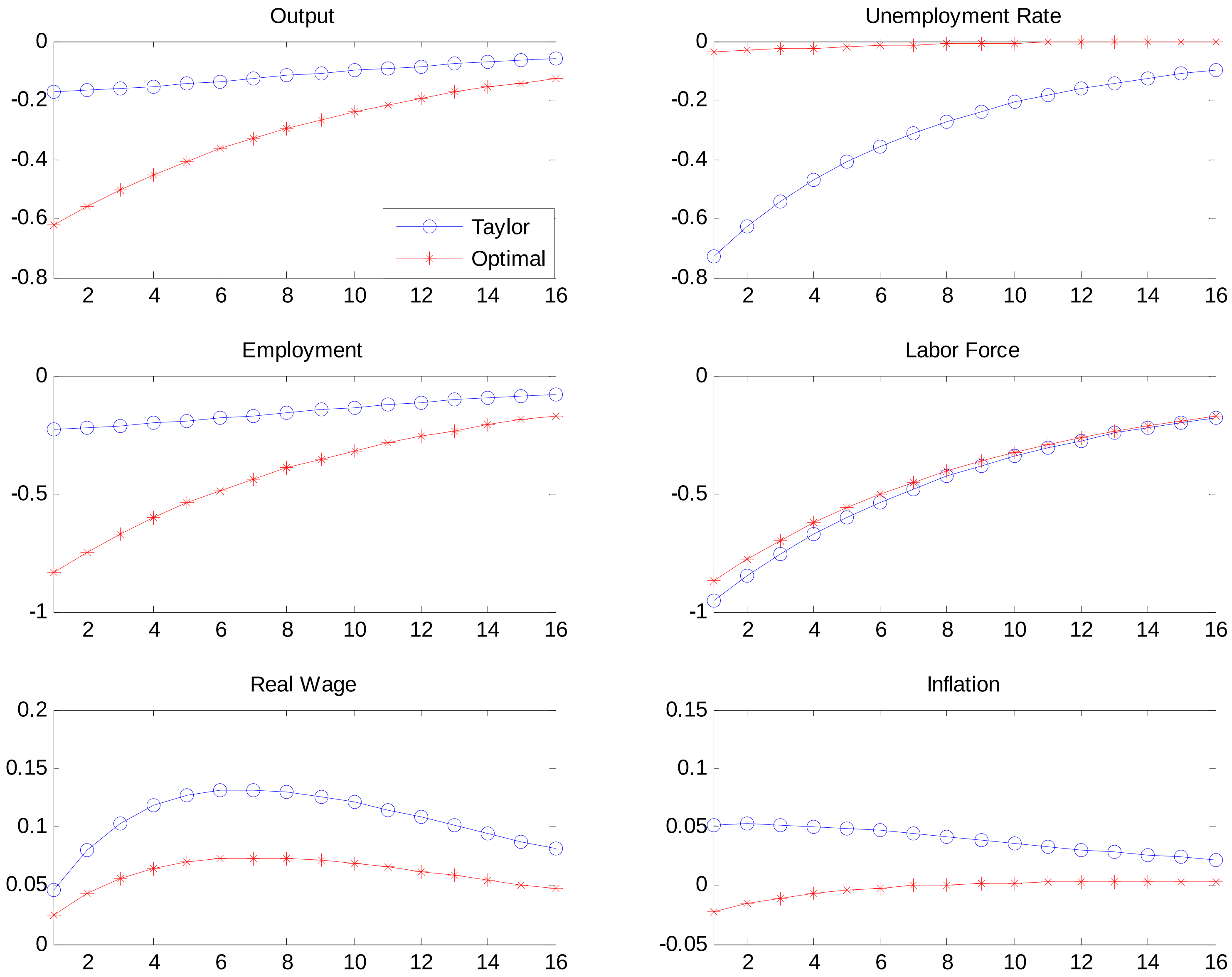


Figure 8b . Dynamic Responses to a Labor Supply Shock: Optimal vs. Taylor



Simple Interest Rate Rules

- General specification

$$\widehat{i}_t = \phi_i \widehat{i}_{t-1} + (1 - \phi_i)(\phi_\pi \pi_t^p + \phi_y \widehat{y}_t + \phi_u \widehat{u}_t + \phi_w \pi_t^w)$$

- Optimized coefficients and performance against fully optimal policy
- A Simple Rule

$$\widehat{i}_t = 1.5\ \pi_t^p - 0.5\ \widehat{u}_t$$

- Performance against optimal policy

Table 6. Optimal Simple Rules												
	Technology Shocks						*Labor Supply Shocks*					
	ϕ_i	ϕ_p	ϕ_y	ϕ_u	ϕ_w	*Loss*	ϕ_i	ϕ_p	ϕ_y	ϕ_u	ϕ_w	*Loss*
(a)		2.55	−0.06			4.15		3.22	−0.07			6.93
(b)	0.85	1.02	−0.06			1.31	0.60	1.11	−0.08			3.98
(c)		1.45	−0.13	−0.45		1.006		1.66	−0.08	−0.60		1.007
(d)	0.33	1.46	−0.12	−0.45		1.004	−0.22	1.33	−0.09	−0.31		1.006
(e)		1.46	−0.13	−0.46	−0.005	1.006		1.66	−0.08	−0.60	0.00	1.007
(f)	0.33	1.46	−0.12	−0.45	−0.01	1.004	−0.22	1.33	−0.09	−0.31	0.00	1.006
(g)		1.50		−0.50		1.106		1.50		−0.50		1.83

Figure 9a . Dynamic Responses to a Technology Shock: Optimal Simple Rule

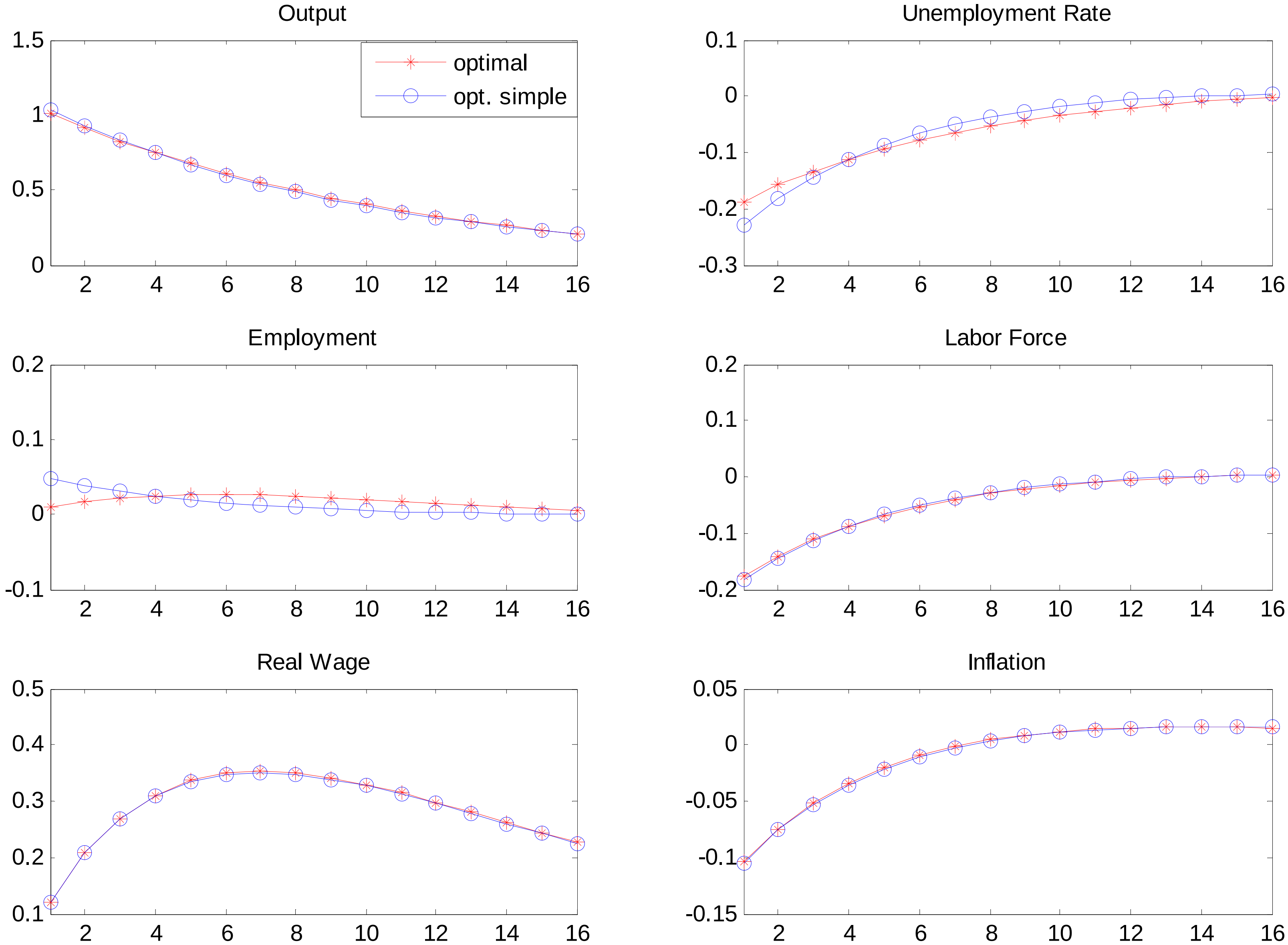


Figure 9b . Dynamic Responses to a Labor Supply Shock: Optimal Simple Rule

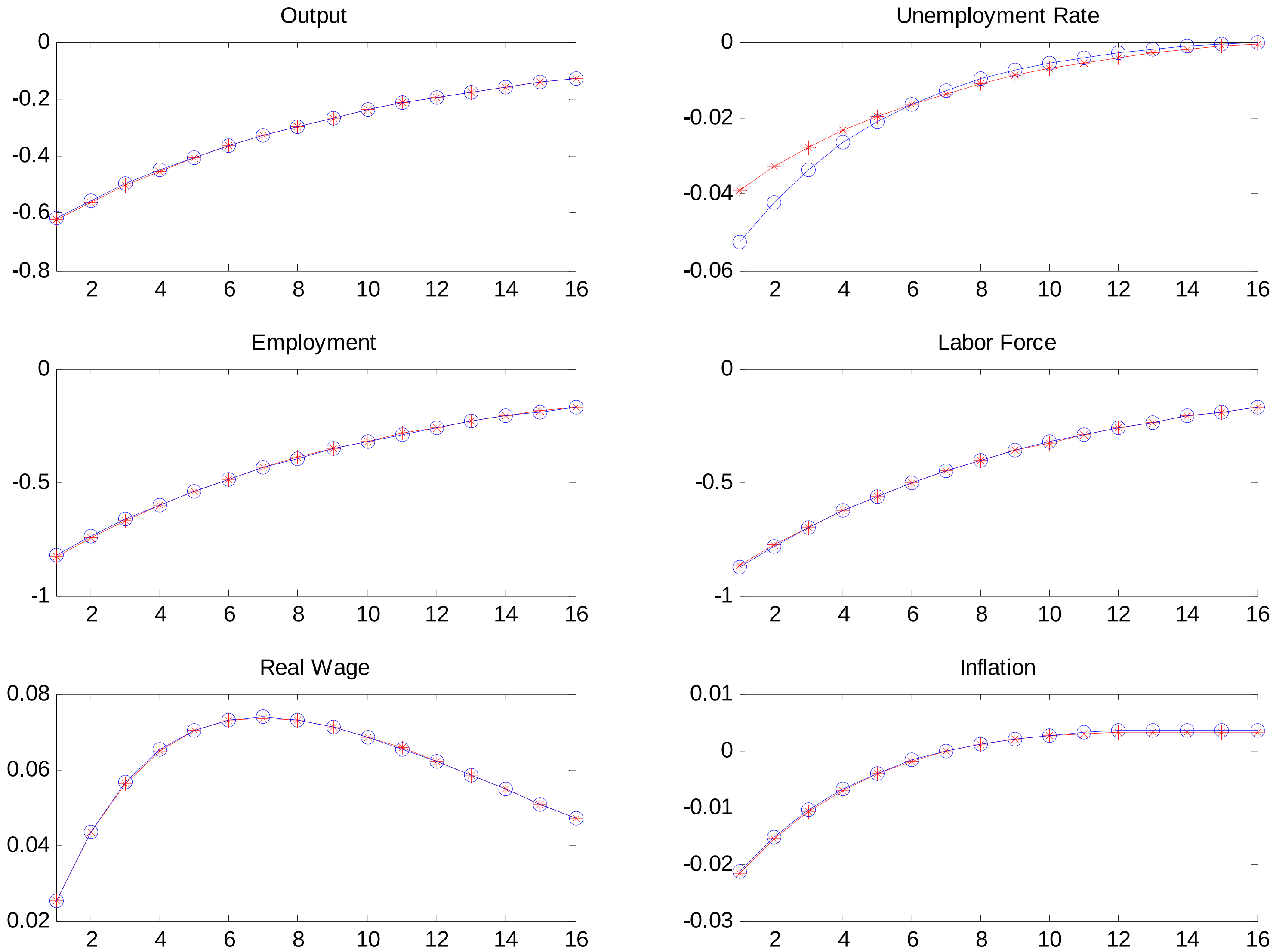


Figure 10a . Dynamic Responses to a Technology Shock: Simple Rule

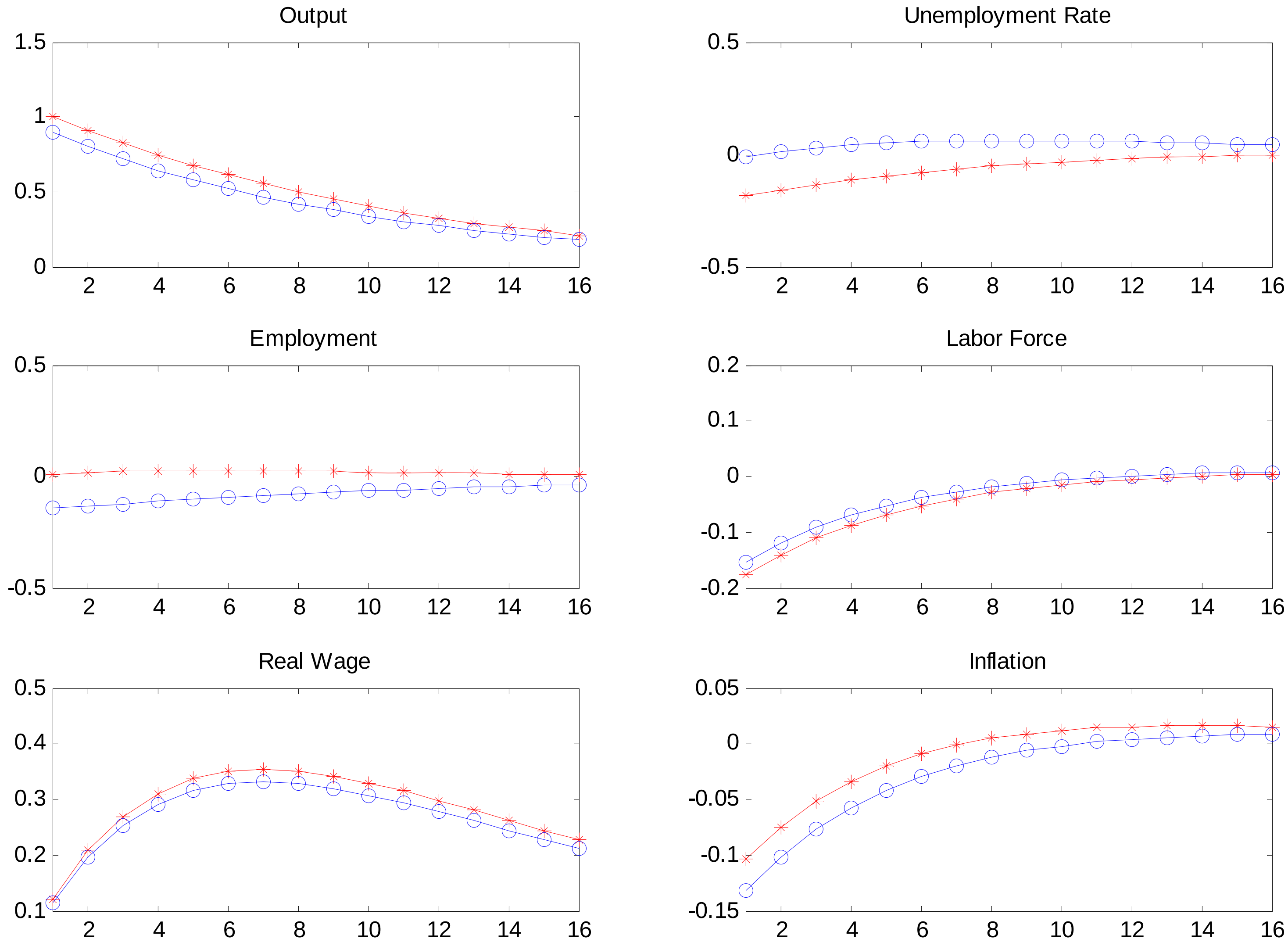
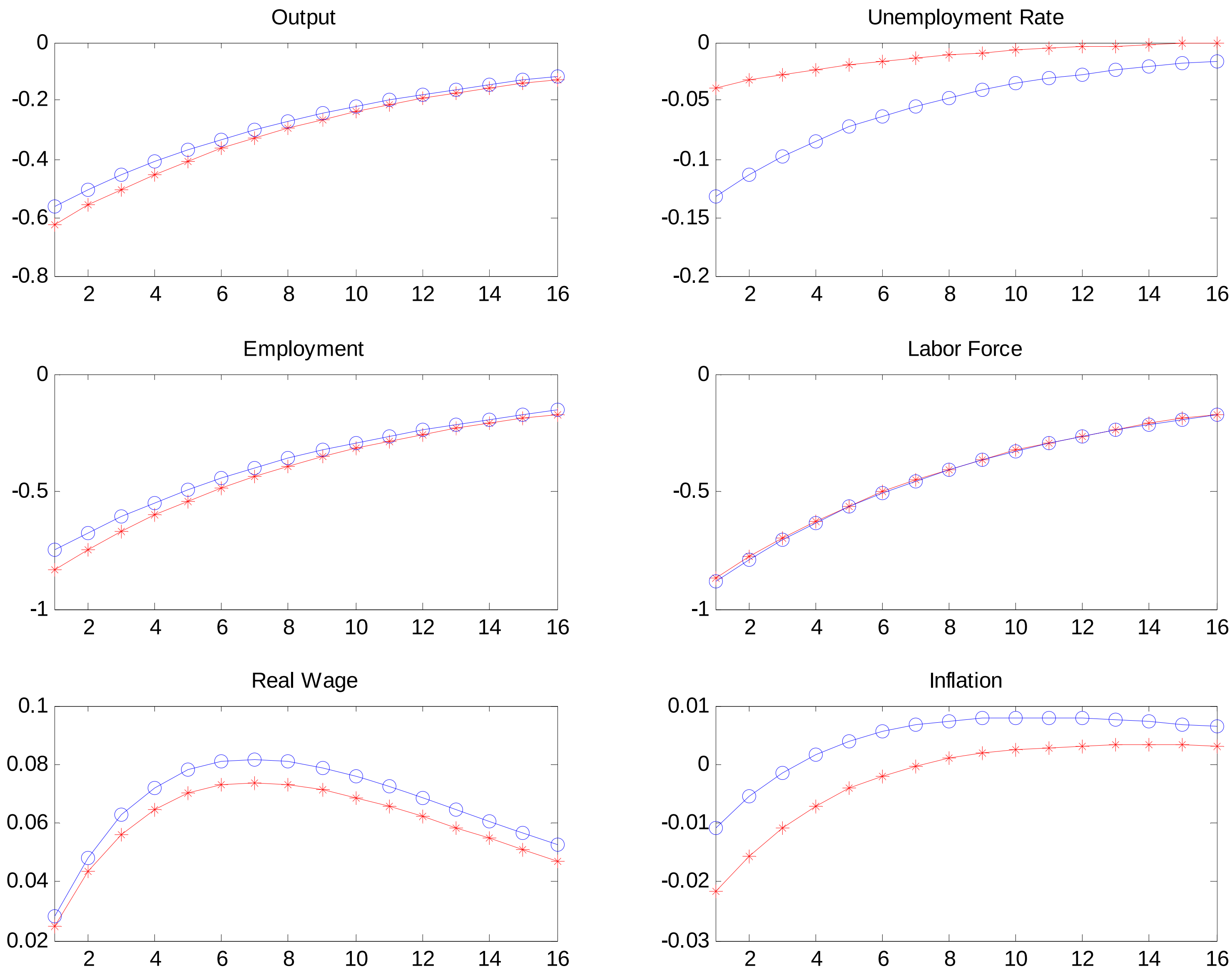


Figure 10b . Dynamic Responses to a Labor Supply Shock: Simple Rule



Empirical Performance of the Simple Rule

- Empirical Performance of a Simple Rule

$$i_t = r + \pi^* + 1.5\ (\pi_t^p - \pi^*) - 2\ (u_t - u^*)$$

- Calibration:

$r = 2\%$ $\qquad \pi^* = 1.5\%$
$u^* = 6\%$ (U.S., 1987Q3-1998Q4)
$u^* = 5\%$ (U.S., 1999Q1-2009Q4)
$u^* = 8.5\%$ (Euro area, 1999Q1-2009Q4)

- Benchmark: The Taylor rule

$$i_t = 4 + 1.5\ (\pi_t^p - 2) + 0.5\ \widehat{y}_t$$

Figure 11a . Monetary Policy in the Greenspan-Bernanke Era (1987Q3-2009Q4)

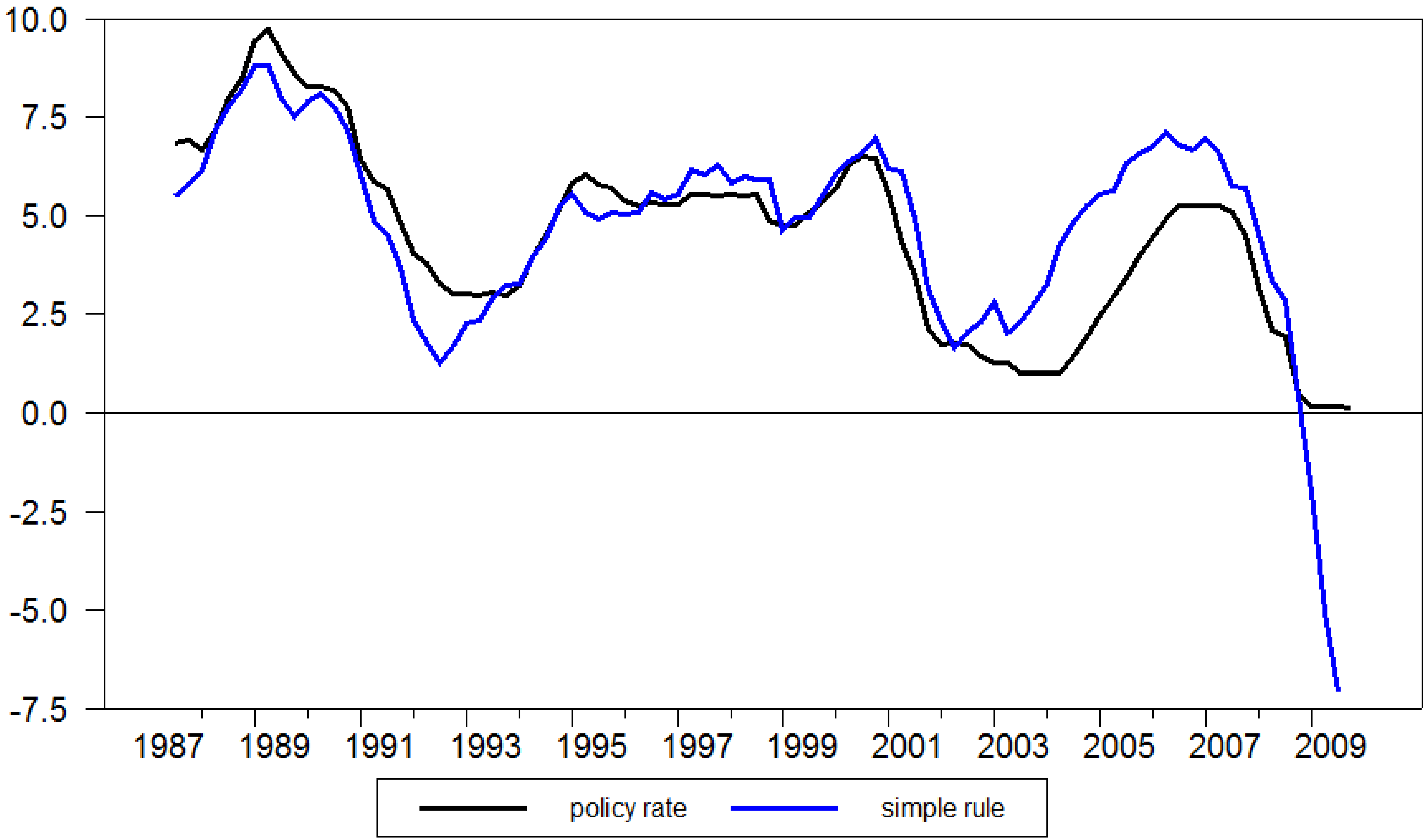


Figure 11b . Monetary Policy in the Greenspan-Bernanke Era (1987Q3-2008Q4)

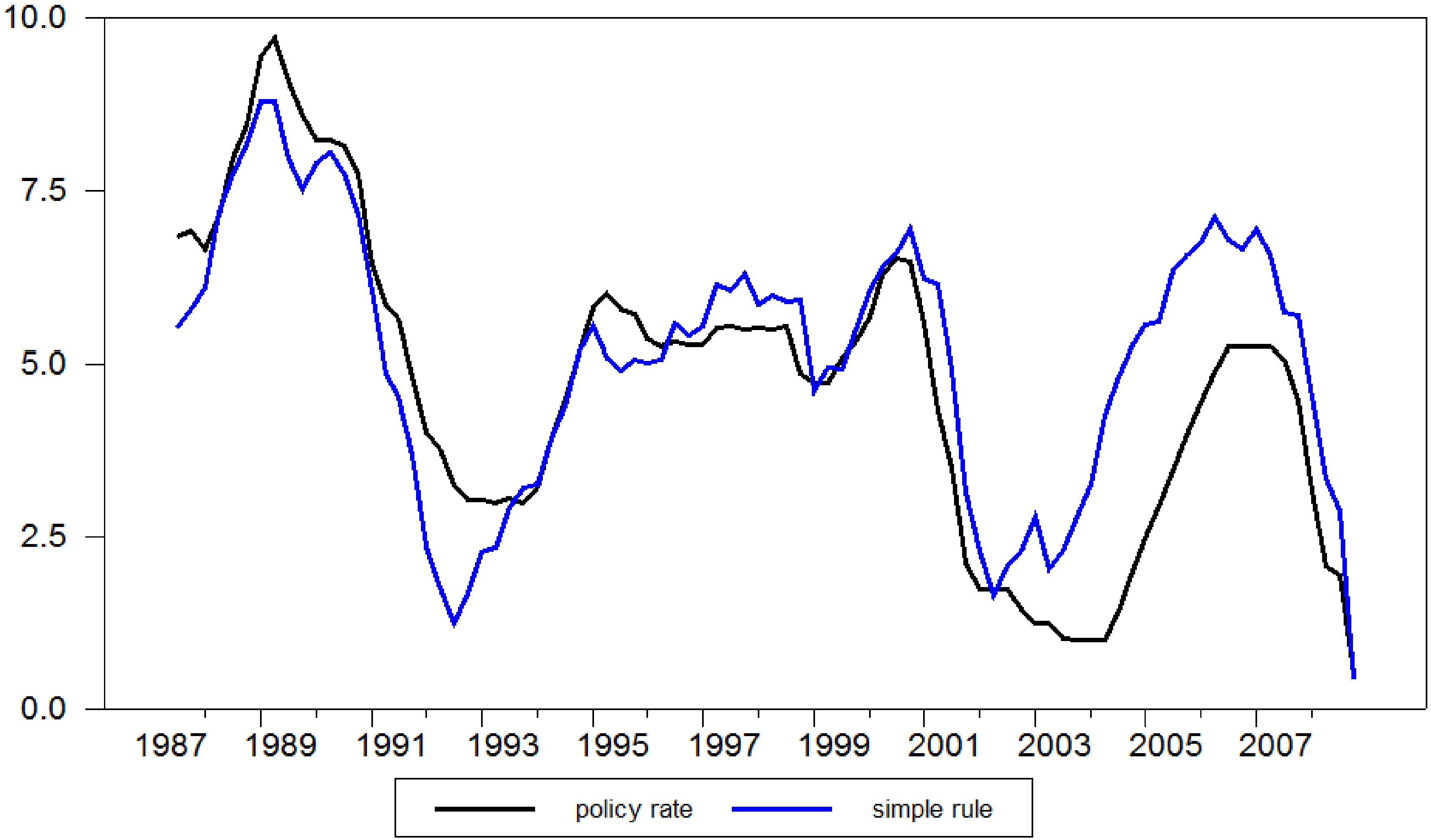


Figure 11c . Monetary Policy in the Greenspan-Bernanke Era (1987Q3-2008Q4)

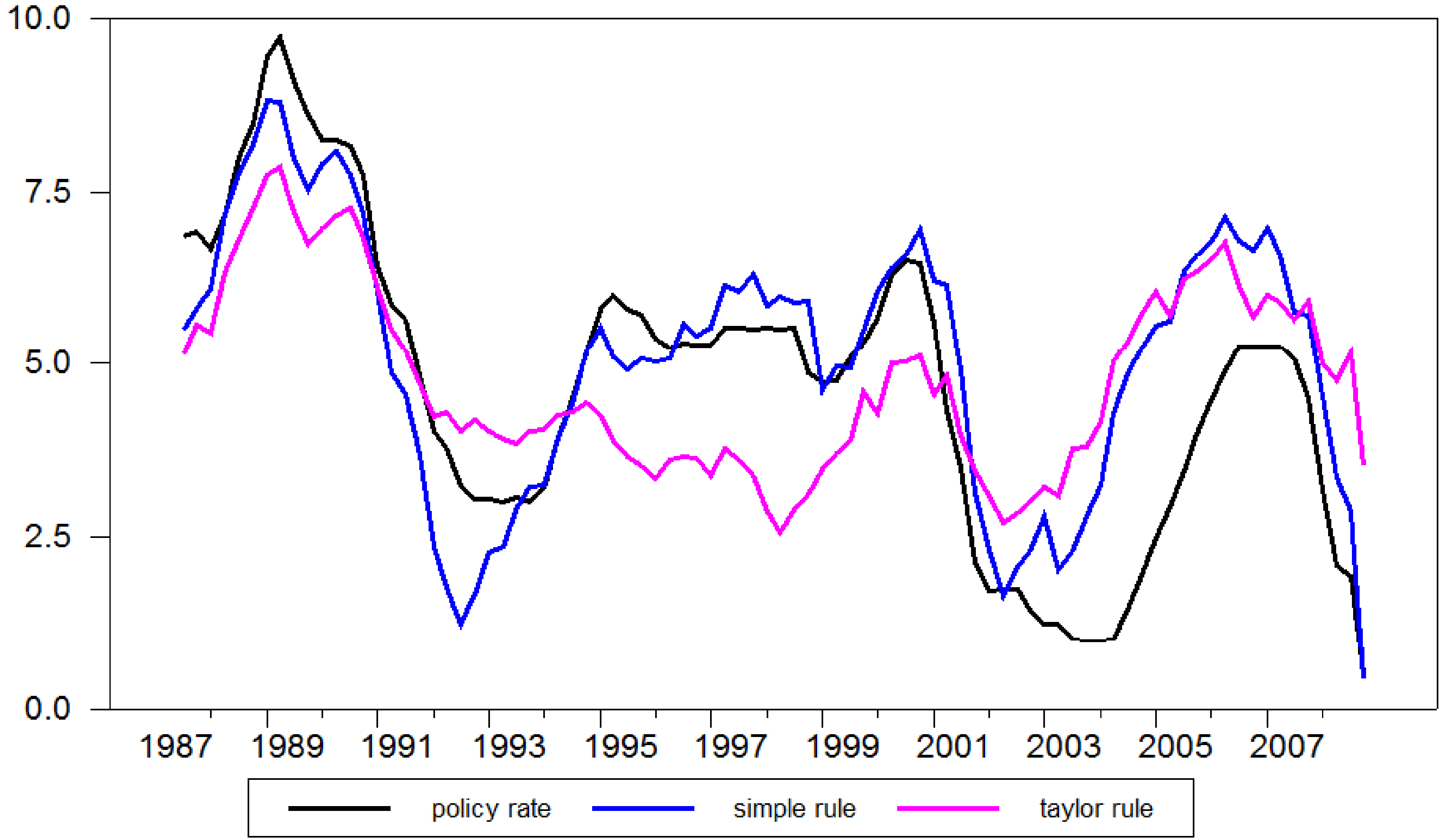


Figure 12 . Monetary Policy in the Euro Area (1999Q1-2008Q4)