Unemployment, the Output Gap and the Design of Monetary Policy

Jordi Galí

CREI, UPF and Barcelona GSE

Zeuthen Lectures II and III

Two Views about Economic Fluctuations

- "Keynesian"

  - ugly face of capitalism
  - recessions as periods in which the economy operates below the *efficient* level of activity and resource utilization.
  - calls for stabilization policies

- "RBC"

  - cyclical fluctuations as the economy's efficient response to a variety of exogenous disturbances
  - stabilization policies likely to be counterproductive

Two Views about Economic Fluctuations

- "Keynesian"

  - ugly face of capitalism
  - recessions as periods in which the economy operates below the *efficient* level of activity and resource utilization.
  - calls for stabilization policies

- "RBC"

  - cyclical fluctuations as the economy's efficient response to a variety of exogenous disturbances
  - stabilization policies likely to be counterproductive

- Challenge: unobservability of the *efficient* level of output and, hence, of the *output gap*.

What I Do

- A new measure of the *output gap* consistent with a broad class of models, including the standard New Keynesian framework
- Main novelty: I exploit the connection between the unemployment rate and the wage markup
- Implications for welfare
- Evidence based on quarterly data for the U.S. and the Euro area

A New Measure of the Output Gap

- Underlying framework: deviations from efficient output are the result of

  - market power by firms and workers
  - variations in average wage and price markups (e.g. due to nominal rigidities)

- Average price markup

$$\mathcal{M}_t^p = \frac{P_t}{\frac{W_t}{(1-\alpha)(Y_t/N_t)}}$$

- Average wage markup

$$\mathcal{M}_t^w = \frac{W_t/P_t}{\chi_t C_t N_t^{\varphi}}$$

- Goods market clearing condition:

$$C_t = Y_t$$

- Equilibrium employment and output

$$N_t = \left(\frac{1-\alpha}{\mathcal{M}_t \chi_t} \right)^{\frac{1}{1+\varphi}}$$

$$Y_t = A_t \left(\frac{1-\alpha}{\mathcal{M}_t \chi_t} \right)^{\frac{1-\alpha}{1+\varphi}}$$

where $\mathcal{M}_t \equiv \mathcal{M}_t^p \mathcal{M}_t^w \geq 1$ is a *composite markup*.

- Efficient employment and output: $\mathcal{M}_t = 1$, for all t

$$N_t^e = \left(\frac{1-\alpha}{\chi_t} \right)^{\frac{1}{1+\varphi}}$$

$$Y_t^e = A_t \left(\frac{1-\alpha}{\chi_t} \right)^{\frac{1-\alpha}{1+\varphi}}$$

- Output gap

$$x_t \equiv y_t - y_t^e = -\left(\frac{1-\alpha}{1+\varphi} \right) (\mu_t^p + \mu_t^w)$$

where $\mu_t^p \equiv \log \mathcal{M}_t^p$ and $\mu_t^w \equiv \log \mathcal{M}_t^w$

Measuring the Price Markup

- Following Rotemberg and Woodford (1999)

$$\begin{aligned}\mathcal{M}_t^p &= \frac{P_t}{\frac{W_t}{(1-\alpha)(Y_t/N_t)}} \\ &= (1-\alpha)\,\frac{P_t Y_t}{W_t N_t} \\ &= \frac{1-\alpha}{S_t}\end{aligned}$$

Implying

$$\mu_t^p = -s_t + \log(1-\alpha)$$

Measuring the Wage Markup

- 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: $\chi_t j^{\varphi}$, 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 $\chi_t \equiv \exp\{\xi_t\}$ is a preference shifter.

Measuring the Wage Markup

- 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 $L_t(i)$:

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

- 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 (log) *labor force.*

Measuring the Wage Markup

- Unemployment rate

$$u_t \equiv l_t - n_t$$

- Average wage markup:

$$\mathcal{M}_t^w = \frac{W_t / P_t}{\chi_t C_t N_t^{\varphi}}$$

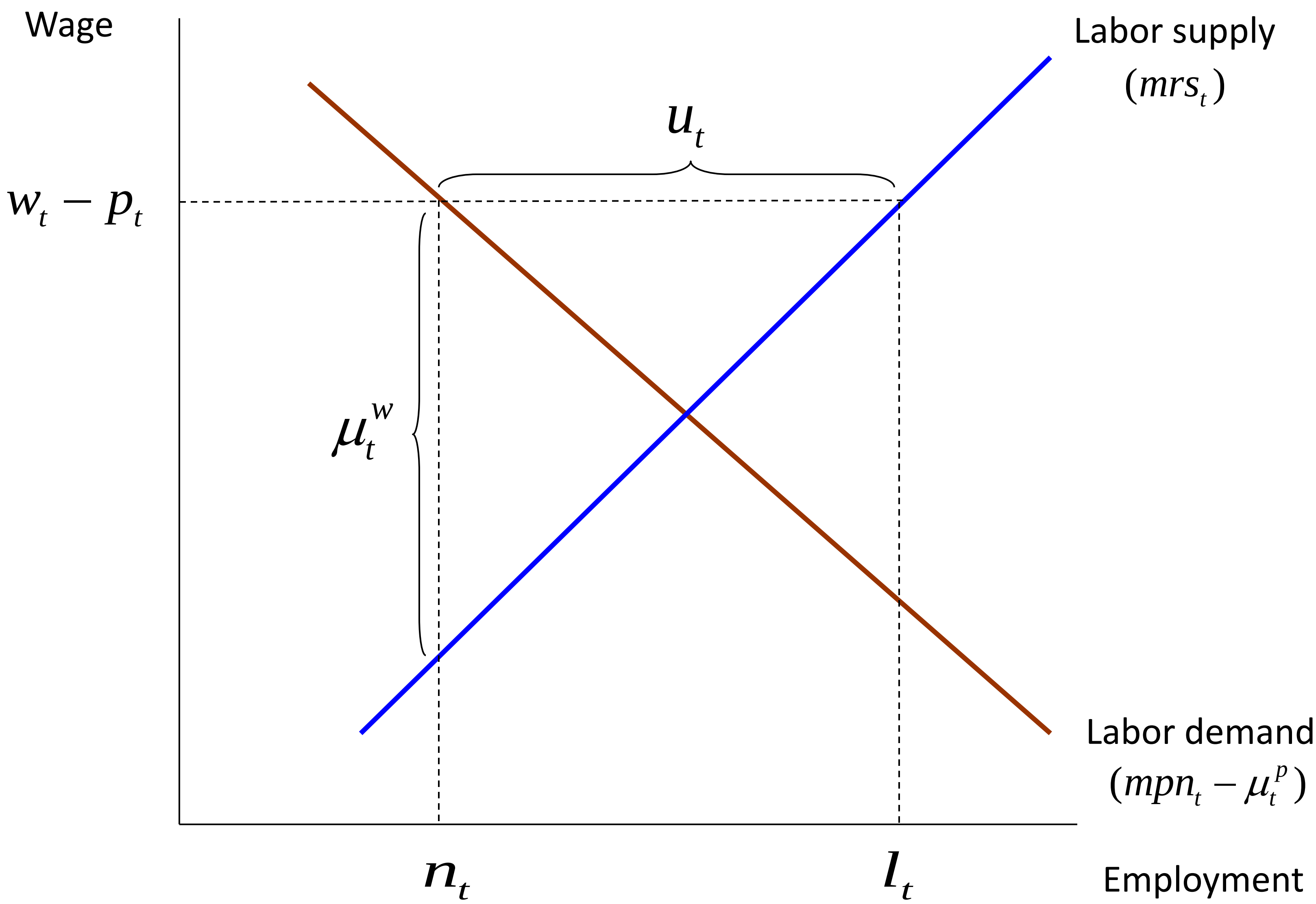
implying

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

- Relation robust to:

- alternative specifications of the wage setting process
- time-varying desired wage markups
- the presence of unobservable preference shocks (vs. GGL or CKM).
- alternative specifications of the utility function with smaller wealth effects (see Galí-Smets-Wouters)

Figure 1.1: The Wage Markup and the Unemployment Rate



Measuring the Output Gap

- Proposed Output Gap Measure

$$\begin{aligned} x_t &\equiv y_t - y_t^e \\ &= -\left(\frac{1-\alpha}{1+\varphi}\right)(\mu_t^p + \mu_t^w) \\ &= \left(\frac{1-\alpha}{1+\varphi}\right)(s_t - \varphi u_t - \log(1-\alpha)) \end{aligned}$$

- Calibration

Technology: $\alpha = 0.25$
- consistent with $\mathcal{M}^p = 1.2$, given $\alpha = 1 - S\mathcal{M}^p$ and $S = 0.62$
- alternative: $\alpha = 0.38$ (maximum consistent with non-negative markup)

Preferences: $\varphi = 5$
- implied Frisch labor supply elasticity: 0.2
- alternatives: $\varphi = 1$ (high elasticity) and $\varphi = 10$ (low elasticity)

- Evidence

Figure 2.1 : The U.S. Output Gap

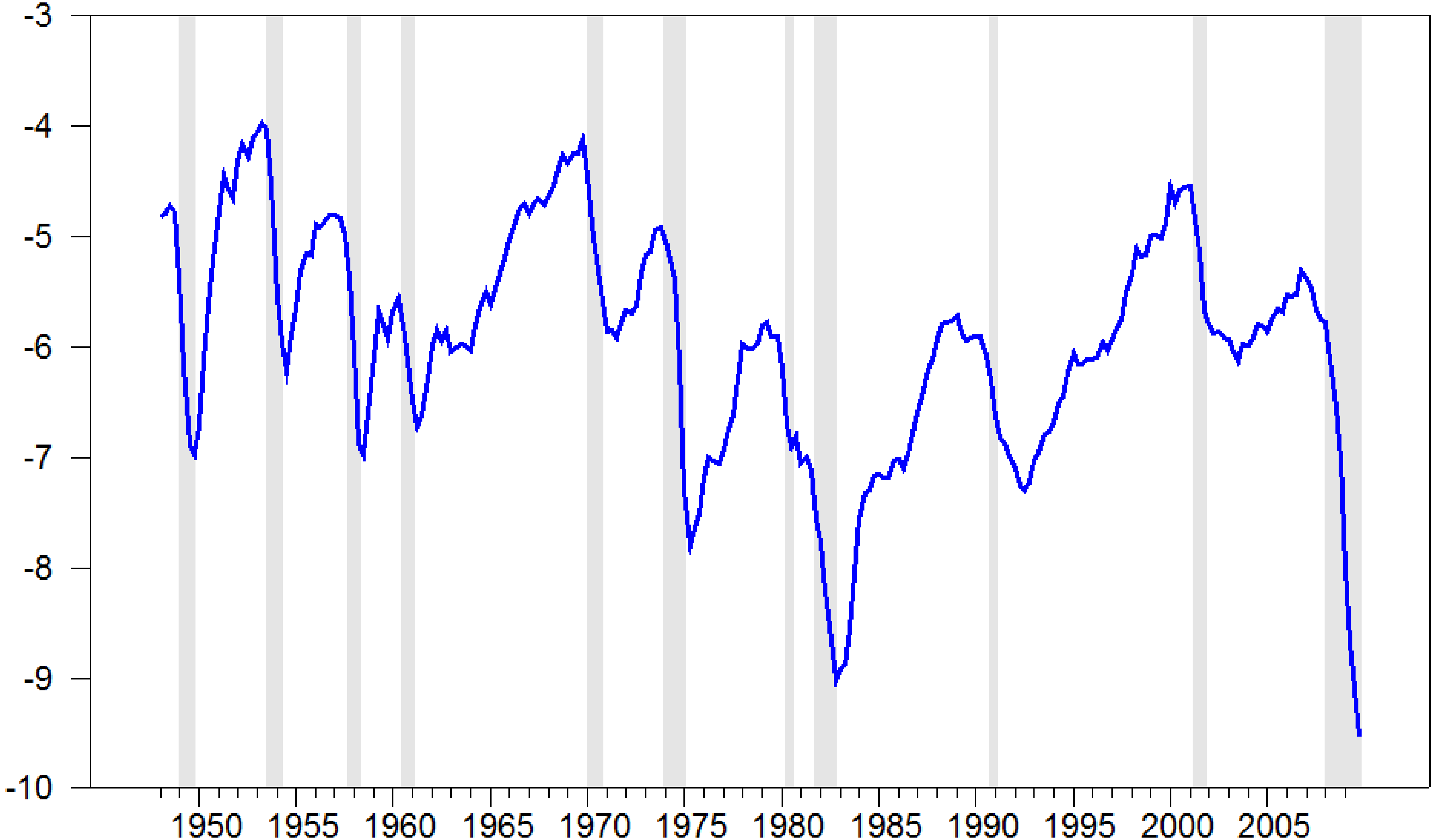


Figure 2.2: The Euro Area Output Gap

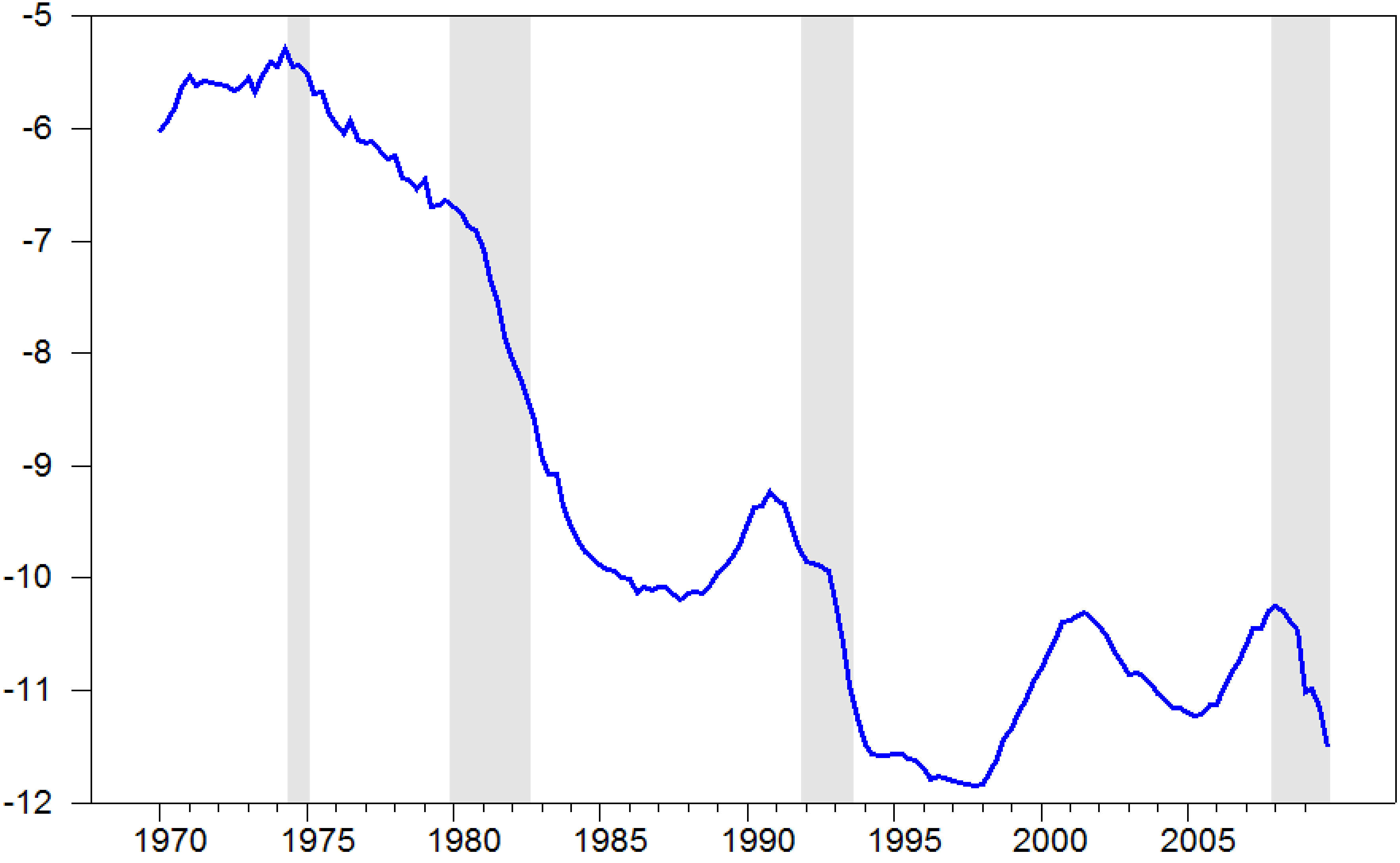


Figure 2.3: The U.S. Output Gap and its Components

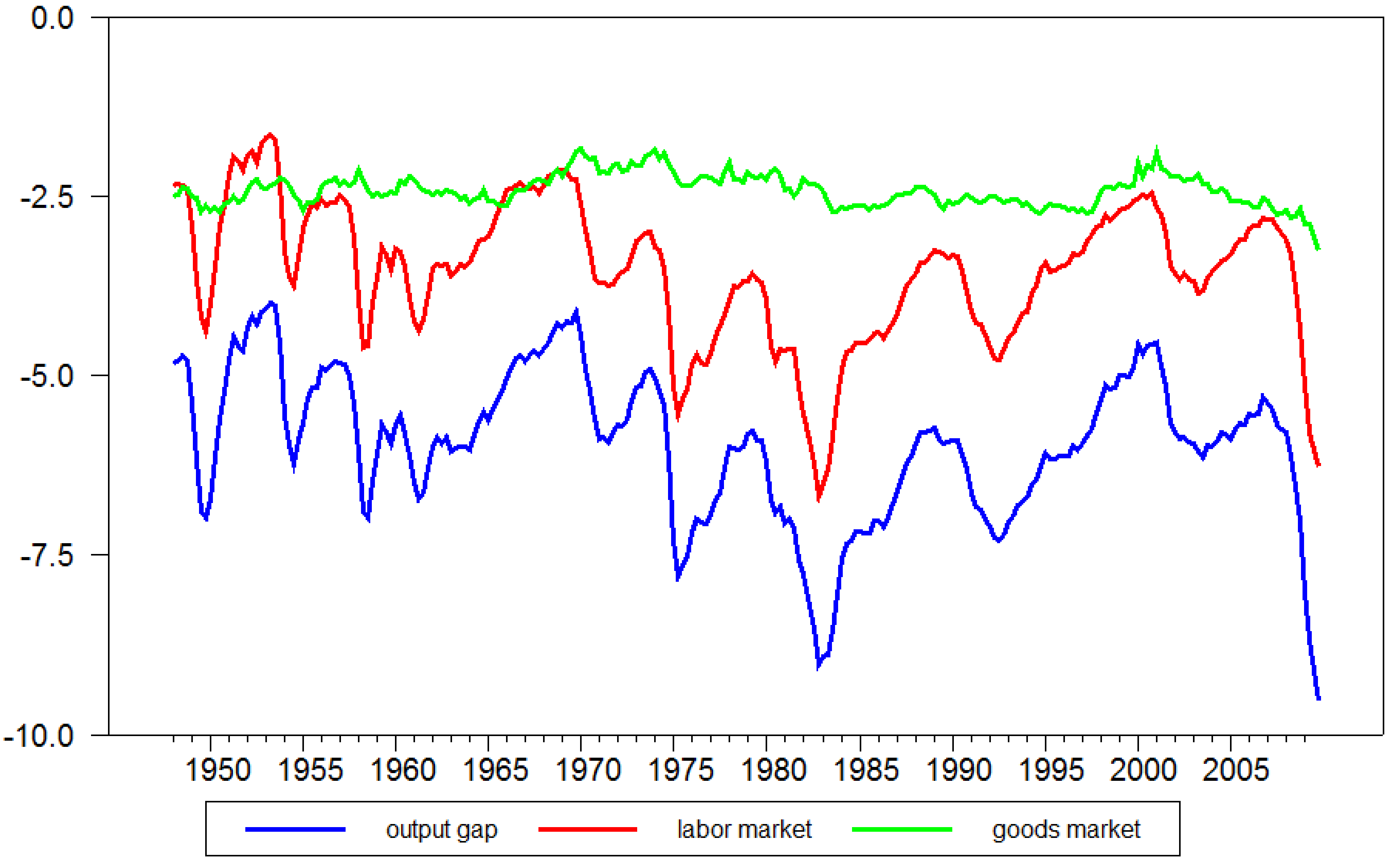


Figure 2.4: The Euro Area Output Gap and its Components

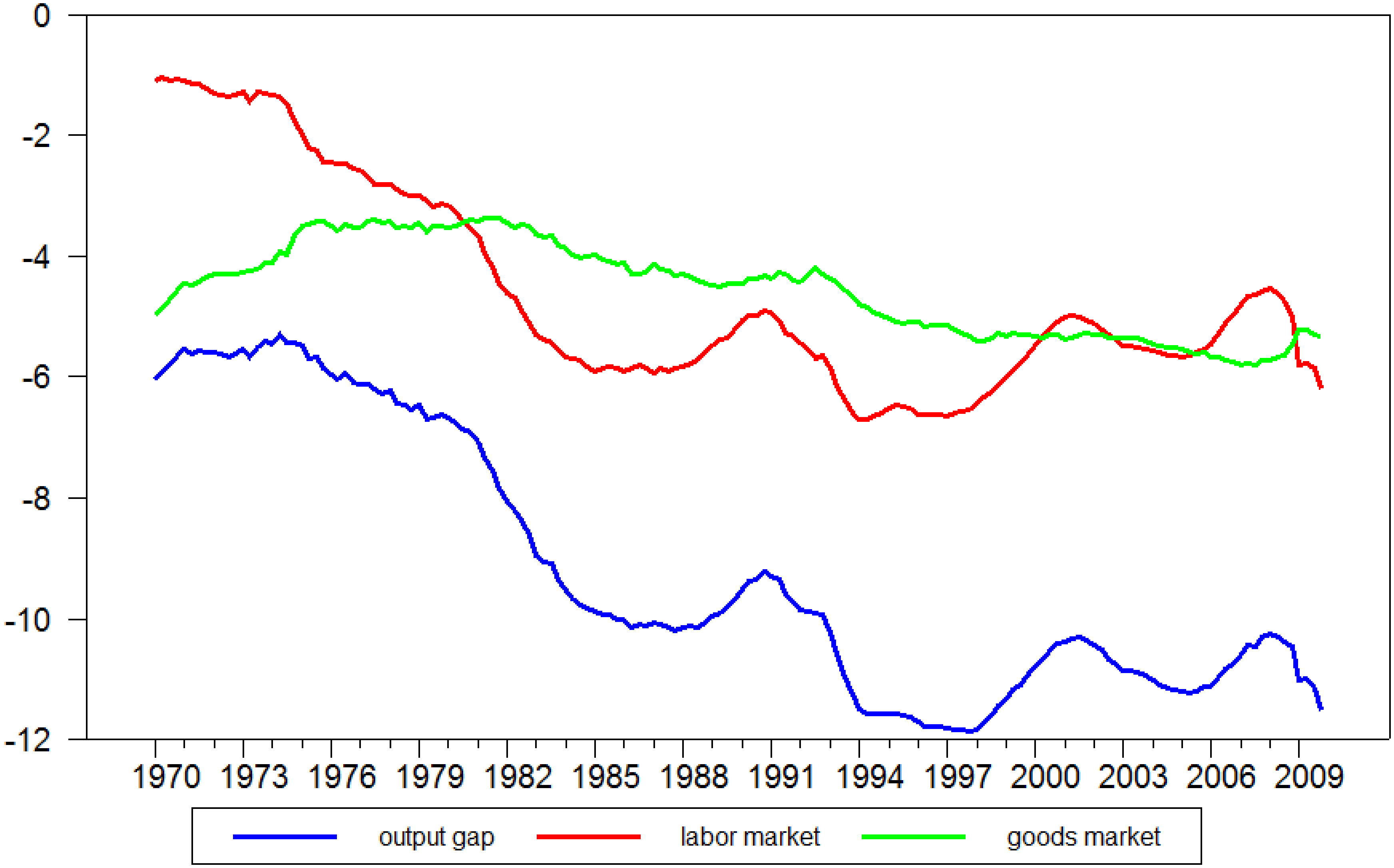


Figure 2.7: The U.S. Output Gap: The Impact of α

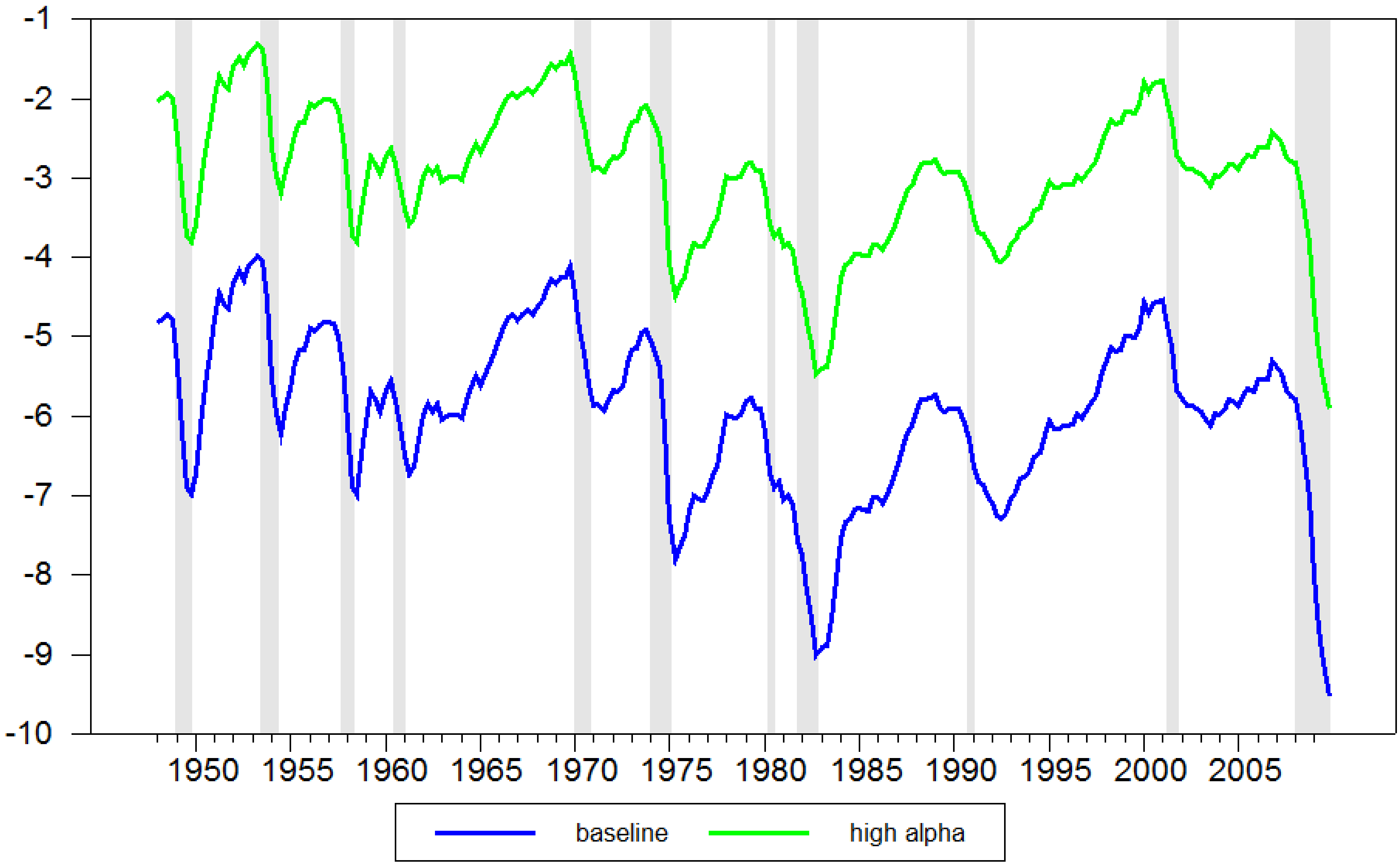


Figure 2.8: The U.S. Output Gap: Alternative Frisch Elasticities

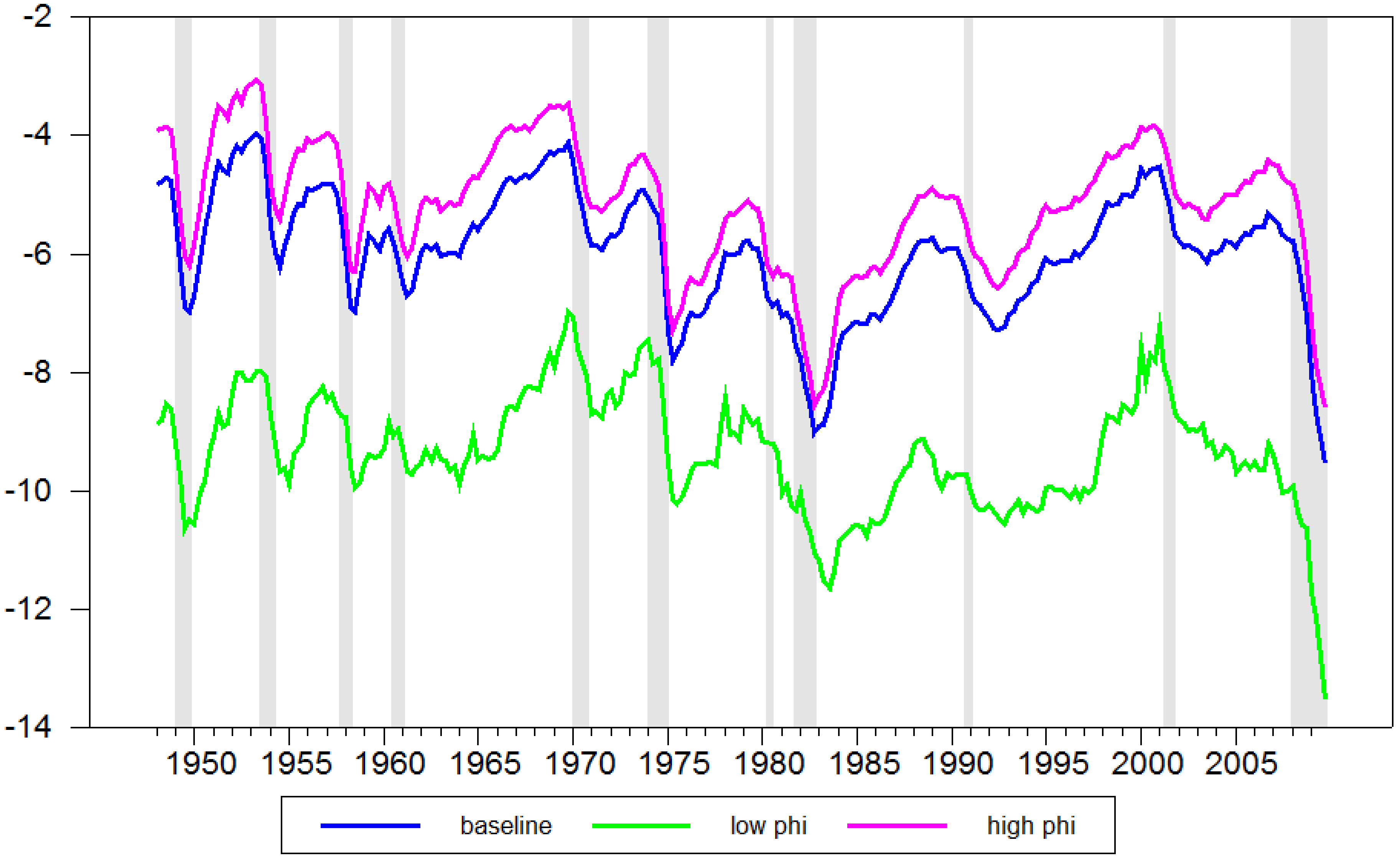
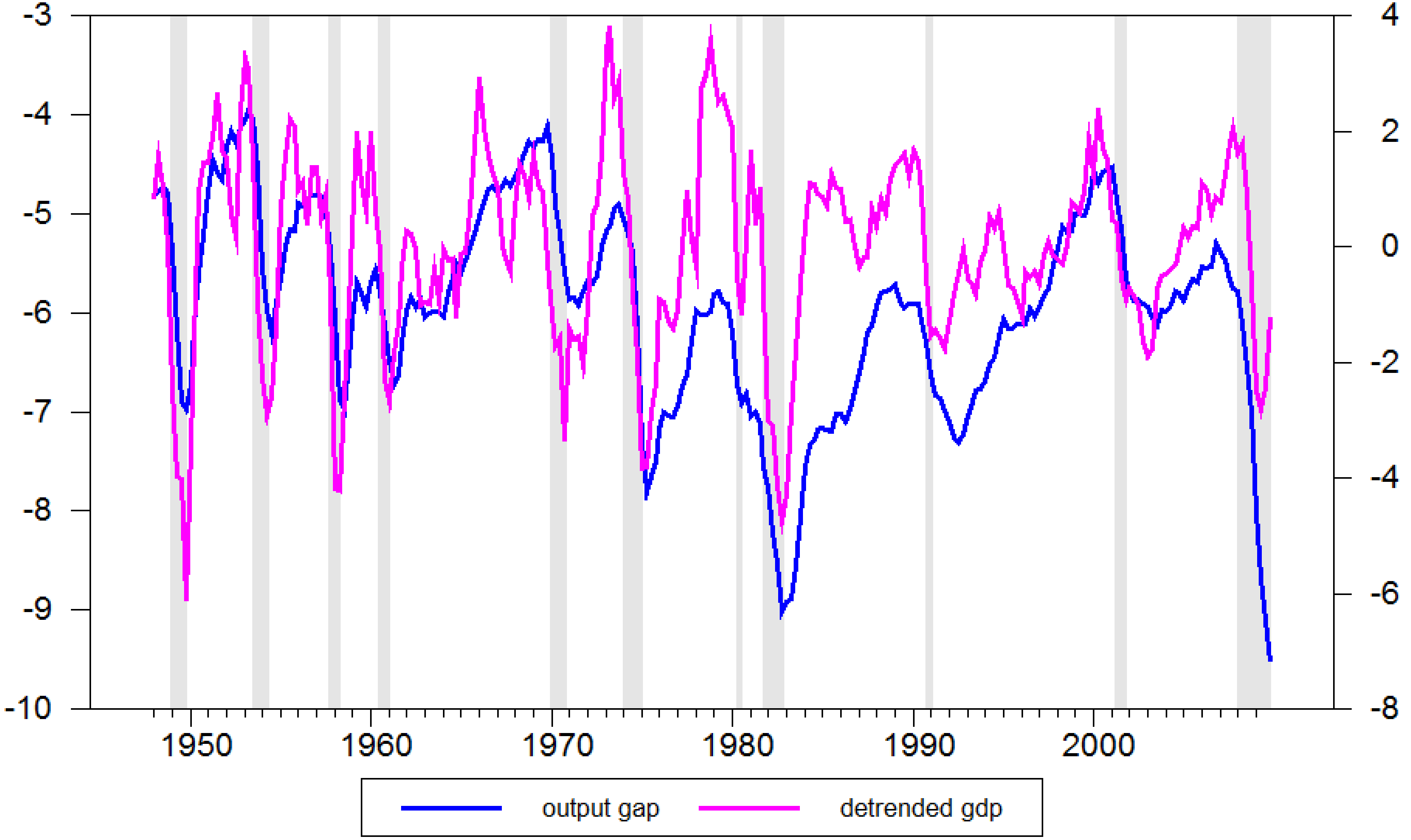


Figure 2.5: Output Gap vs. Detrended GDP: U.S. Evidence



The Output Gap vs. the Unemployment Rate: U.S. Evidence

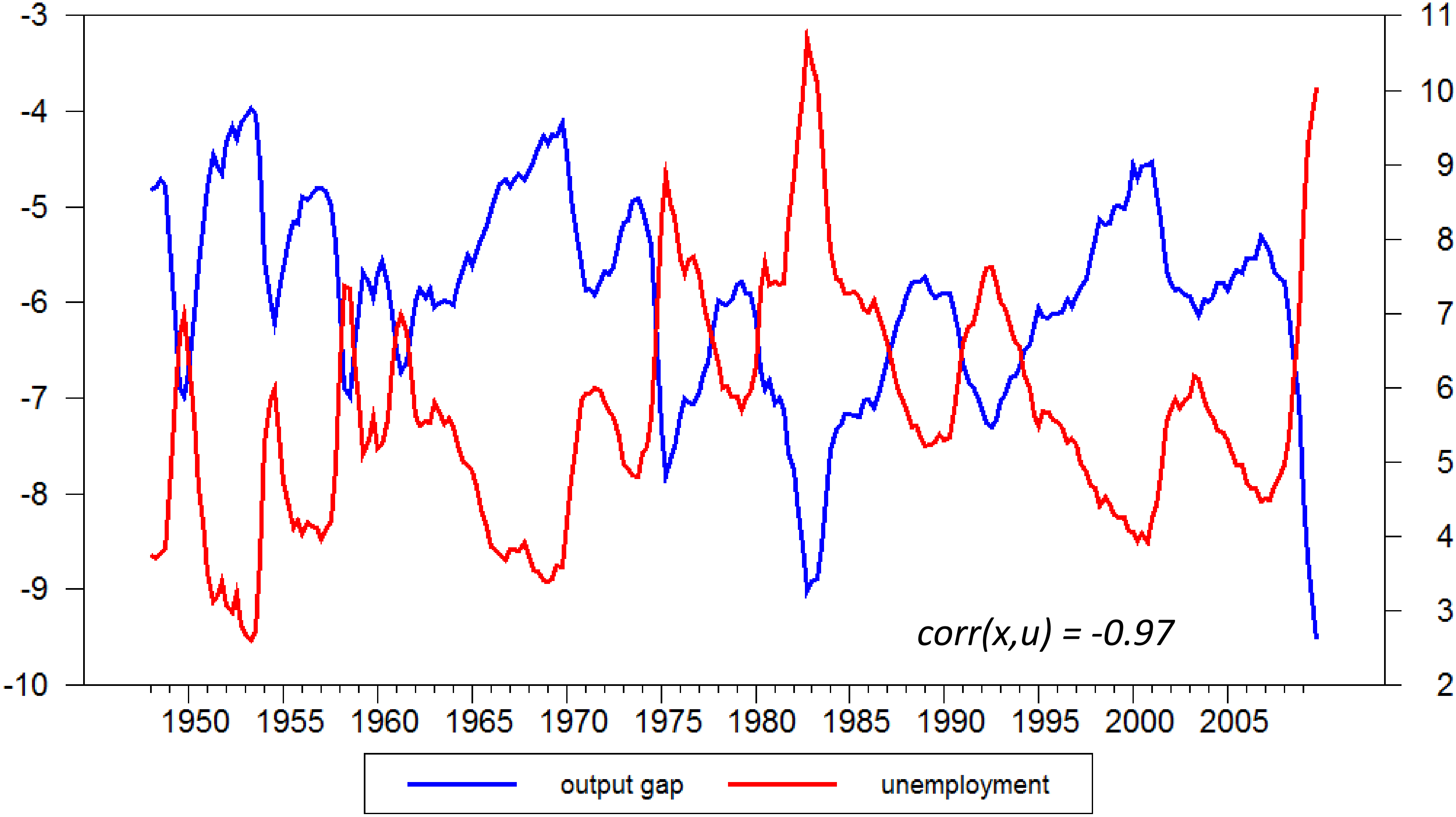
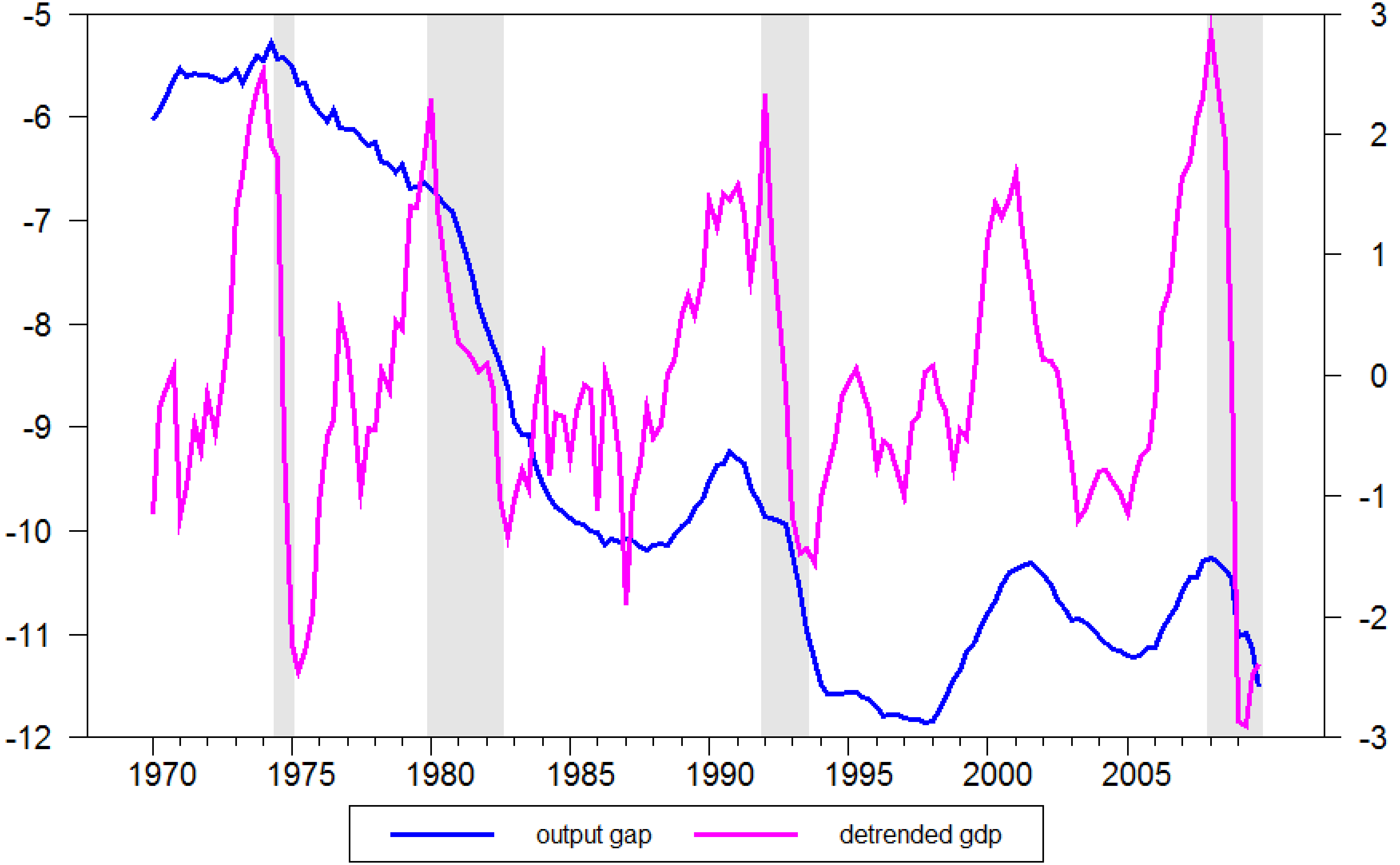


Figure 2.6: The Output Gap vs. Detrended GDP: Euro Area Evidence



The Output Gap vs. the Unemployment Rate: Euro Area Evidence

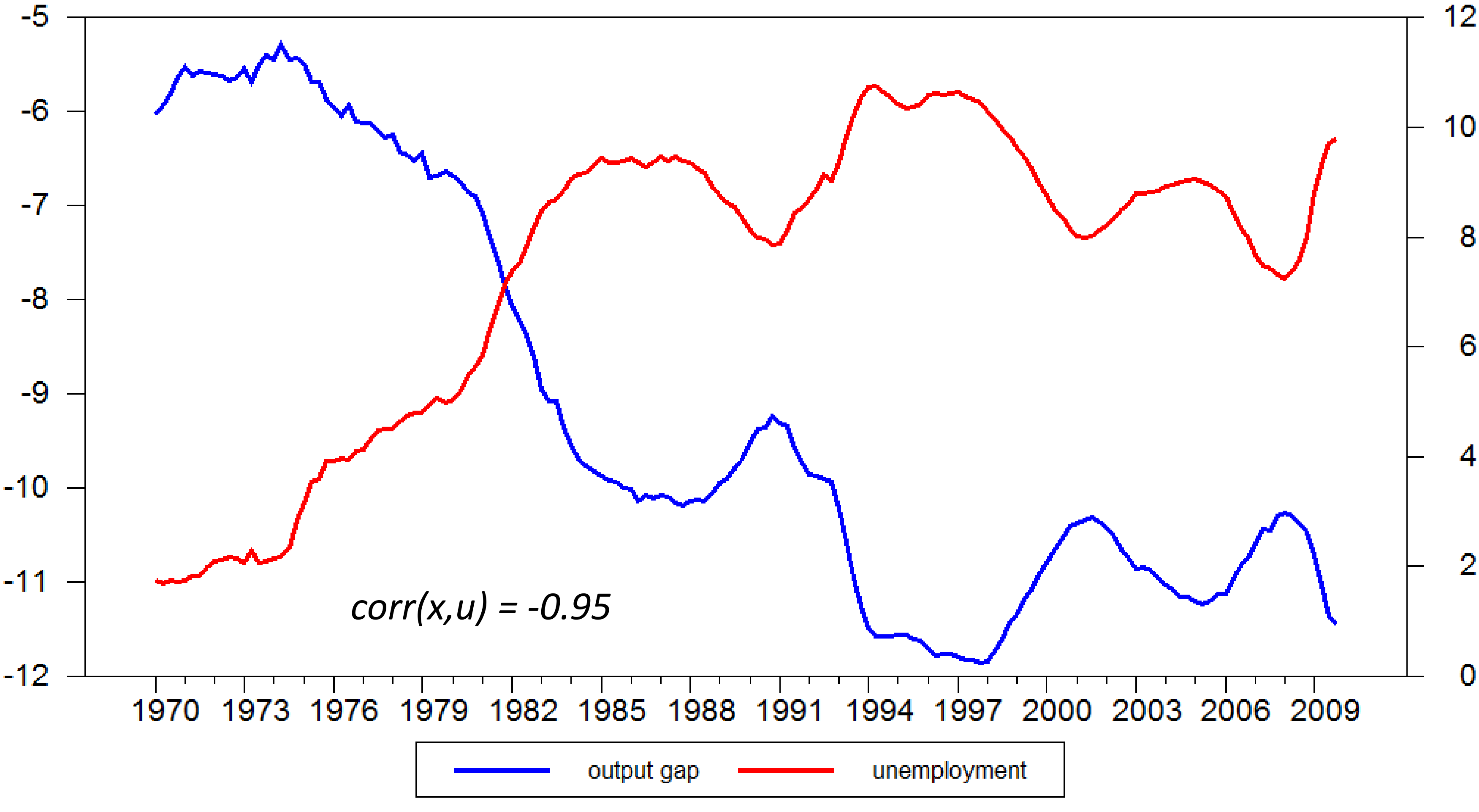


Figure 9. The Output Gap vs. Detrended GDP

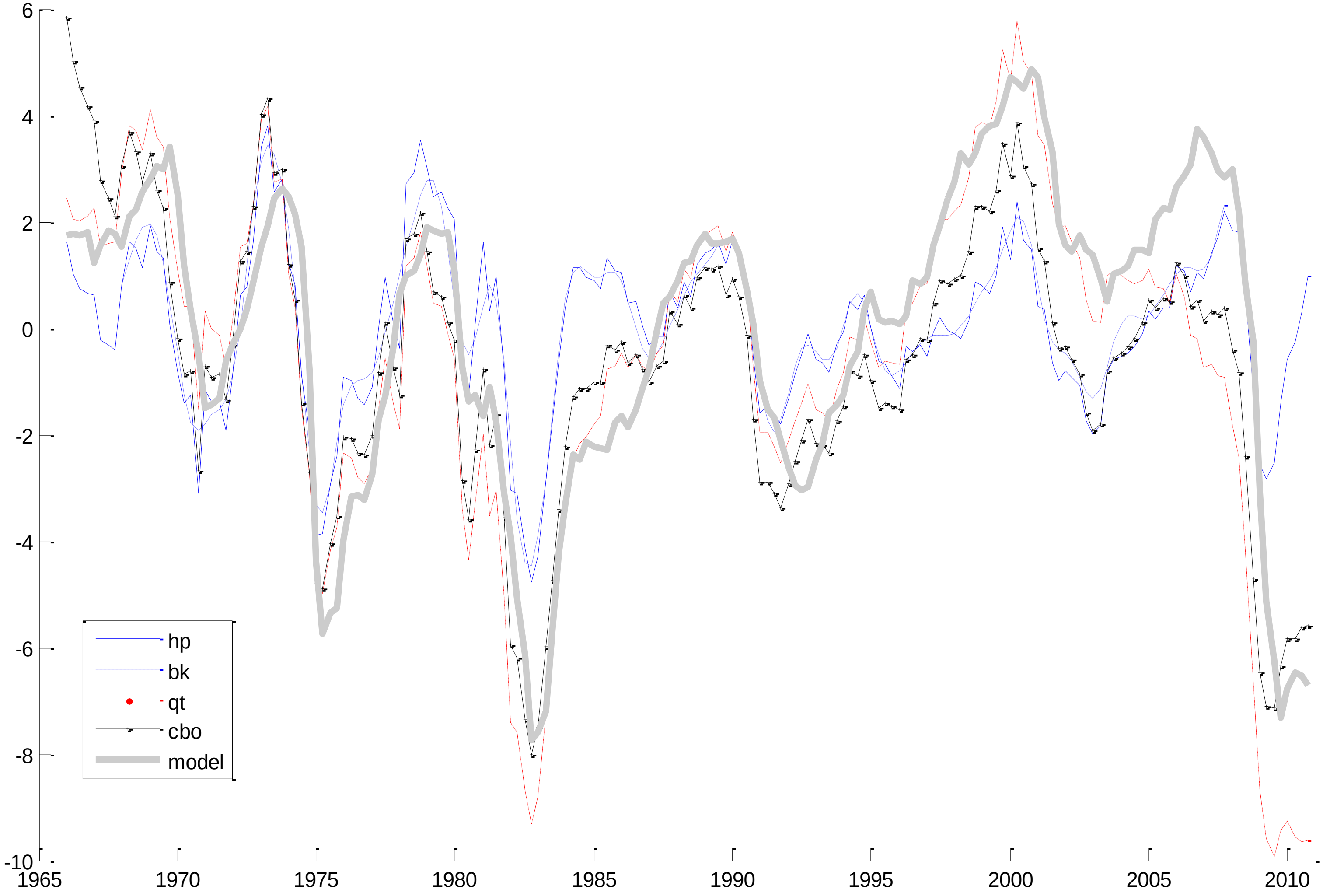
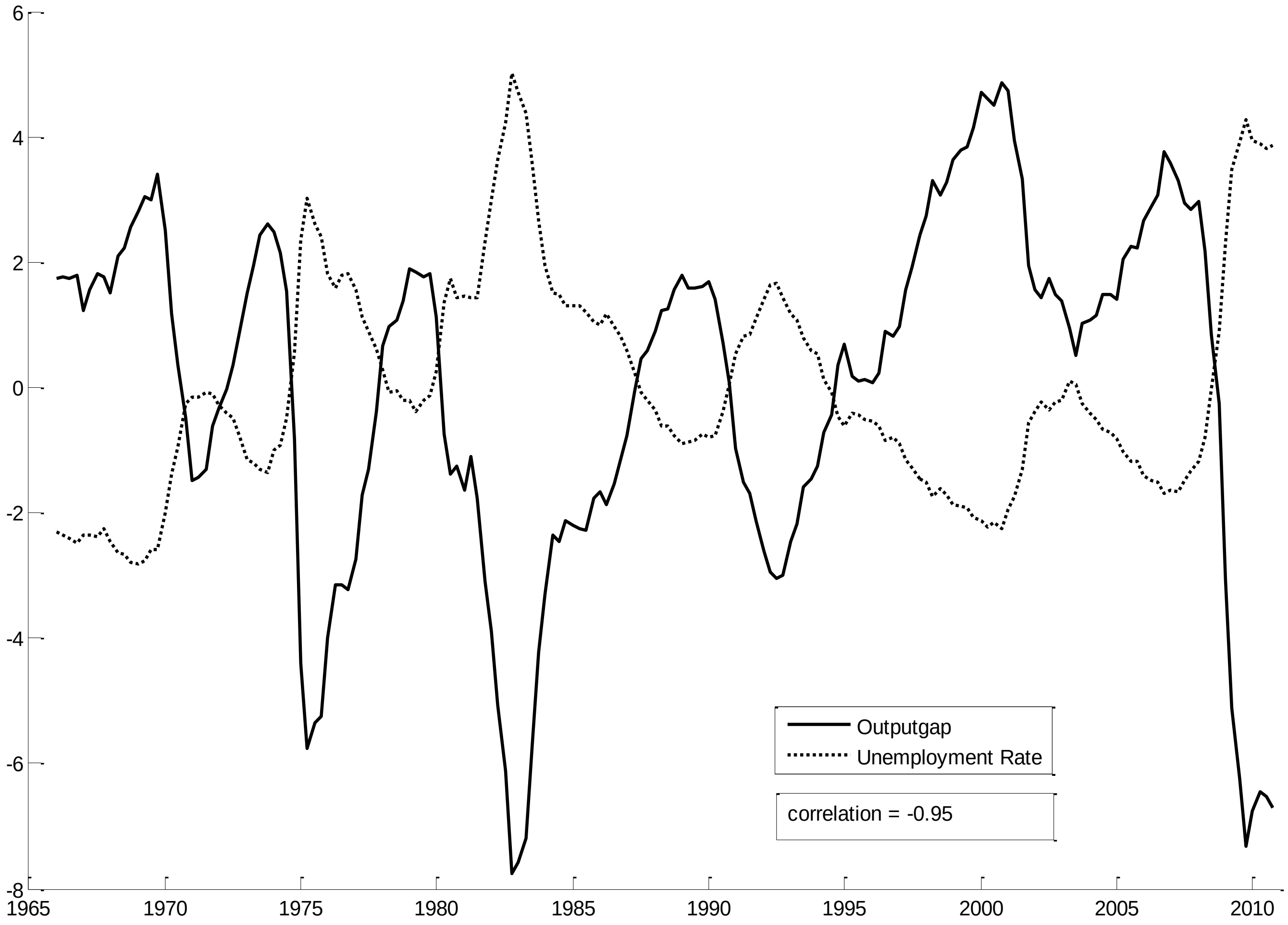


Figure 8. The Output Gap and the Unemployment Rate



Output Gap Fluctuations and Welfare

- Utility losses caused by deviations from first-best:

$$\begin{aligned} \mathcal{L}_t &\equiv U_t^e - U_t \\ &= \log(Y_t^e / Y_t) - \left(\frac{\chi_t}{1+\varphi}\right)\left((N_t^e)^{1+\varphi} - \int_0^1 N_t(i)^{1+\varphi} di\right) \\ &= \log(Y_t^e / Y_t) - \left(\frac{1-\alpha}{1+\varphi}\right)\left(1 - (N_t / N_t^e)^{1+\varphi}\right) \\ &= -x_t - \left(\frac{1-\alpha}{1+\varphi}\right)\left(1 - \exp\left\{\left(\frac{1+\varphi}{1-\alpha}\right) x_t\right\}\right) \equiv \mathcal{L}(x_t) \end{aligned}$$

Caveat: I ignore dispersion-driven inefficiencies ⇒ lower bound

- Evidence

Figure 2.9: Utility Losses and the Output Gap

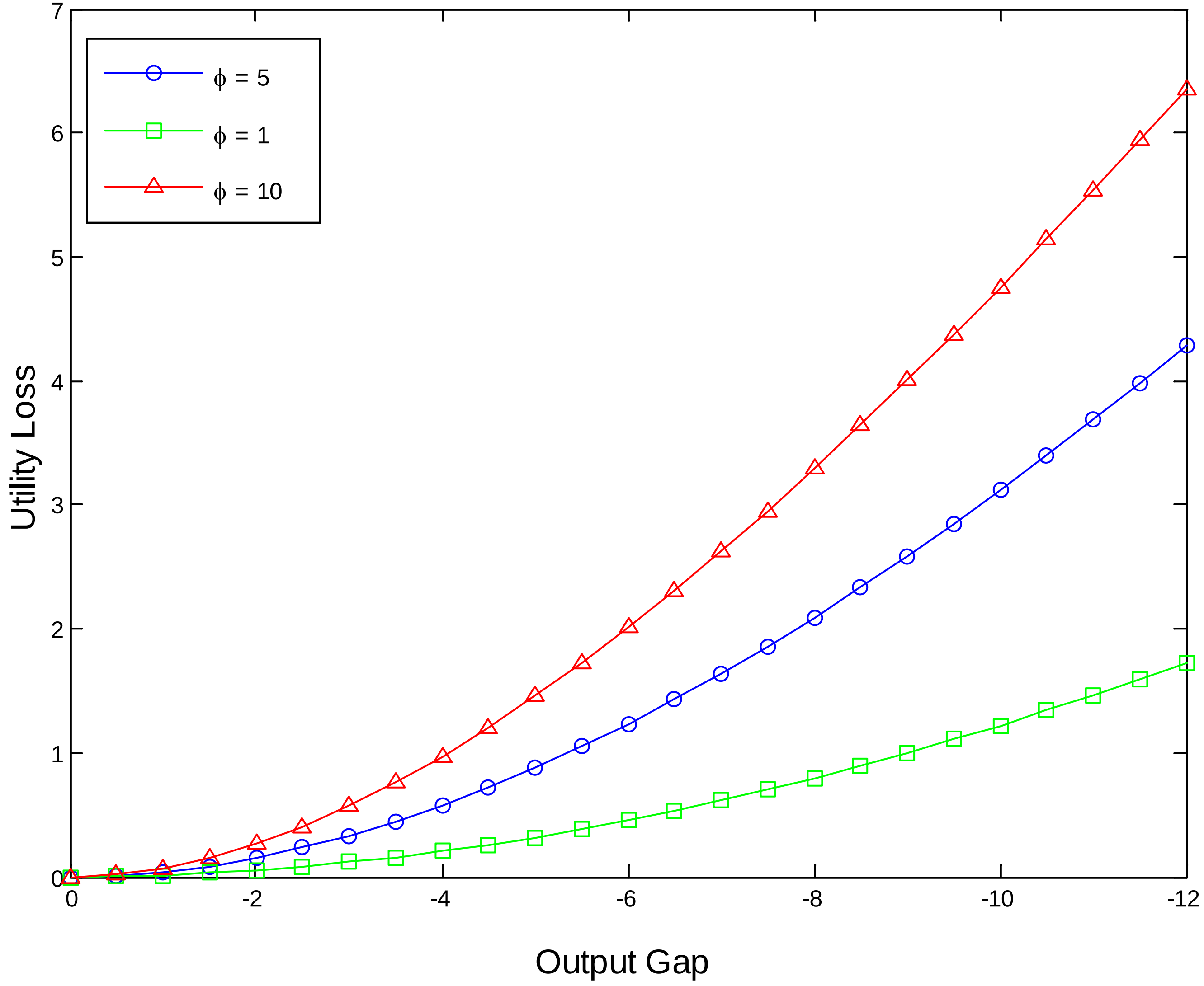


Figure 2.11: Utility Losses and the U.S. Business Cycle

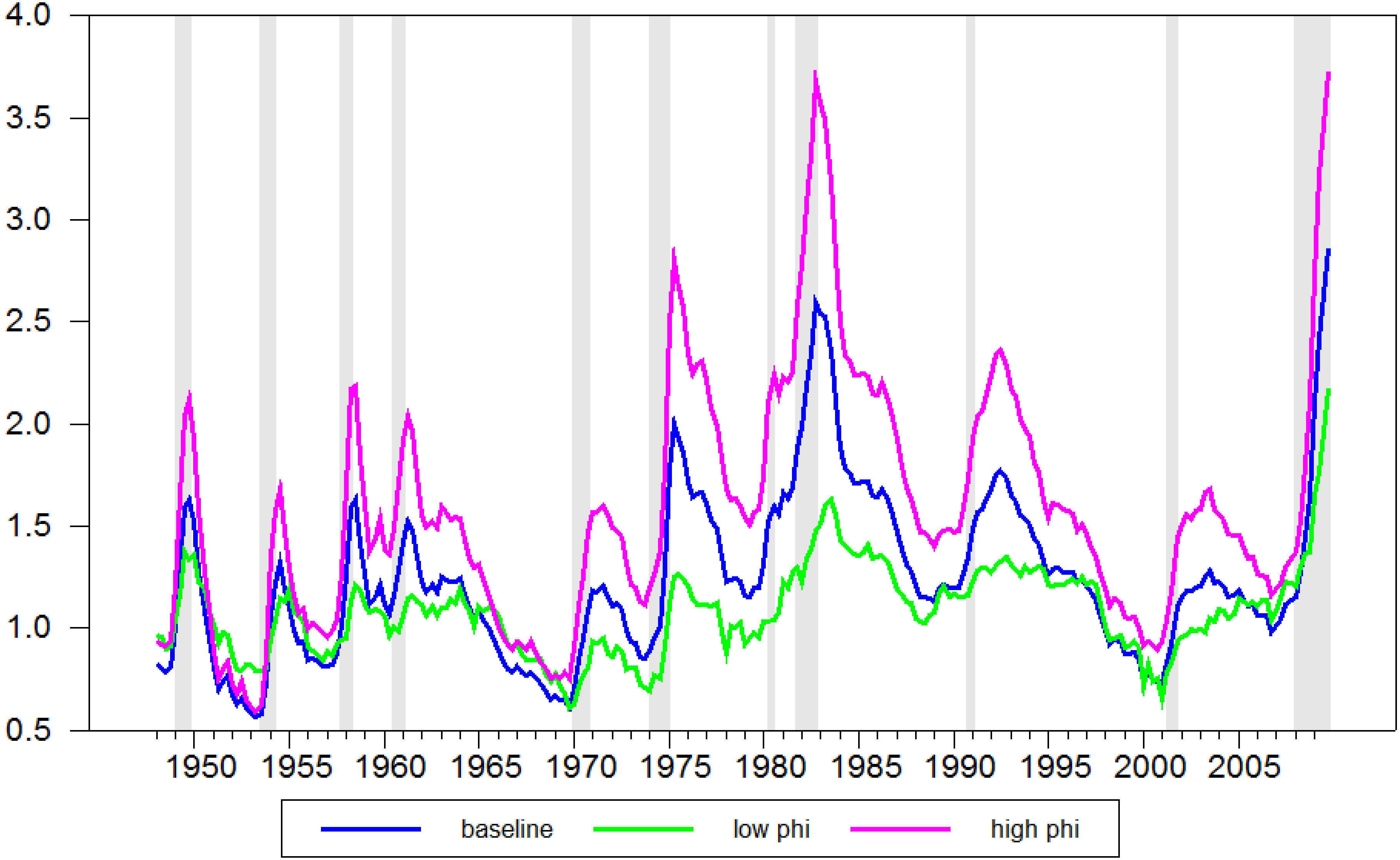
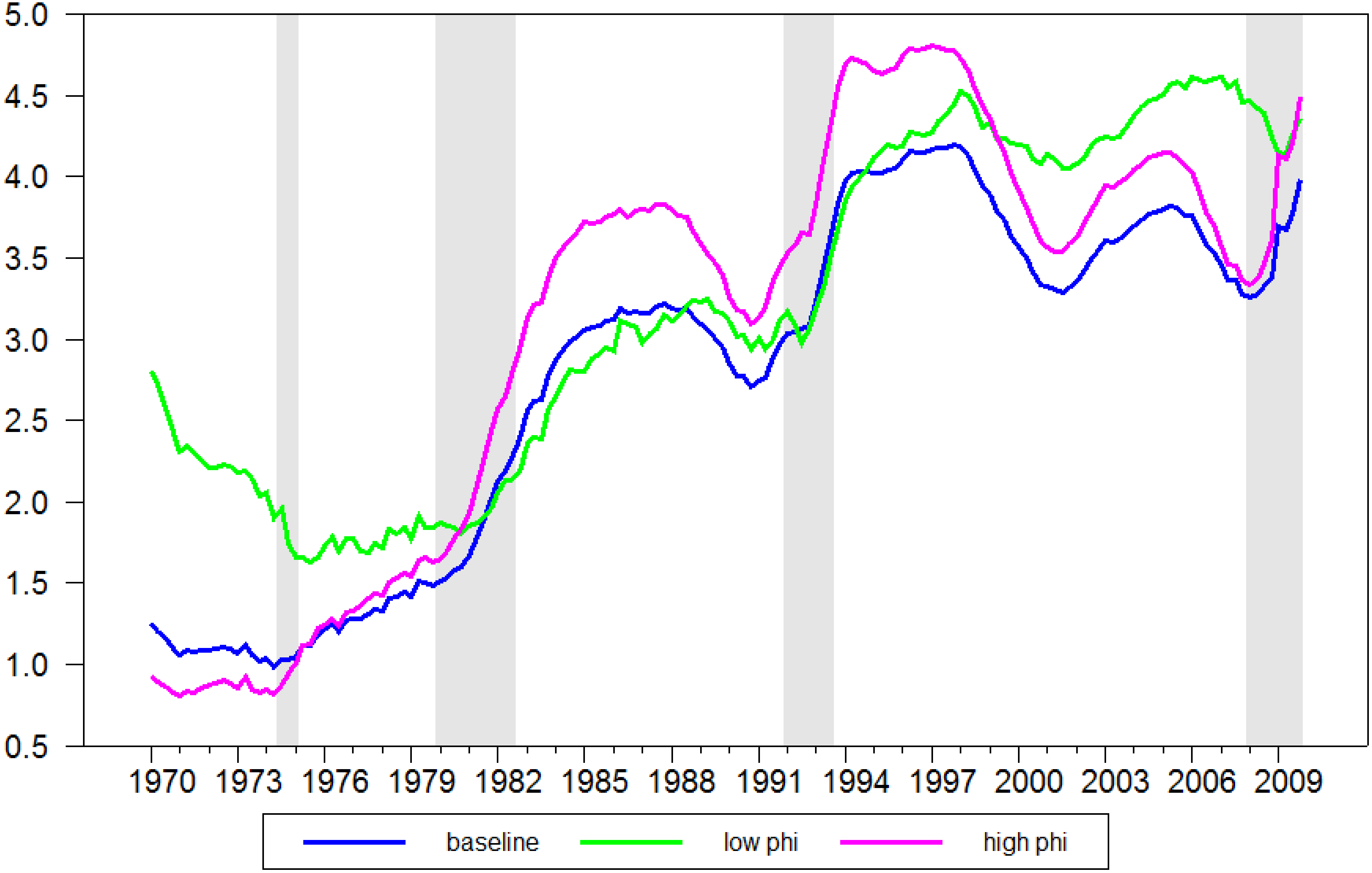


Figure 2.12: Utility Losses and the Euro Area Business Cycle



Output Gap Fluctuations and Welfare

- Utility losses caused by deviations from first-best

$$\mathcal{L}(x_t) = -x_t - \left(\frac{1-\alpha}{1+\varphi}\right)\left(1 - \exp\left\{\left(\frac{1+\varphi}{1-\alpha}\right) x_t\right\}\right)$$

- Utility losses *from fluctuations* (about a given steady state):

$$E\{\mathcal{L}(x_t)\} - \mathcal{L}(x) \simeq \frac{1}{2}\left(\frac{1+\varphi}{1-\alpha}\right) var(x_t)$$

- Evidence

Table 4. Output Gap Fluctuations and Welfare						
	U.S.			*Euro area*		
	$\varphi = 5$	$\varphi = 10$	$\varphi = 1$	$\varphi = 5$	$\varphi = 10$	$\varphi = 1$
$E\{\mathcal{L}(x_t)\}$	1.23	1.58	1.08	2.76	3.08	3.19
$E\{\mathcal{L}(x_t)\} - \mathcal{L}(x)$	0.04	0.08	0.01	0.18	0.32	0.11
$E\{\mathcal{L}(x_t)\} - E\{\mathcal{L}(x_t \geq x)\}$	0.16	0.24	0.09	0.52	0.63	0.49
$E\{\mathcal{L}(x_t)\} - E\{\mathcal{L}(x_t + \Delta)\}$	0.22	0.34	0.08	0.31	0.43	0.13

Conclusions

- Large variations in the degree of efficiency of the economy, as measured by the output gap.

  - in the U.S.: closely related to traditional measures of the business cycle.
  - in the Euro area: nonstationary component, beyond cyclical fluctuations.

- Substantial utility costs of an inefficient level of activity, especially in recessions.
- Average costs of inefficient fluctuations are small.
- Policy implications? Need to account for inflation-related distortions (part III). Preview: optimized simple policy rule responds significantly to the unemployment rate

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

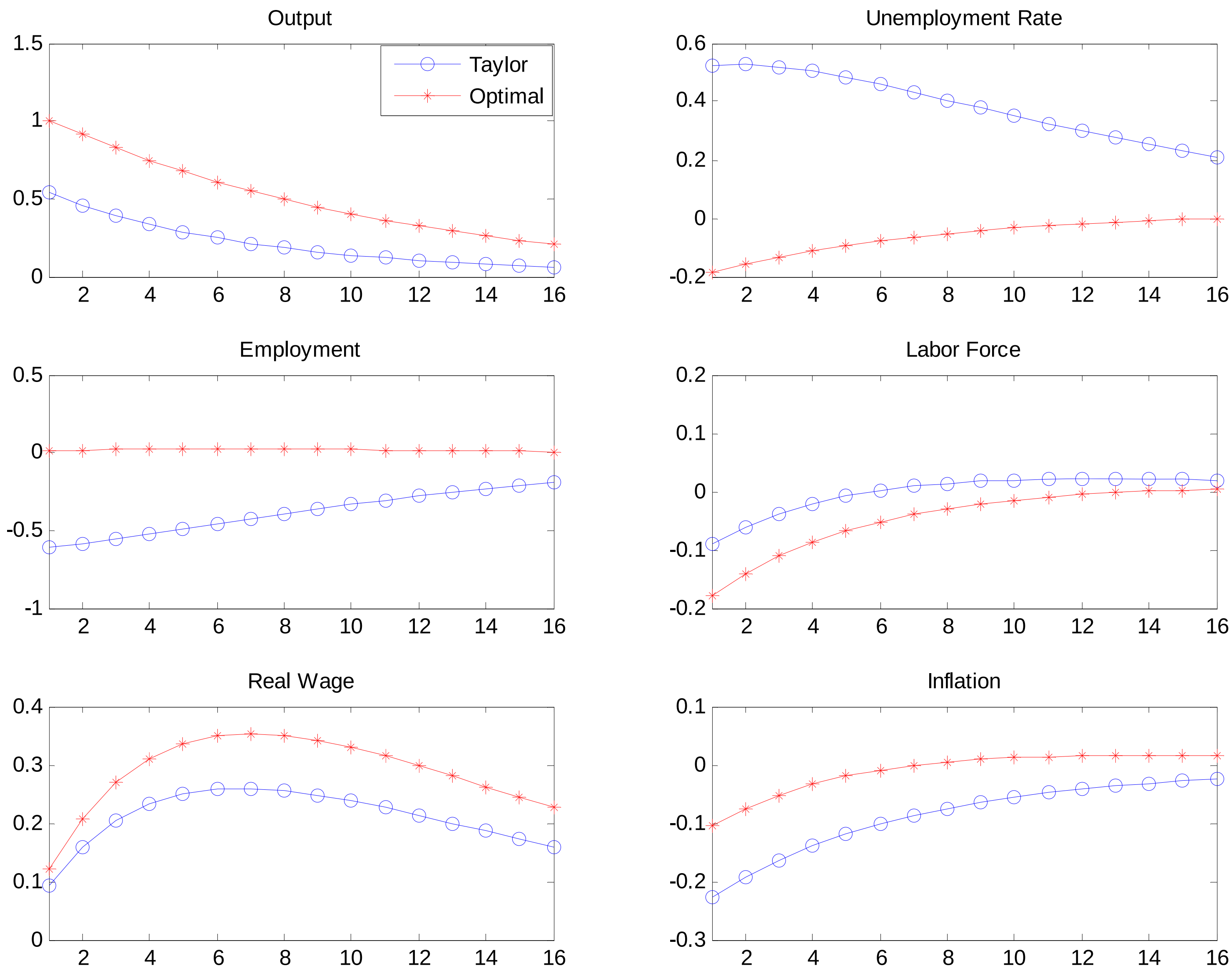
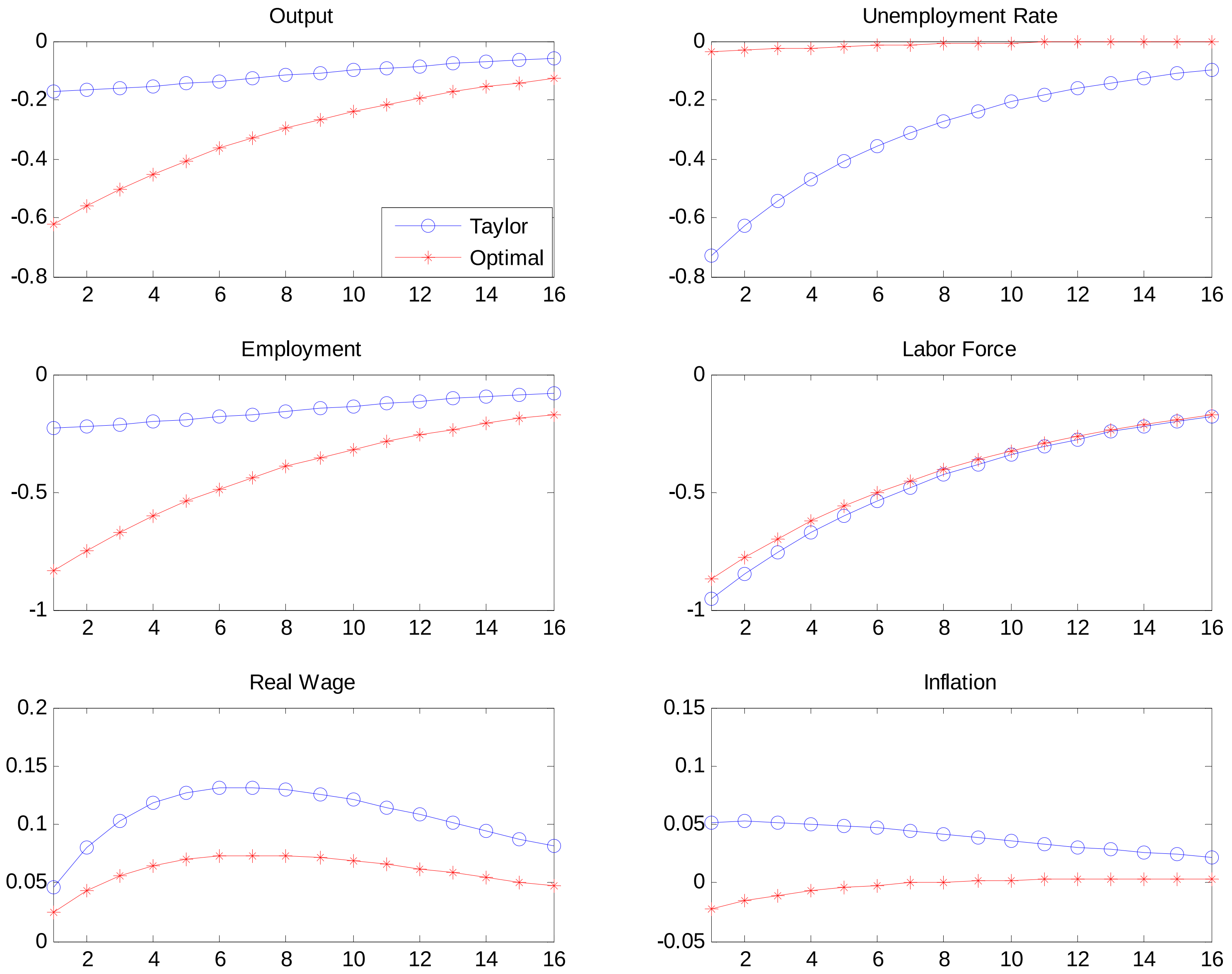


Figure 8b . Dynamic Responses to a Labor Supply Shock: Optimal vs. Taylor



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

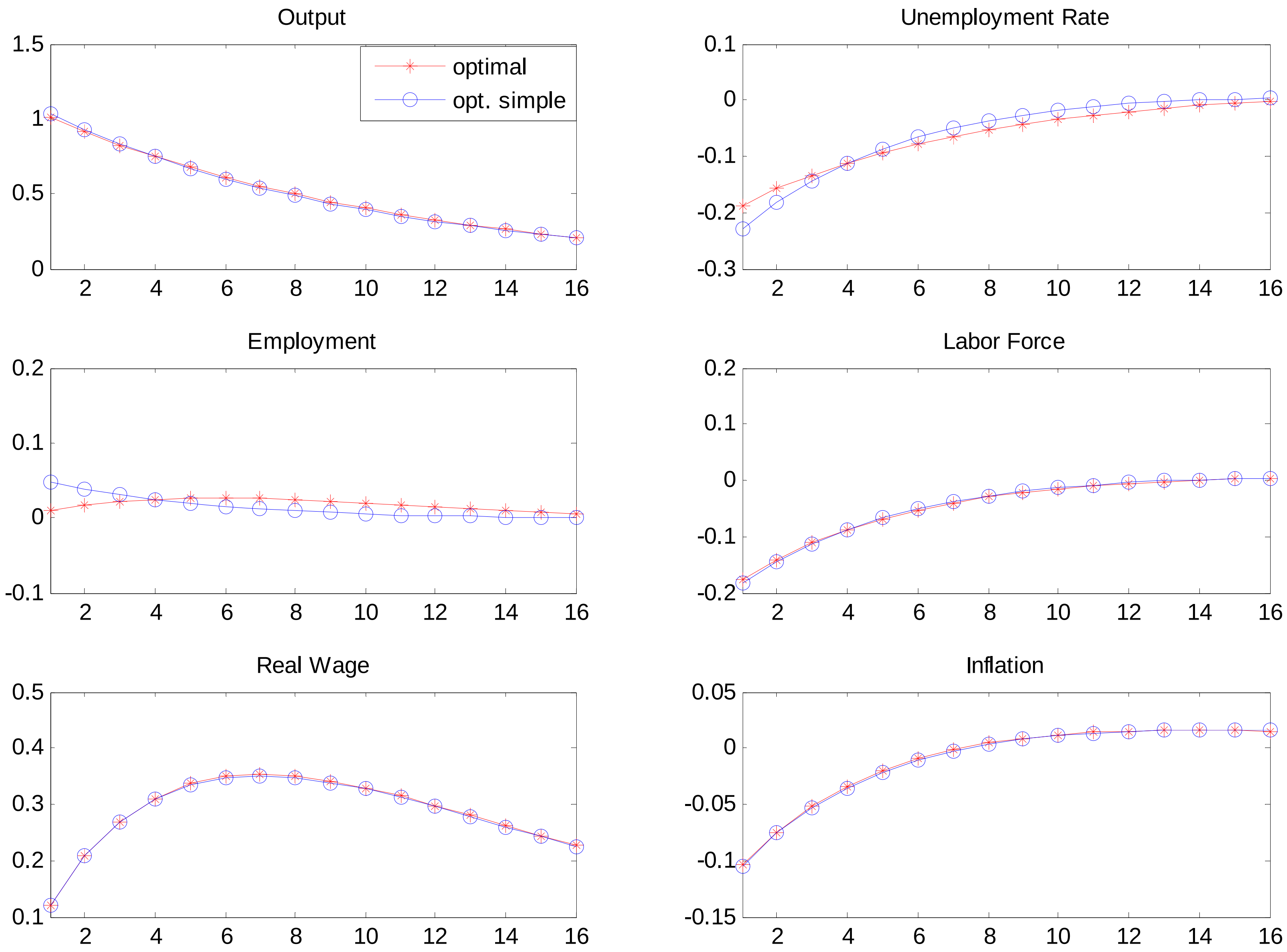


Figure 9b . Dynamic Responses to a Labor Supply Shock: Optimal Simple Rule

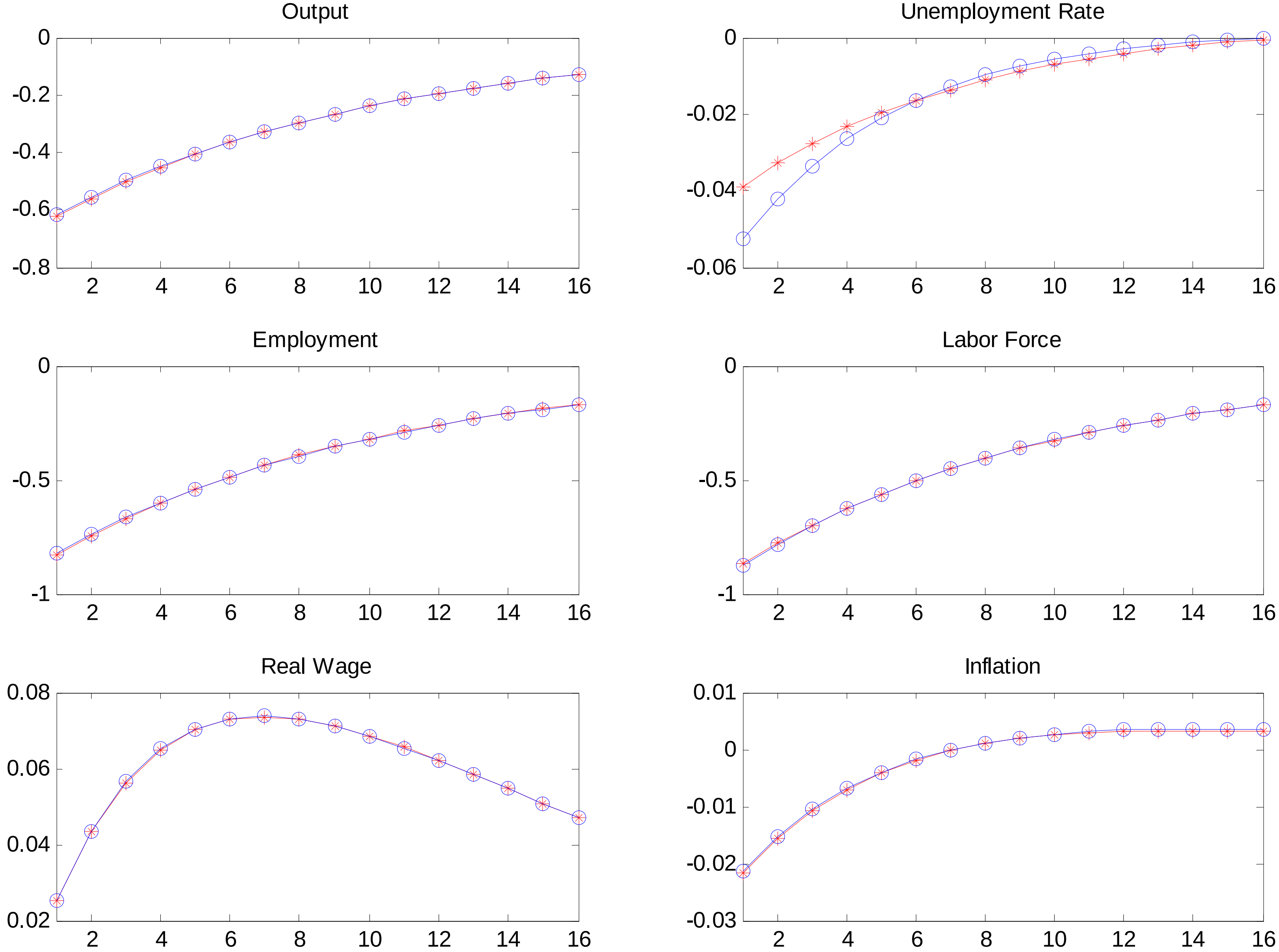


Figure 10a . Dynamic Responses to a Technology Shock: Simple Rule

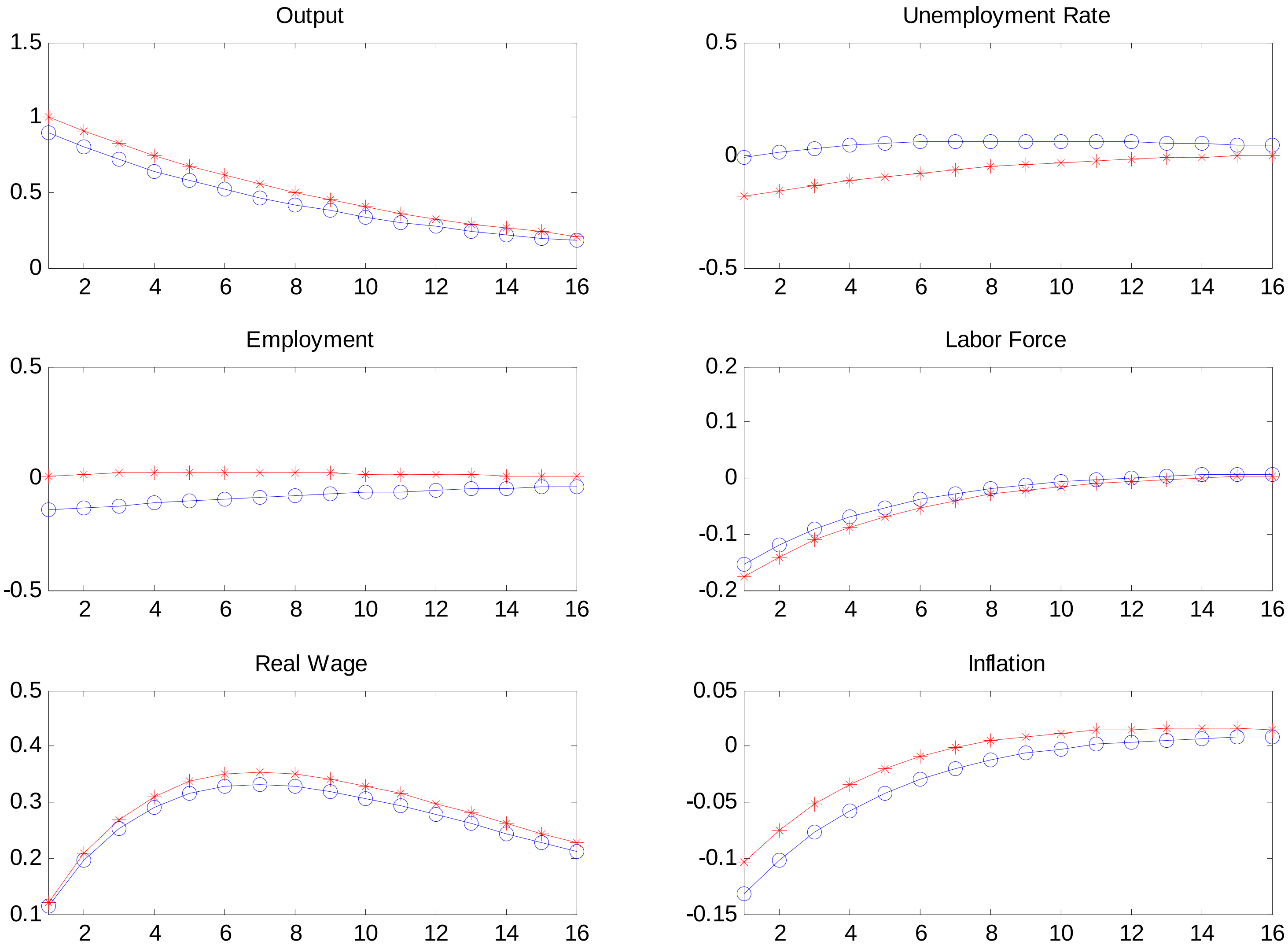
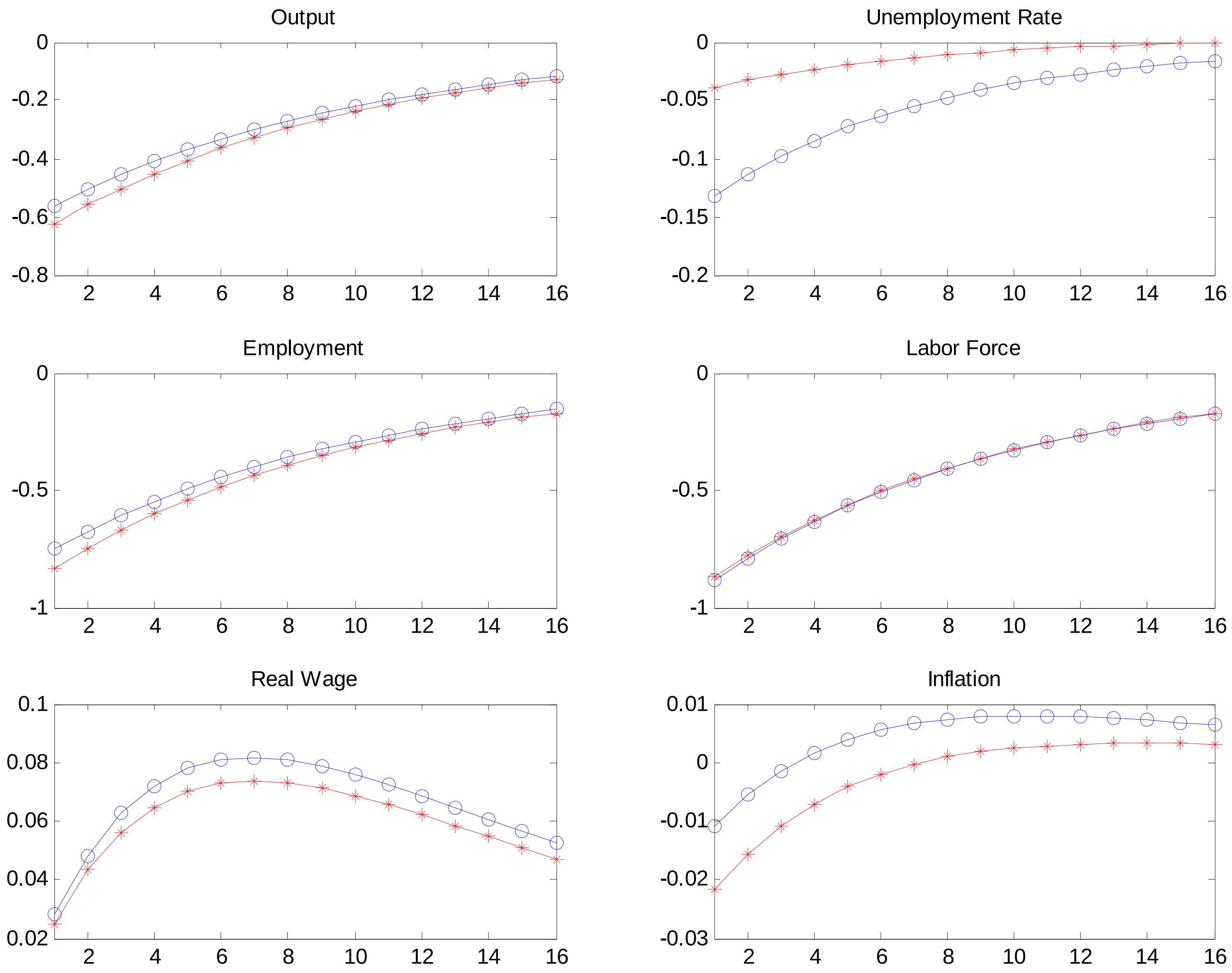


Figure 10b . Dynamic Responses to a Labor Supply Shock: Simple Rule



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)

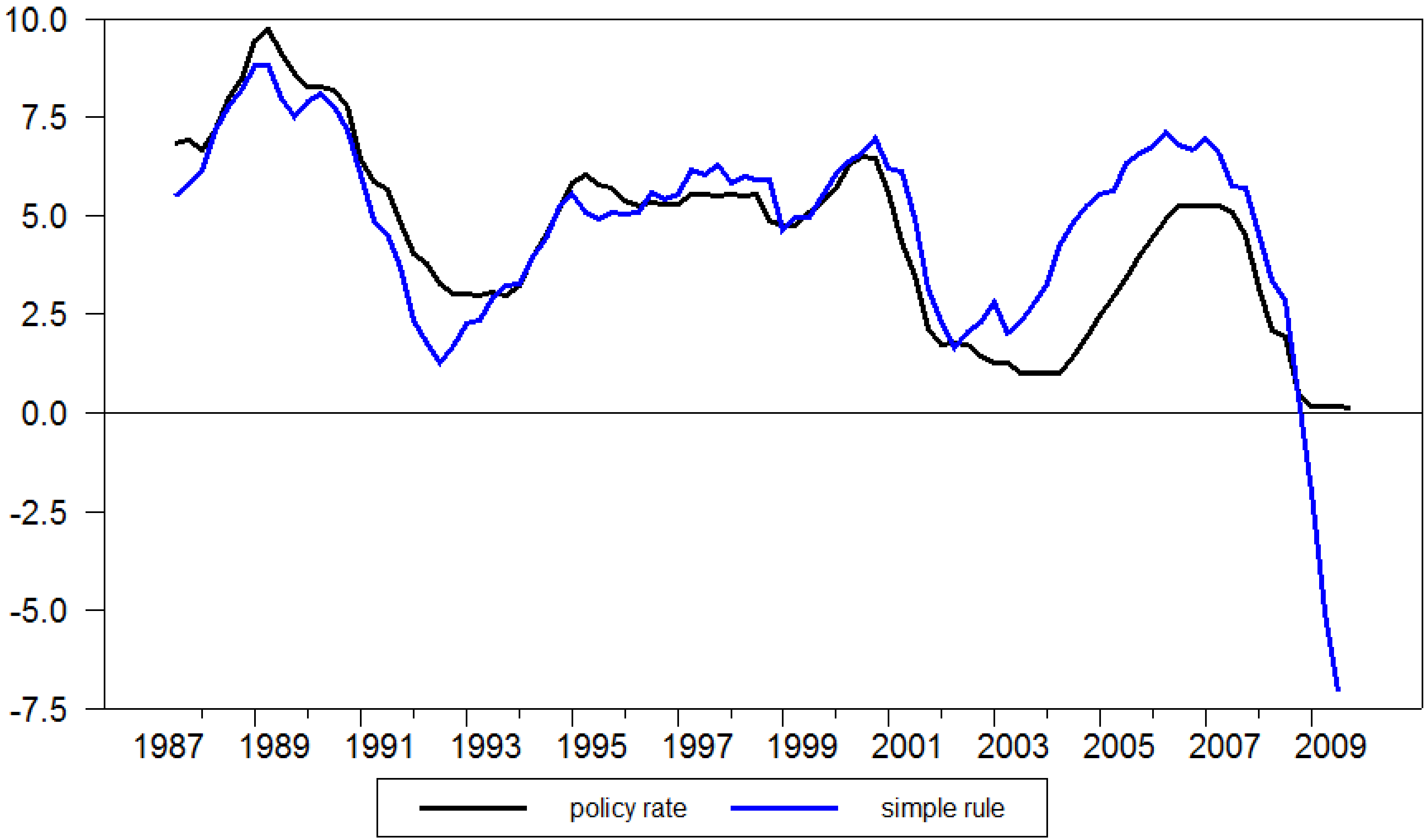


Figure 11b . Monetary Policy in the Greenspan-Bernanke Era (1987Q3-2008Q4)

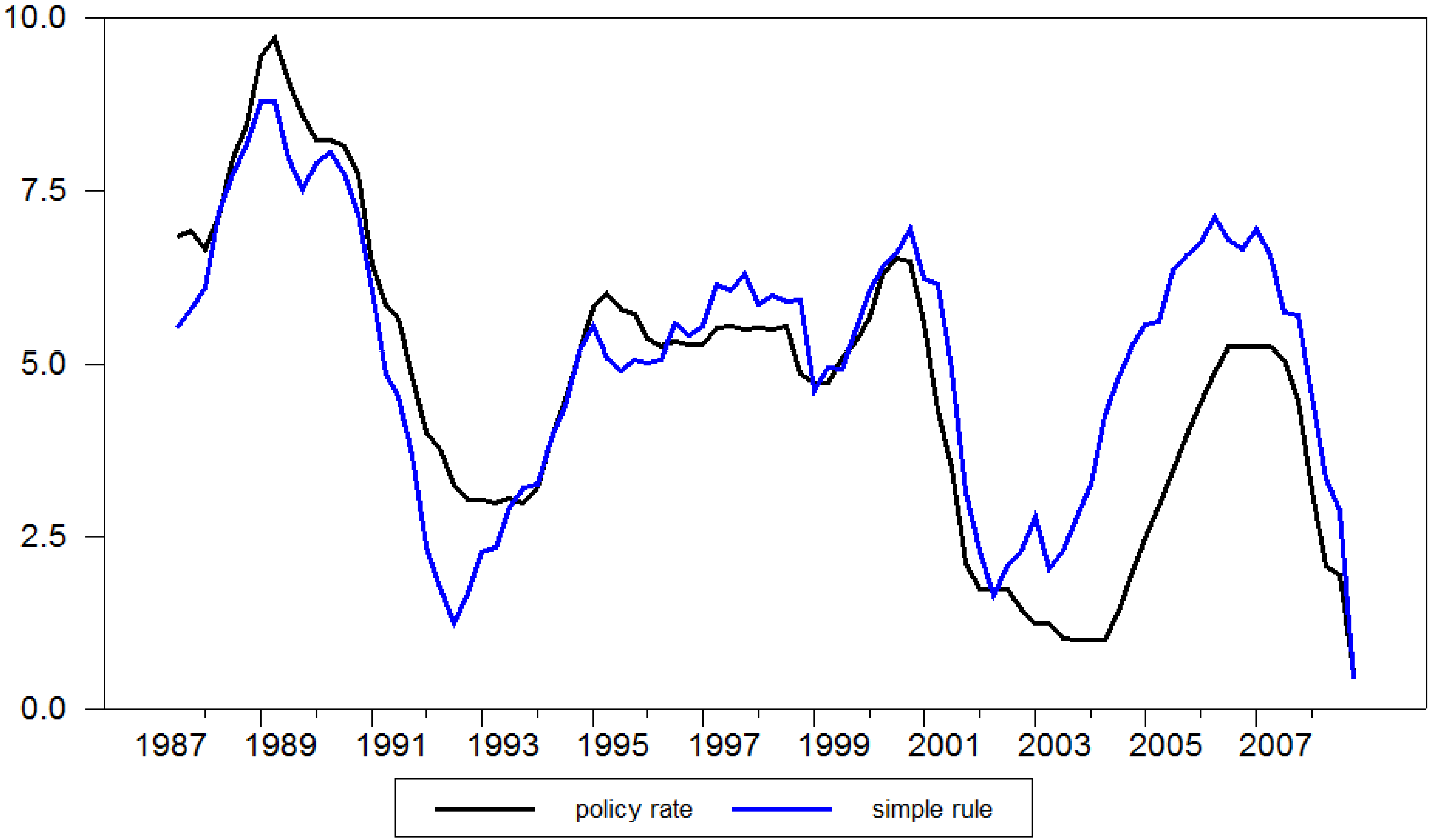


Figure 11c . Monetary Policy in the Greenspan-Bernanke Era (1987Q3-2008Q4)

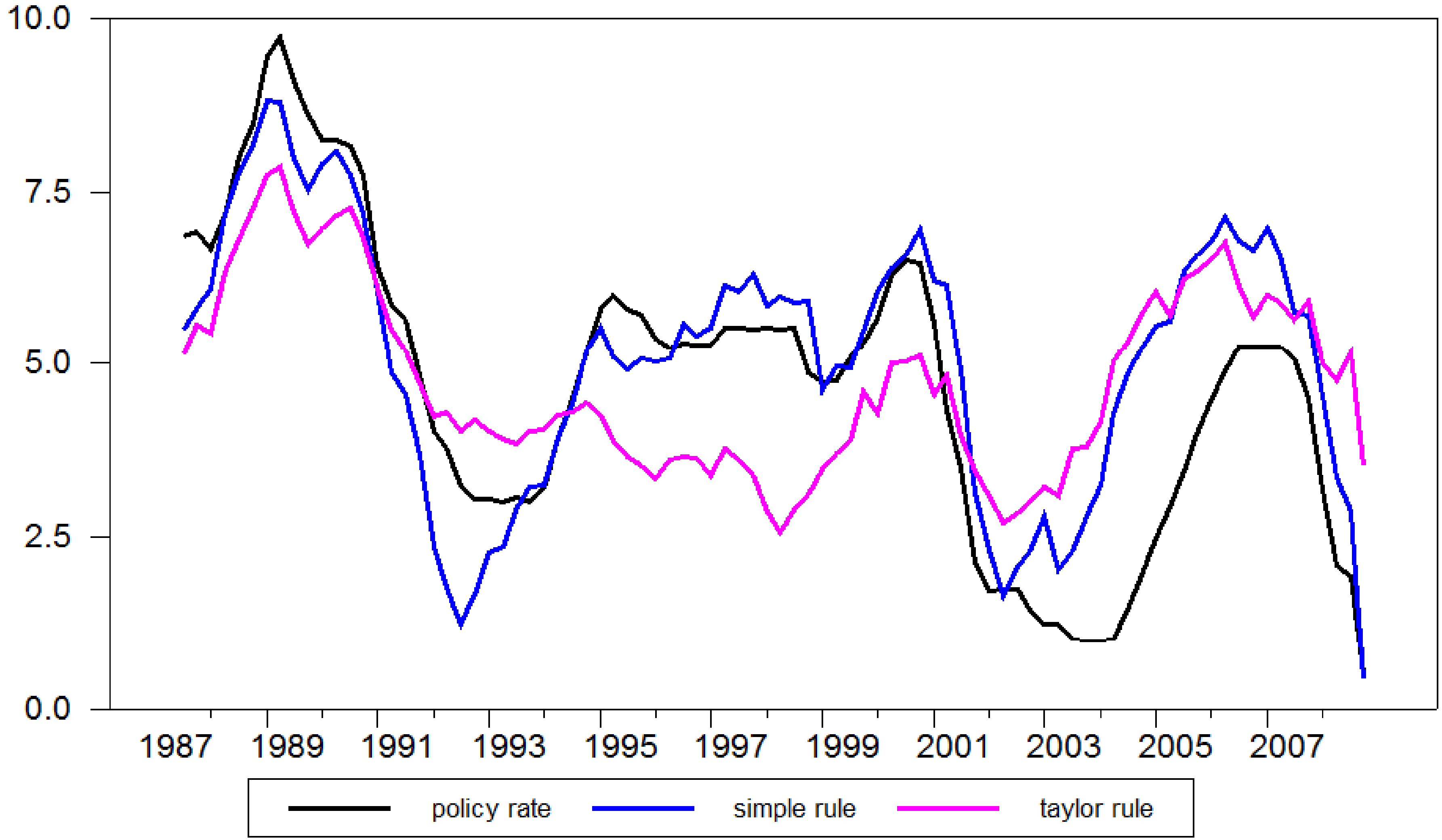
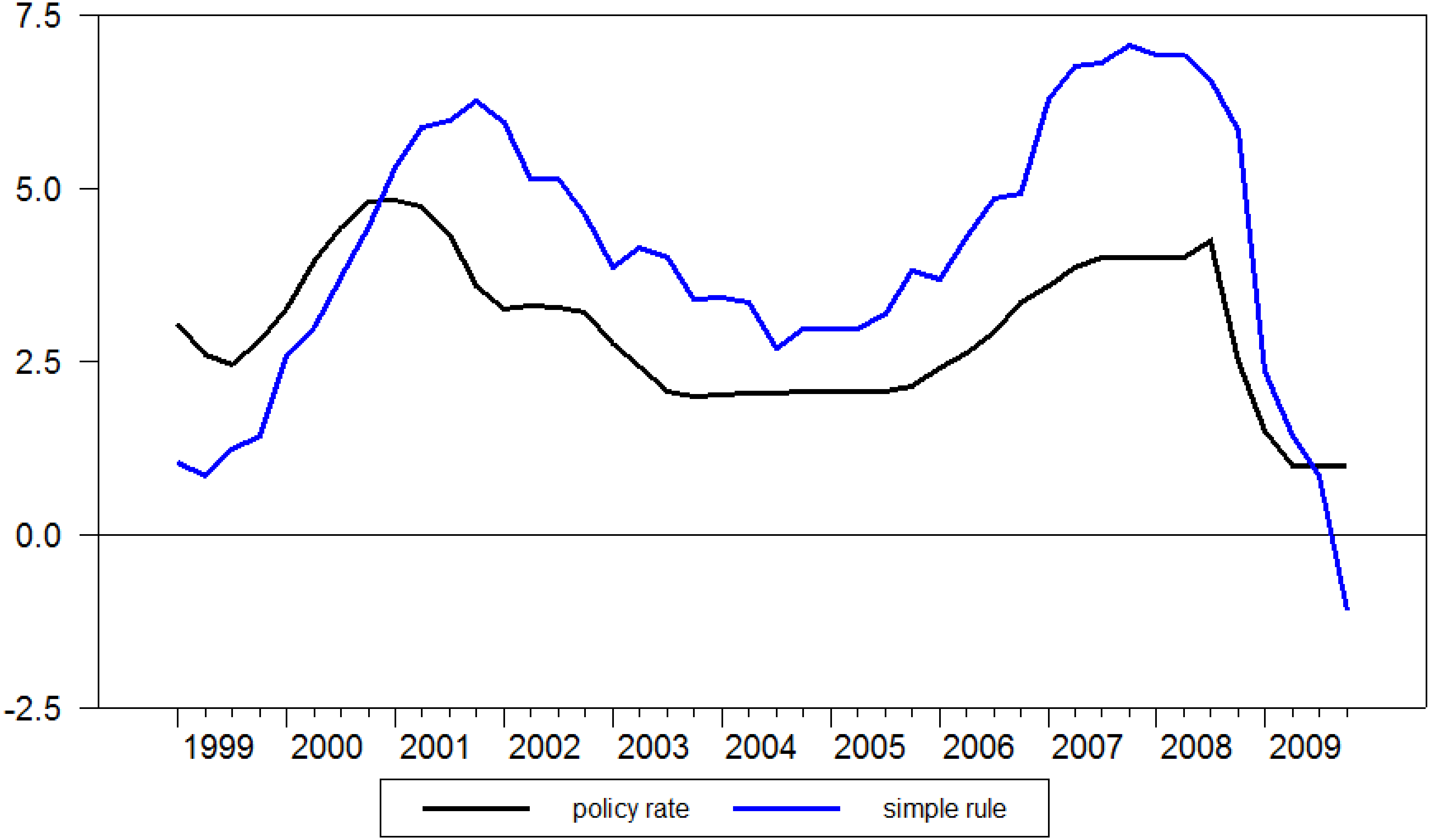


Figure 12 . Monetary Policy in the Euro Area (1999Q1-2008Q4)



Summary and Conclusions

- Optimal monetary policy involves more stability in unemployment than implied by the standard Taylor rule
- Simple interest rate rules that respond to inflation and the unemployment rate can approximate very well the optimal policy
- A simple, unconditional rule of the form

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

  captures surprisingly well the Fed interest rate policy until the early 2000s, though less so ECB policy.
- Message: unemployment's role in monetary policy may have been underplayed by the academic literature, more than by central bank practice.