Sticky Wages and Monetary Policy

by

Jordi Galí

August 2009

Alternative Labor Market Specifications

- Competitive labor markets

$$w_t - p_t = mrs_t$$

where $mrs_t = \sigma \ c_t + \varphi \ n_t$.

- General labor market imperfections

$$w_t - p_t = \mu_t^w + mrs_t$$

where μ_t^w: (log) wage markup.

Example: monopolistic unions, flexible wages, and isoelastic labor demand:

$$\mu_t^w = \log\left(\frac{\epsilon_w}{\epsilon_w - 1}\right) \equiv \mu^w$$

Implications for Inflation Dynamics

Recall

$$\pi_t^p = \beta E_t\{\pi_{t+1}^p\} + \lambda_p \, \widehat{mc}_t$$

Now

$$\begin{aligned} mc_t &= w_t - p_t - a_t \\ &= \mu_t^w + mrs_t - a_t \\ &= \mu_t^w + (\sigma + \varphi) \, y_t - (1 + \varphi) \, a_t \end{aligned}$$

Thus,

$$\widehat{mc}_t = (\sigma + \varphi) \, (y_t - y_t^n) + (\mu_t^w - \mu^w)$$

Implied inflation equation:

$$\pi_t^p = \beta E_t\{\pi_{t+1}^p\} + \kappa_p \, \widetilde{y}_t + \lambda_p \, \widehat{\mu}_t^w$$

$\Longrightarrow$ tradeoff between inflation and output gap stabilization

The Erceg-Henderson-Levin Model

- Fraction of households/trade unions adjusting nominal wage: $1-\theta_w$
- Constant elasticity of labor demand ϵ_w
- Aggregate wage dynamics

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

- Optimal wage setting rule:

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

- Implied wage inflation equation

$$\pi_t^w = \beta \; E_t\{\pi_{t+1}^w\} - \lambda_w \; \widehat{\mu}_t^w \tag{1}$$

where $\lambda_w \equiv \frac{(1-\beta\theta_w)(1-\theta_w)}{\theta_w \; (1+\varphi\epsilon_w)}$

Equilibrium

Define *real wage gap:*

$$\widetilde{\omega}_t \equiv \omega_t - \omega_t^n$$

Price markups vs. output and real wage gaps:

$$\begin{aligned} \widehat{\mu}_t^p &= (mpn_t - \omega_t) - \mu^p \\ &= (\widetilde{y}_t - \widetilde{n}_t) - \widetilde{\omega}_t \\ &= -\frac{\alpha}{1-\alpha}\,\widetilde{y}_t - \widetilde{\omega}_t \end{aligned} \tag{2}$$

Recall:

$$\pi_t^p = \beta\ E_t\{\pi_{t+1}^p\} - \lambda_p\ \widehat{\mu}_t^p$$

Combined with (2):

$$\pi_t^p = \beta\ E_t\{\pi_{t+1}^p\} + \kappa_p\ \widetilde{y}_t + \lambda_p\ \widetilde{\omega}_t \tag{3}$$

where $\kappa_p \equiv \frac{\alpha\lambda_p}{1-\alpha}$.

Wage markups vs. output and real wage gaps:

$$\begin{aligned} \widehat{\mu}_t^w &= \omega_t - mrs_t - \mu^w \\ &= \widetilde{\omega}_t - (\sigma \widetilde{y}_t + \varphi \widetilde{n}_t) \\ &= \widetilde{\omega}_t - \left(\sigma + \frac{\varphi}{1-\alpha}\right) \widetilde{y}_t \end{aligned} \tag{4}$$

Combining (1) and (4):

$$\pi_t^w = \beta E_t\{\pi_{t+1}^w\} + \kappa_w \, \widetilde{y}_t - \lambda_w \, \widetilde{\omega}_t \tag{5}$$

where $\kappa_w \equiv \lambda_w \left(\sigma + \frac{\varphi}{1-\alpha}\right)$.

Wage gap identity:

$$\widetilde{\omega}_{t-1} \equiv \widetilde{\omega}_t - \pi_t^w + \pi_t^p + \Delta\omega_t^n \tag{6}$$

Dynamic IS equation

$$\widetilde{y}_t = -\frac{1}{\sigma}\left(i_t - E_t\{\pi_{t+1}^p\} - r_t^n\right) + E_t\{\widetilde{y}_{t+1}\} \tag{7}$$

Interest Rate Rule:

$$i_t = \rho + \phi_p\ \pi_t^p + \phi_w\ \pi_t^w + \phi_y\ \widetilde{y}_t + v_t \tag{8}$$

Dynamical system:

$$\mathbf{x}_t = \mathbf{A}_w \; E_t\{\mathbf{x}_{t+1}\} + \mathbf{B}_w \; \mathbf{z}_t \tag{9}$$

where

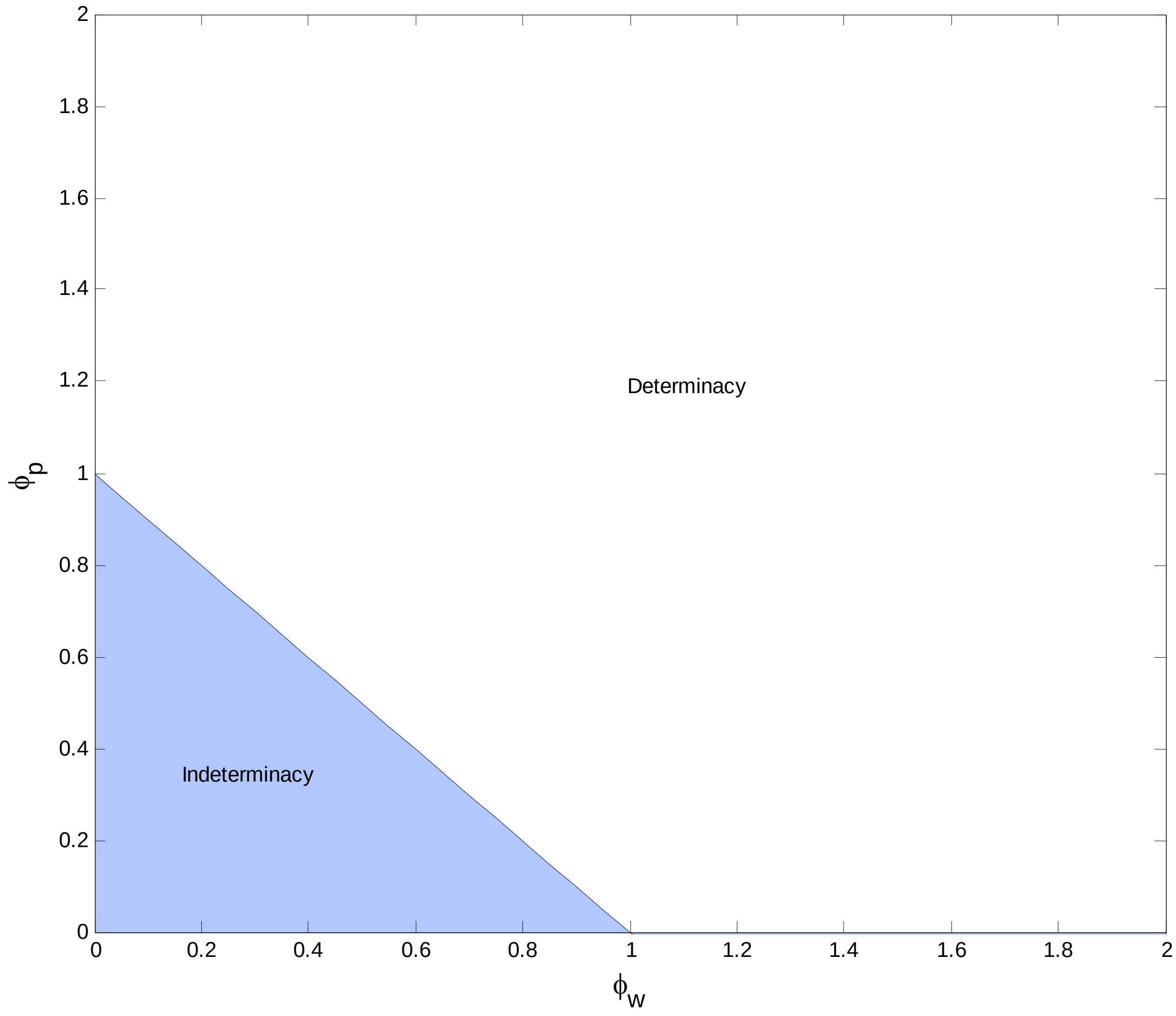
$$\mathbf{x}_t \equiv [\widetilde{y}_t, \; \pi_t^p, \; \pi_t^w, \; \widetilde{\omega}_{t-1}]'$$
$$\mathbf{z}_t \equiv [\widehat{r}_t^n - v_t, \; \Delta\omega_t^n]'$$

Conditions for uniqueness of the equilibrium

Particular case ($\phi_y = 0$):

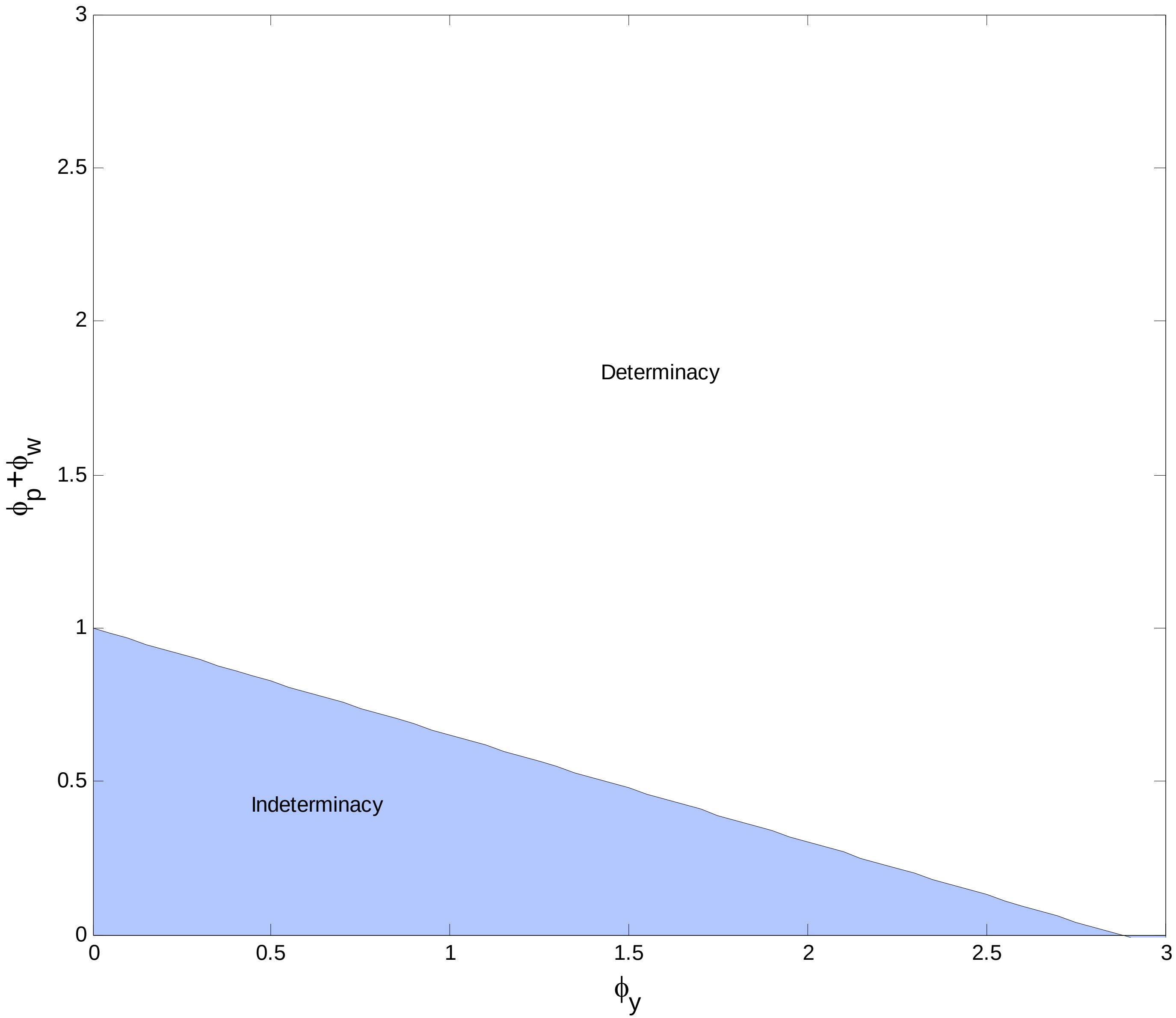
$$\phi_p + \phi_w > 1$$

Figure 6.1



Determinacy
Indeterminacy
ϕ_p
ϕ_w
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2

Figure 6.2



Dynamic Responses to a Monetary Policy Shock

Interest rate rule: $\phi_p = 1.5$, $\phi_y = \phi_w = 0$, $\rho_v = 0.5$

Three calibrations:

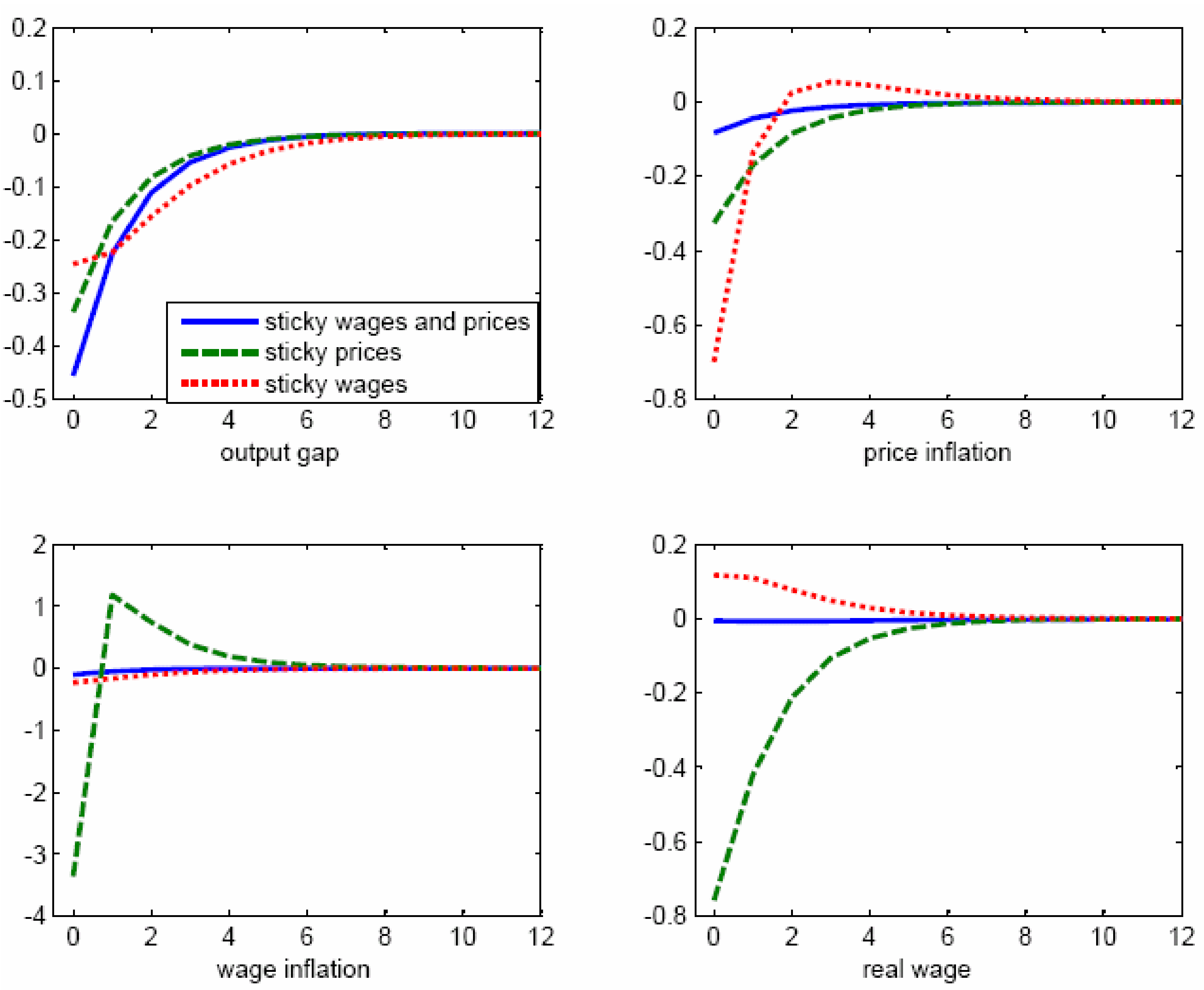
Baseline: $\theta_p = 2/3$, $\theta_w = 3/4$

Flexible wage: $\theta_p = 2/3$, $\theta_w = 0$

Flexible price: $\theta_p = 0$, $\theta_w = 3/4$

Figure 6.3

Figure 6.3: Sticky Wages and the Effects of a Monetary Policy Shock



Monetary Policy Design

- Emergence of a tradeoff between output gap and inflation stabilization
- Frictionless equilibrium allocation is no longer feasible (as long as it requires real wage changes)
- Welfare losses (second order approximation)

$$\mathbb{L} = \left(\sigma + \frac{\varphi + \alpha}{1 - \alpha}\right) \, var(\widetilde{y}_t) + \frac{\epsilon_p}{\lambda_p} \, var(\pi_t^p) + \frac{\epsilon_w (1 - \alpha)}{\lambda_w} \, var(\pi_t^w)$$

$\Longrightarrow$ strict price inflation targeting is no longer optimal

Optimal Monetary Policy

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

subject to

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

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

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

Optimality conditions:

$$\left(\sigma + \frac{\varphi + \alpha}{1 - \alpha}\right)\ \widetilde{y}_t + \kappa_p\ \xi_{1,t} + \kappa_w\ \xi_{2,t} = 0 \tag{10}$$

$$\frac{\epsilon_p}{\lambda_p}\ \pi_t^p - \Delta\xi_{1,t} + \xi_{3,t} = 0 \tag{11}$$

$$\frac{\epsilon_w(1-\alpha)}{\lambda_w}\ \pi_t^w - \Delta\xi_{2,t} - \xi_{3,t} = 0 \tag{12}$$

$$\lambda_p\ \xi_{1,t} - \lambda_w\ \xi_{2,t} + \xi_{3,t} - \beta E_t\{\xi_{3,t+1}\} = 0 \tag{13}$$

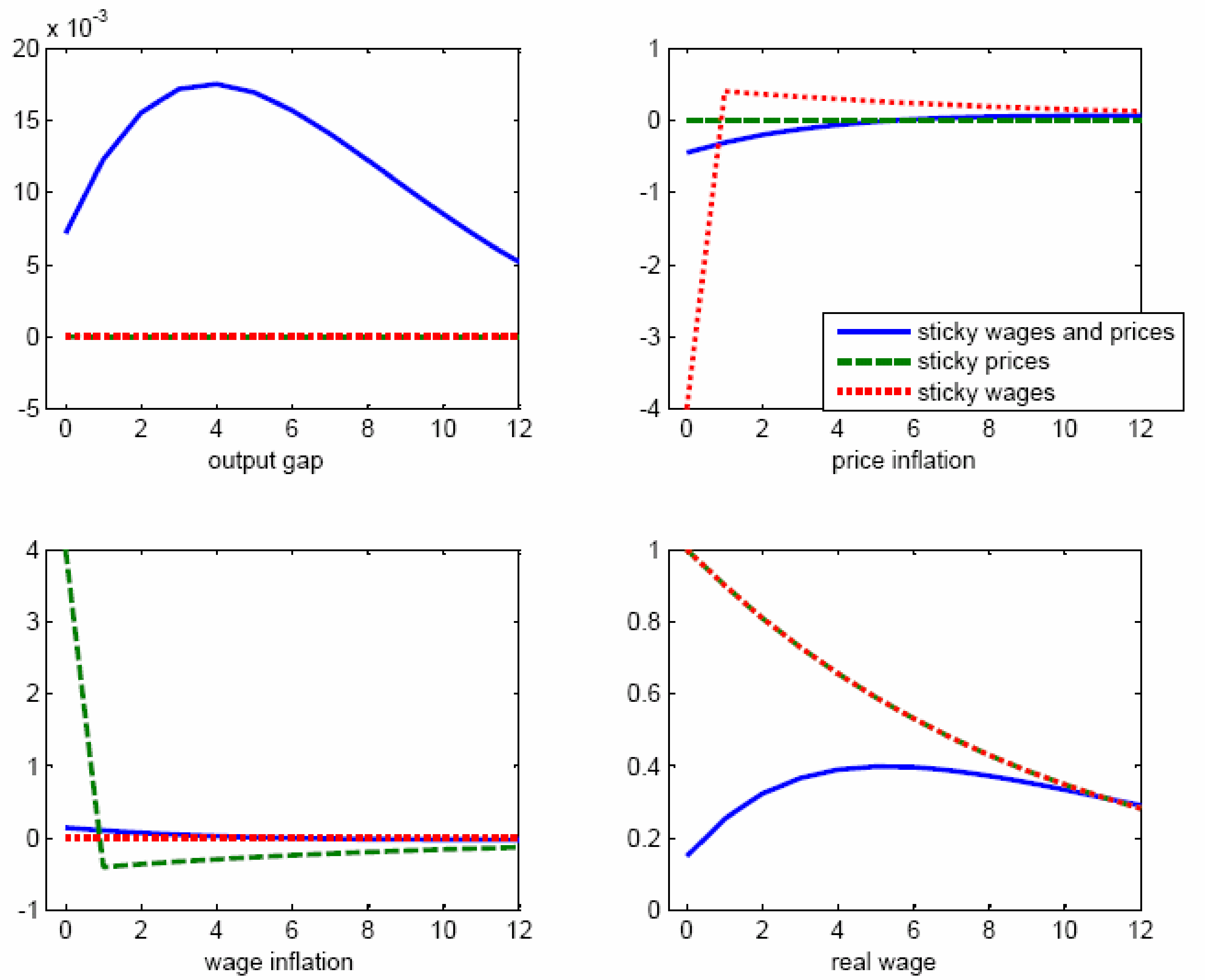
Combined with (3), (5), and (6):

$$\mathbf{A}_0^* \, \mathbf{x}_t = \mathbf{A}_\mathbf{1}^* \, E_t\{\mathbf{x}_{t+1}\} + \mathbf{B}^* \, \Delta a_t$$

where $\mathbf{x}_t \equiv [\widetilde{y}_t, \; \pi_t^p, \; \pi_t^w, \, \widetilde{\omega}_{t-1}, \, \xi_{1,t-1}, \; \xi_{2,t-1}, \; \xi_{3,t}]'$

Dynamic Responses to a Technology Shock (Figure 6.4)

Figure 6.4: The Effects of a Technology Shock under the Optimal Policy



Approximately Optimal Monetary Policy

Composite inflation

$$\pi_t = \beta \, E_t\{\pi_{t+1}\} + \kappa \, \widetilde{y}_t$$

where

$$\pi_t \equiv (1-\vartheta) \, \pi_t^p + \vartheta \, \pi_t^w$$

with $\vartheta \equiv \frac{\lambda_p}{\lambda_p+\lambda_w} \in [0,1]$ and $\kappa \equiv \frac{\lambda_p \lambda_w}{\lambda_p+\lambda_w} \left(\sigma + \frac{\varphi+\alpha}{1-\alpha}\right)$

$\Longrightarrow$ no policy tradeoff

$\Longrightarrow$ stabilization of π_t is optimal if $\frac{\alpha \lambda_p}{1-\alpha} = \lambda_w \left(\sigma + \frac{\varphi}{1-\alpha}\right)$ and $\epsilon_p = \epsilon_w(1-\alpha)$

.. but nearly optimal for plausible calibrations

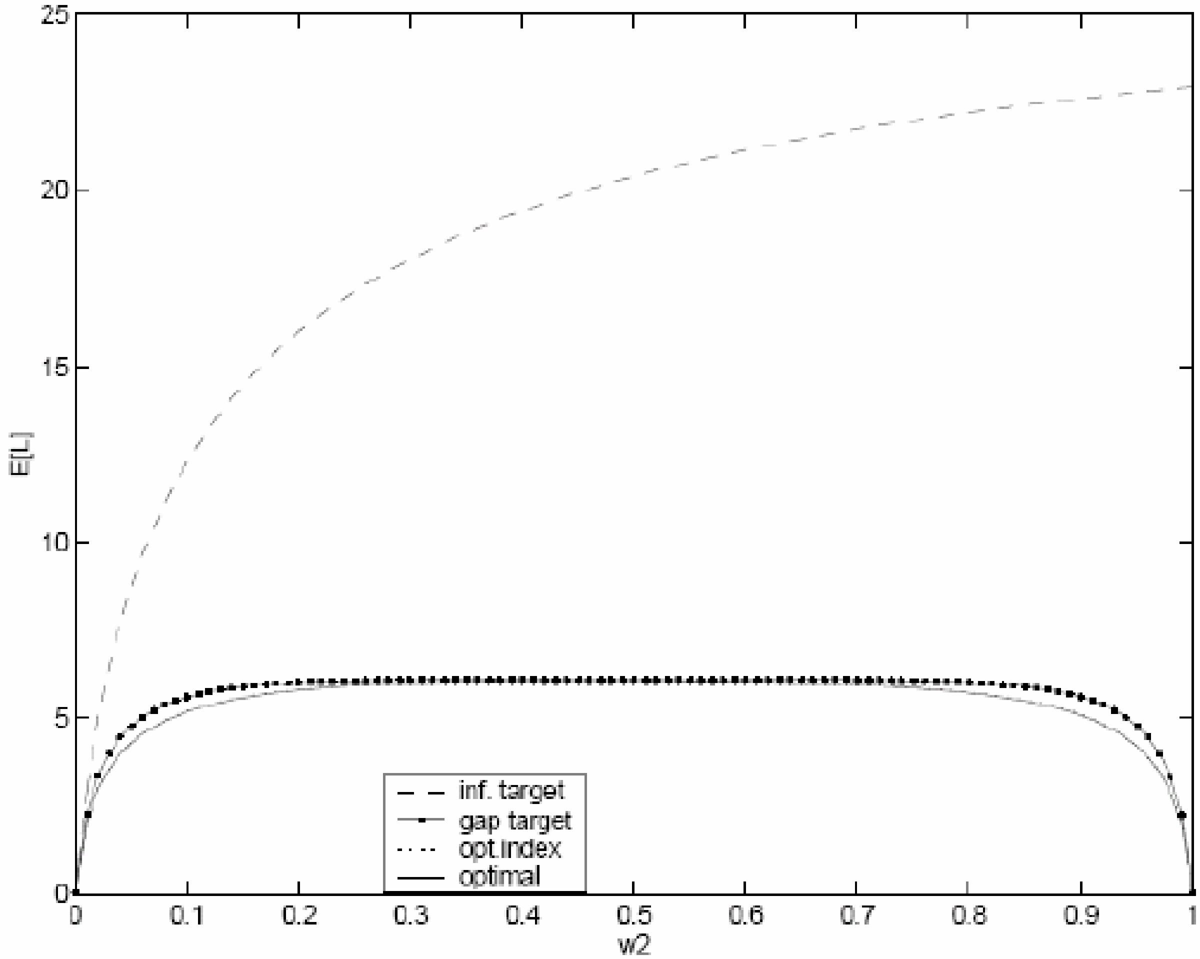


Figure 6.4: Welfare losses under alternative policies with sticky wages and prices.

Woodford (2003)