The Return of the Wage Phillips Curve

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Introduction

- Two shortcomings of the standard New Keynesian model

  - no financial frictions
  - no reference to unemployment

- Recent literature: labor market frictions + nominal rigidities

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

- My approach: reformulation of the *standard* NK model $\Rightarrow$ unemployment
- Application in the present paper: understanding joint dynamics of wage inflation and unemployment.

Outline

- Reformulation of the wage-setting block of the standard New Keynesian model (Erceg-Henderson-Levin)

  - indivisible labor
  - introduction of unemployment (non-frictional)
  - well defined natural rate of unemployment
  - structural relation between wage inflation and unemployment

    $\Rightarrow$ *New Keynesian Wage Phillips Curve (NKWPC)*

- Empirical assessment: How well can the NKWPC account for observed wage inflation fluctuations?

  - empirical evidence based on postwar U.S. data
  - maintained assumption: constant natural rate of unemployment

Staggered Wage Setting and Wage Inflation Dynamics

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

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

and $\chi_t \equiv \exp\{\xi_t\}$ is a preference shifter ("labor supply shock")

Wage Setting

- Nominal wage for each labor type reset with probability $1-\theta_w$ each period
- No indexation to price inflation (relaxed later)
- Average wage dynamics:

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

- Optimal wage setting rule:

$$w_t^* = \mu^w + (1-\beta\theta_w) \sum_{k=0}^{\infty} (\beta\theta_w)^k E_t \left\{ mrs_{t+k|t} + p_{t+k} \right\} \tag{2}$$

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

$$\pi_t^w = \beta E_t\{\pi_{t+1}^w\} - \lambda_w(\mu_t^w - \mu^w) \tag{3}$$

where $\mu_t^w \equiv (w_t - p_t) - (c_t + \varphi n_t + \xi_t)$ 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 in market for type-i labor, $L_t(i)$:

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

- 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 model's implied (log) aggregate participation rate.

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:

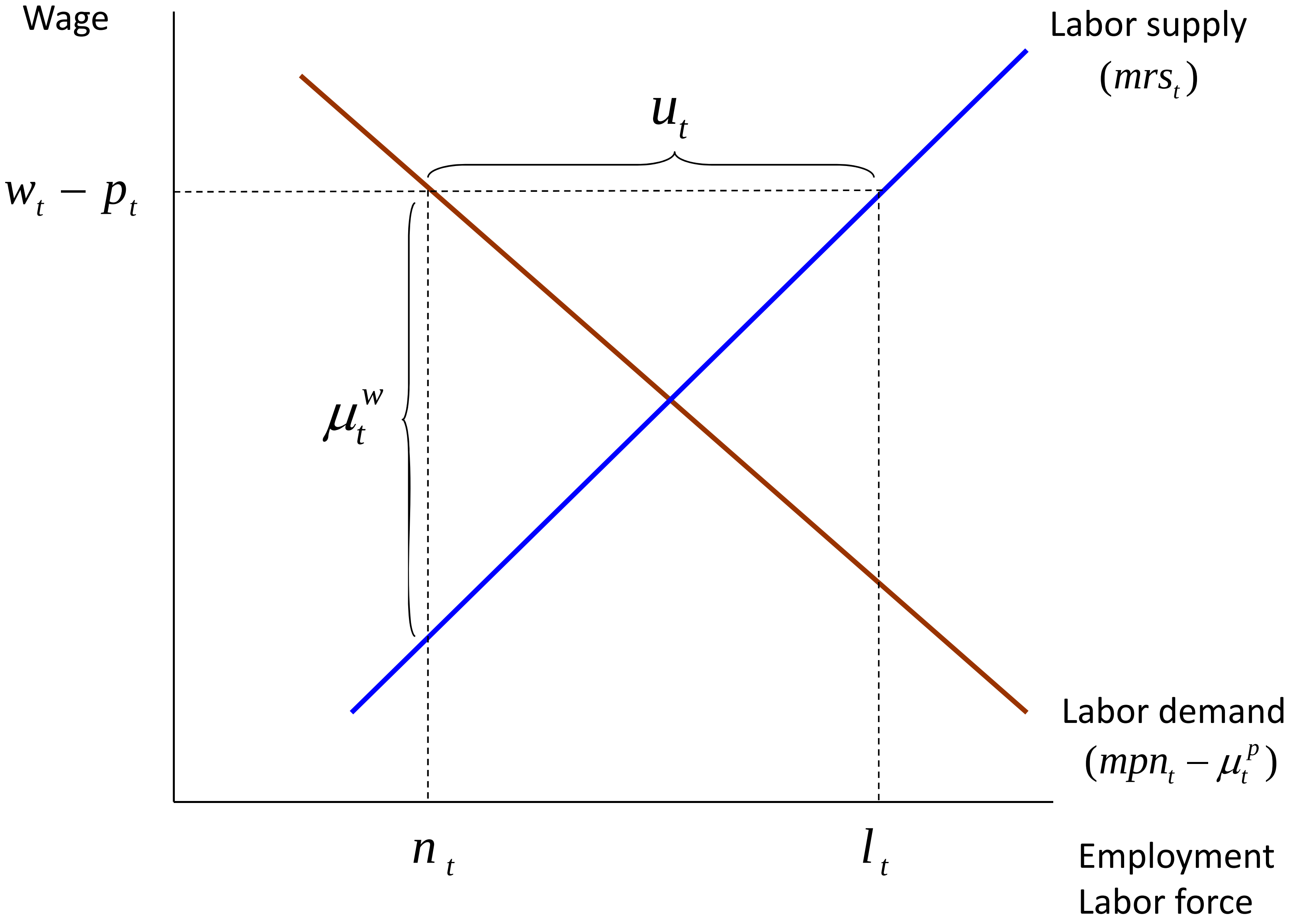
$$\mu^w = \varphi u^n$$

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

- *A New Keynesian Wage Phillips Curve*:

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

Figure 1. The Wage Markup and the Unemployment Rate



Allowing for Wage Indexation

- Indexation rule

$$w_{t+k|t} = w_{t+k-1|t} + \gamma \overline{\pi}^{p}_{t+k-1} + (1-\gamma)\pi^{p} + g$$

- Implied wage inflation equation

$$\pi^{w}_{t} = \alpha + \gamma \overline{\pi}^{p}_{t-1} + \beta E_{t}\{\pi^{w}_{t+1} - \gamma \overline{\pi}^{p}_{t}\} - \lambda_{w}(\mu^{w}_{t} - \mu^{w})$$

- Implied New Keynesian Wage Phillips Curve

$$\pi^{w}_{t} = \alpha + \gamma \overline{\pi}^{p}_{t-1} + \beta E_{t}\{\pi^{w}_{t+1} - \gamma \overline{\pi}^{p}_{t}\} - \lambda_{w}\varphi(u_{t} - u^{n})$$

Two Extensions (Galí-Smets-Wouters)

- Time-varying desired wage markups $\{\overline{\mu}_t^w\}$

$$\pi_t^w = \alpha + \gamma \overline{\pi}_{t-1}^p + \beta E_t\{\pi_{t+1}^w - \gamma \overline{\pi}_t^p\} - \lambda_w \varphi u_t + \lambda_w \overline{\mu}_t^w$$

$\Rightarrow$ overcomes the identification problem raised by Chari et al. (2009)

- Preferences with limited short-run wealth effects (Jaimovich-Rebelo)

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

where

$$z_t = \vartheta z_{t-1} + (1 - \vartheta) c_t$$

$\Rightarrow$ unchanged specification of the NKWPC

A Reduced Form Representation of the NKWPC

- Unemployment process

$$\widehat{u}_t = \phi_1 \widehat{u}_{t-1} + \phi_2 \widehat{u}_{t-2} + \varepsilon_t$$

- Implied NKWPC

$$\pi_t^w = \alpha + \gamma \overline{\pi}_{t-1}^p + \psi_0 \widehat{u}_t + \psi_1 \widehat{u}_{t-1} \tag{4}$$

where

$$\psi_0 \equiv -\frac{\lambda_w \varphi}{1 - \beta(\phi_1 + \beta\phi_2)} \quad ; \quad \psi_1 \equiv -\frac{\lambda_w \varphi \beta \phi_2}{1 - \beta(\phi_1 + \beta\phi_2)}$$

or, equivalently,

$$\pi_t^w = \alpha + \gamma \overline{\pi}_{t-1}^p - \delta \widehat{u}_t - \psi_1 \Delta u_t \tag{5}$$

where $\delta \equiv -(\psi_0 + \psi_1)$

- In the data: $\phi_1 > 1$, $-1 < \phi_2 < 0$ $\Rightarrow \psi_0 < 0$, $\psi_1 > 0$, and $\delta > 0$
- Relation to empirical wage inflation equations

Data

- Postwar quarterly U.S. data
- Civilian unemployment rate
- Wage inflation: two alternative measures:

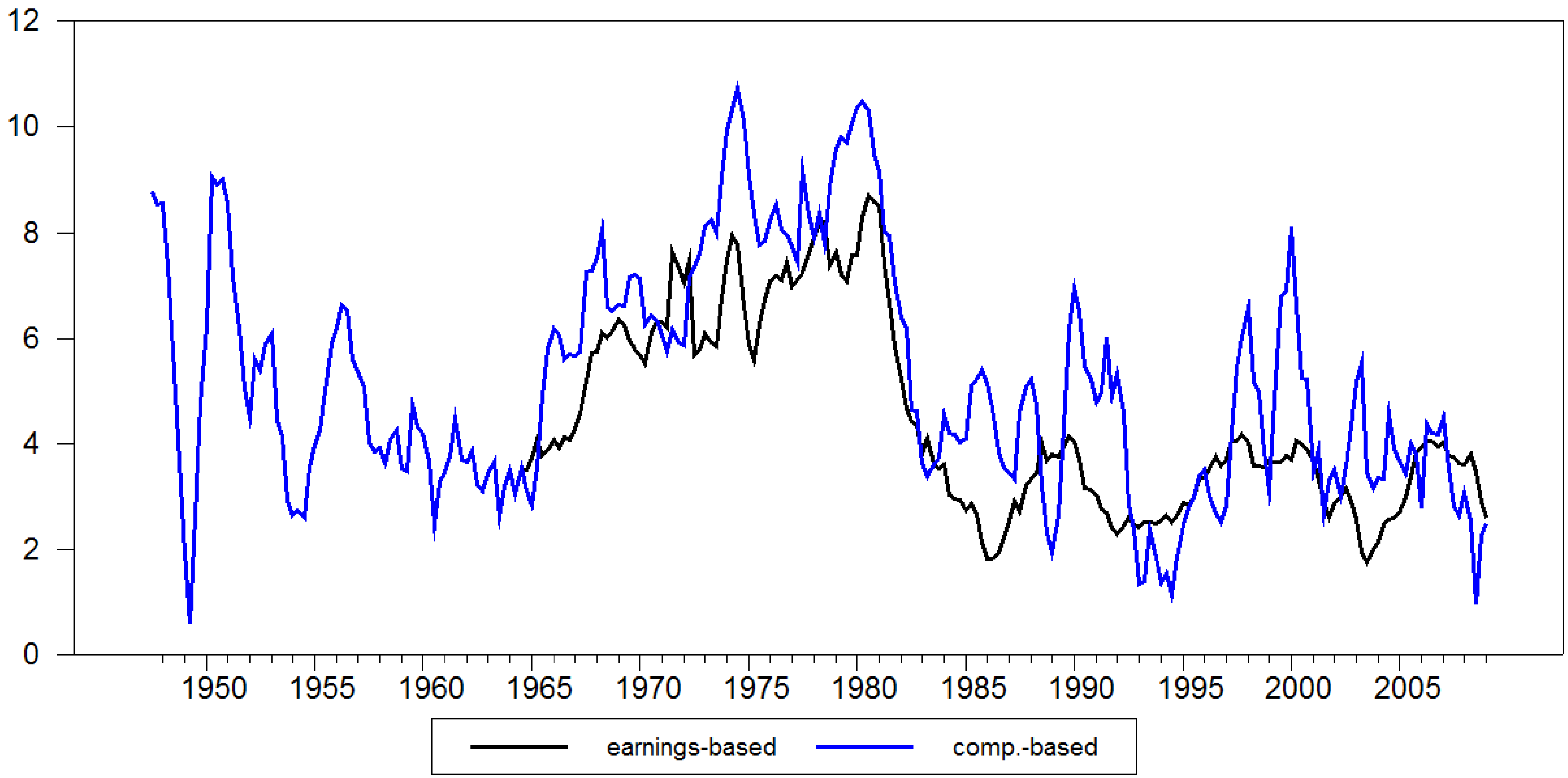
  - earnings ("establishment survey")
  - compensation ("productivity and costs")

- CPI inflation: two alternative indexing variables

$$\overline{\pi}^p_{t-1} = \pi^p_{t-1}$$

$$\overline{\pi}^p_{t-1} = (1/4)(\pi^p_{t-1} + \pi^p_{t-2} + \pi^p_{t-3} + \pi^p_{t-4})$$

Figure 1. Two Measures of Wage Inflation



Empirical Evidence

- A quick glance at the data
- Reduced form estimates

Estimated AR(2) process for unemployment

$$u_t = \underset{(0.08)}{0.22}^{**} + \underset{(0.08)}{1.66}^{**} u_{t-1} - \underset{(0.08)}{0.70}^{**} u_{t-2} + \varepsilon_t$$

Figure 2. Wage Inflation and Unemployment

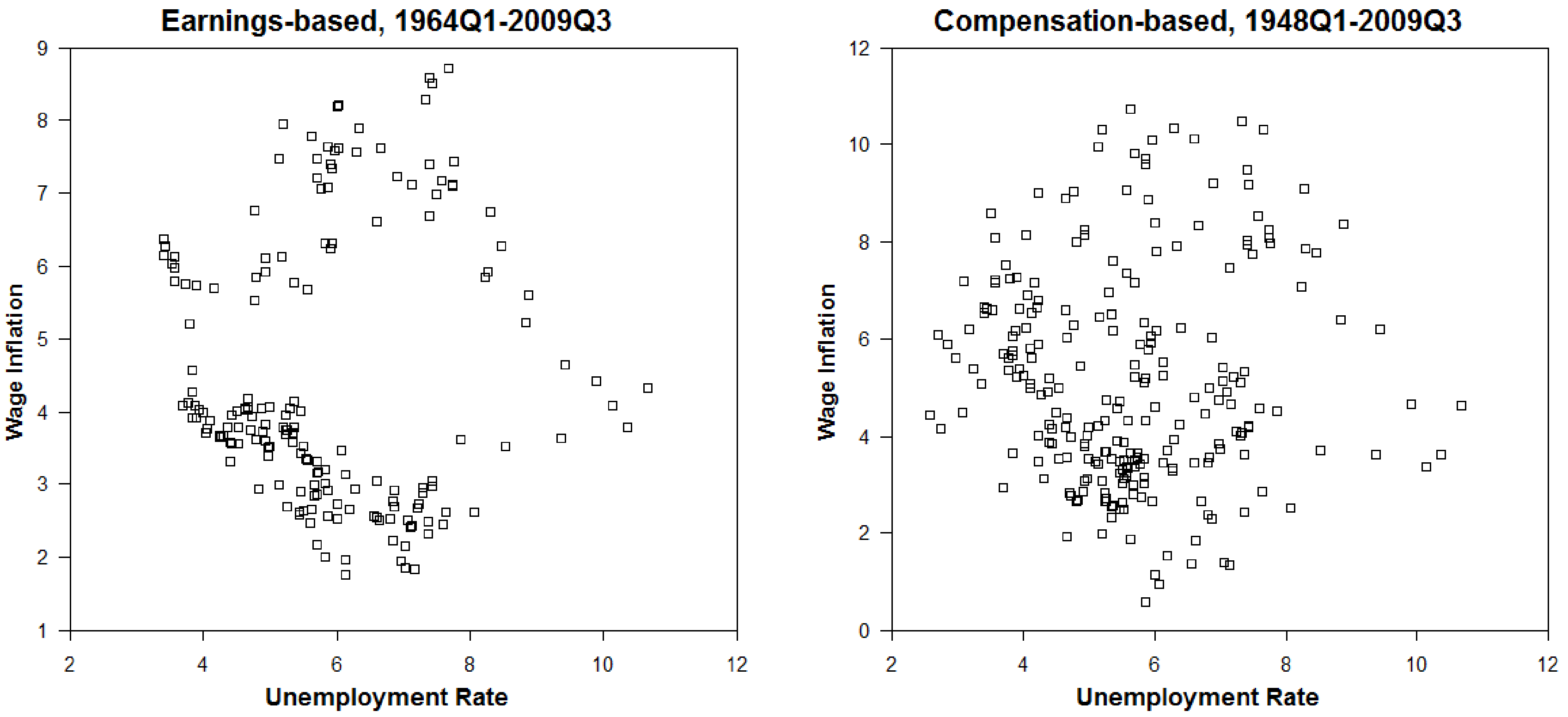


Figure 3. Wage Inflation and Unemployment over Time

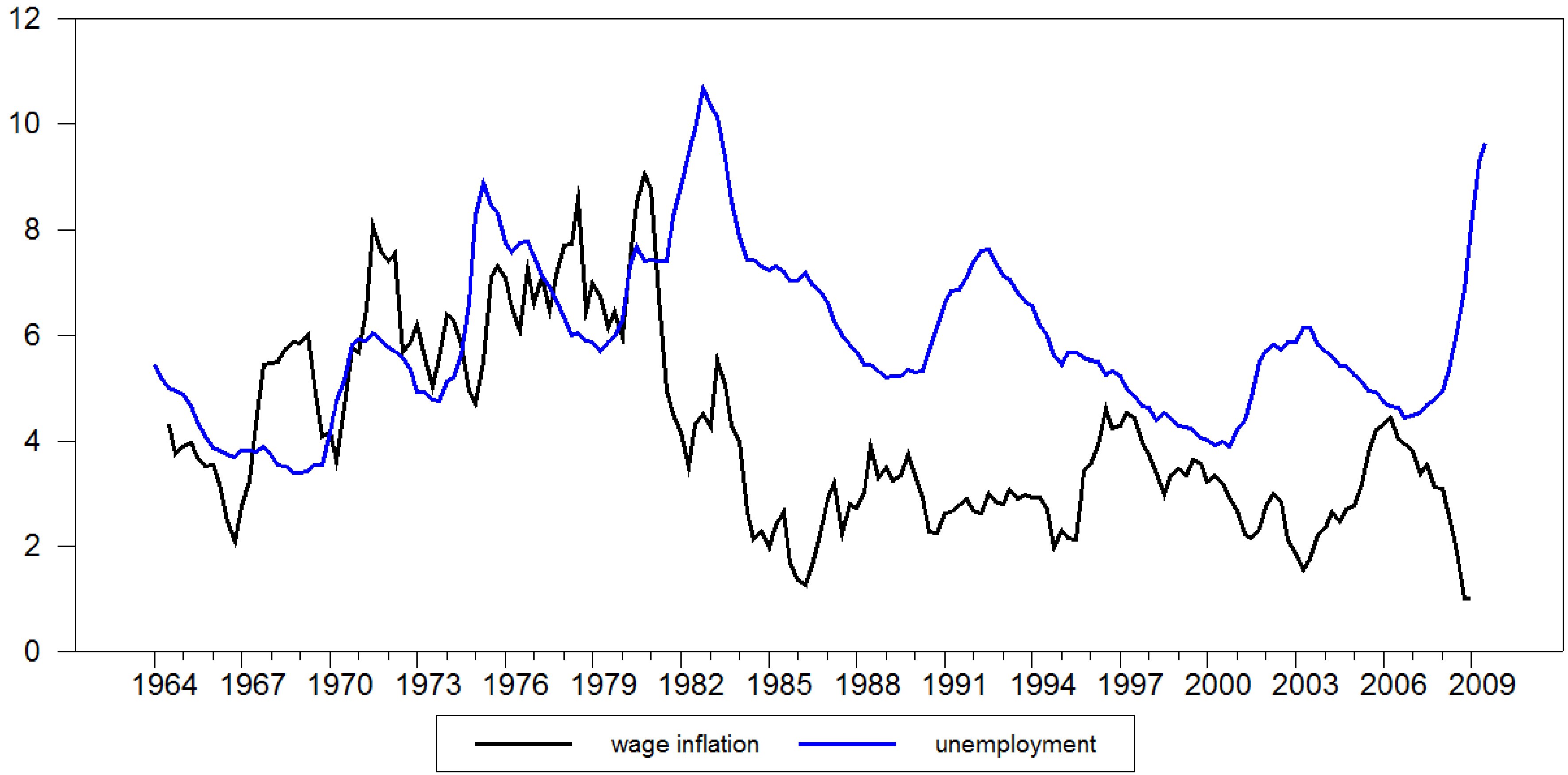


Figure 4. Wage Inflation and Unemployment during the Great Moderation

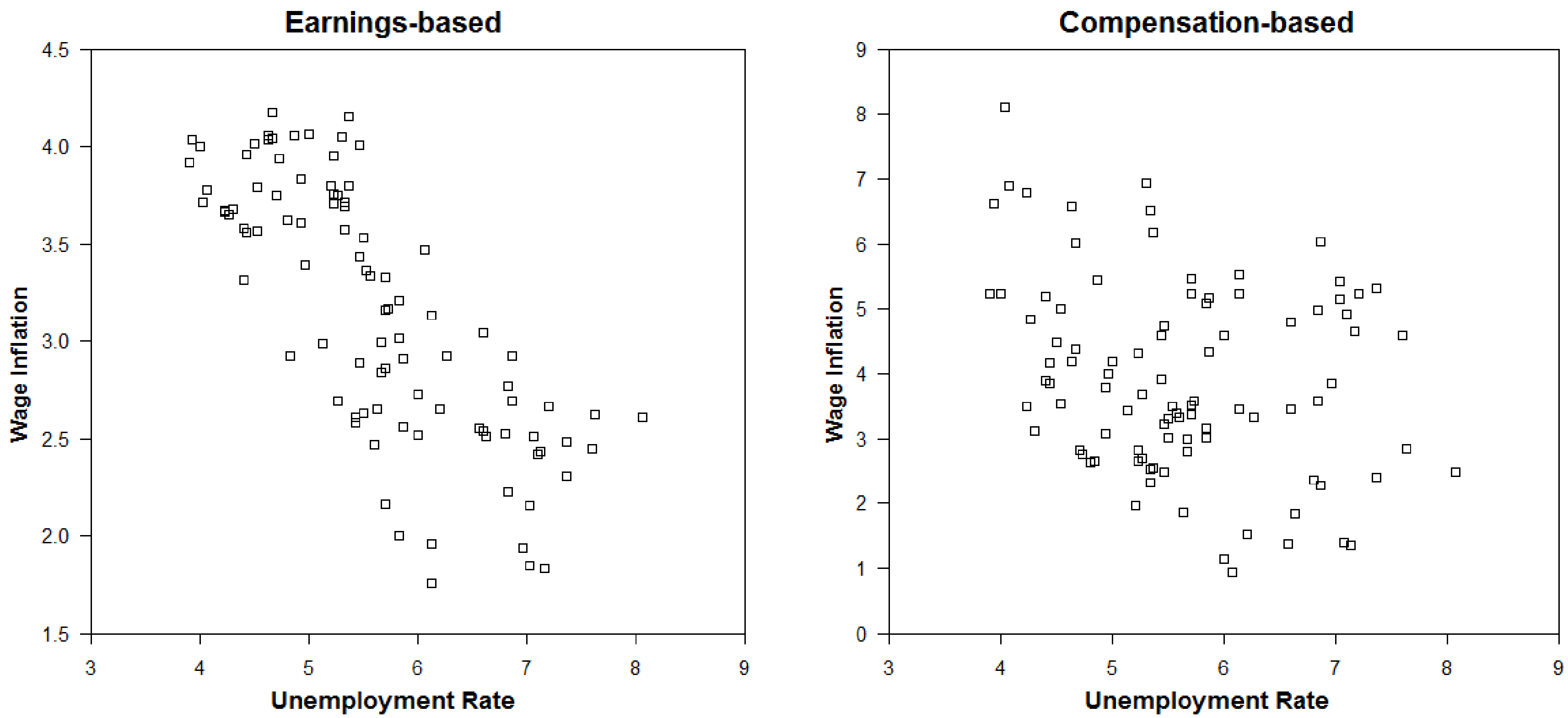
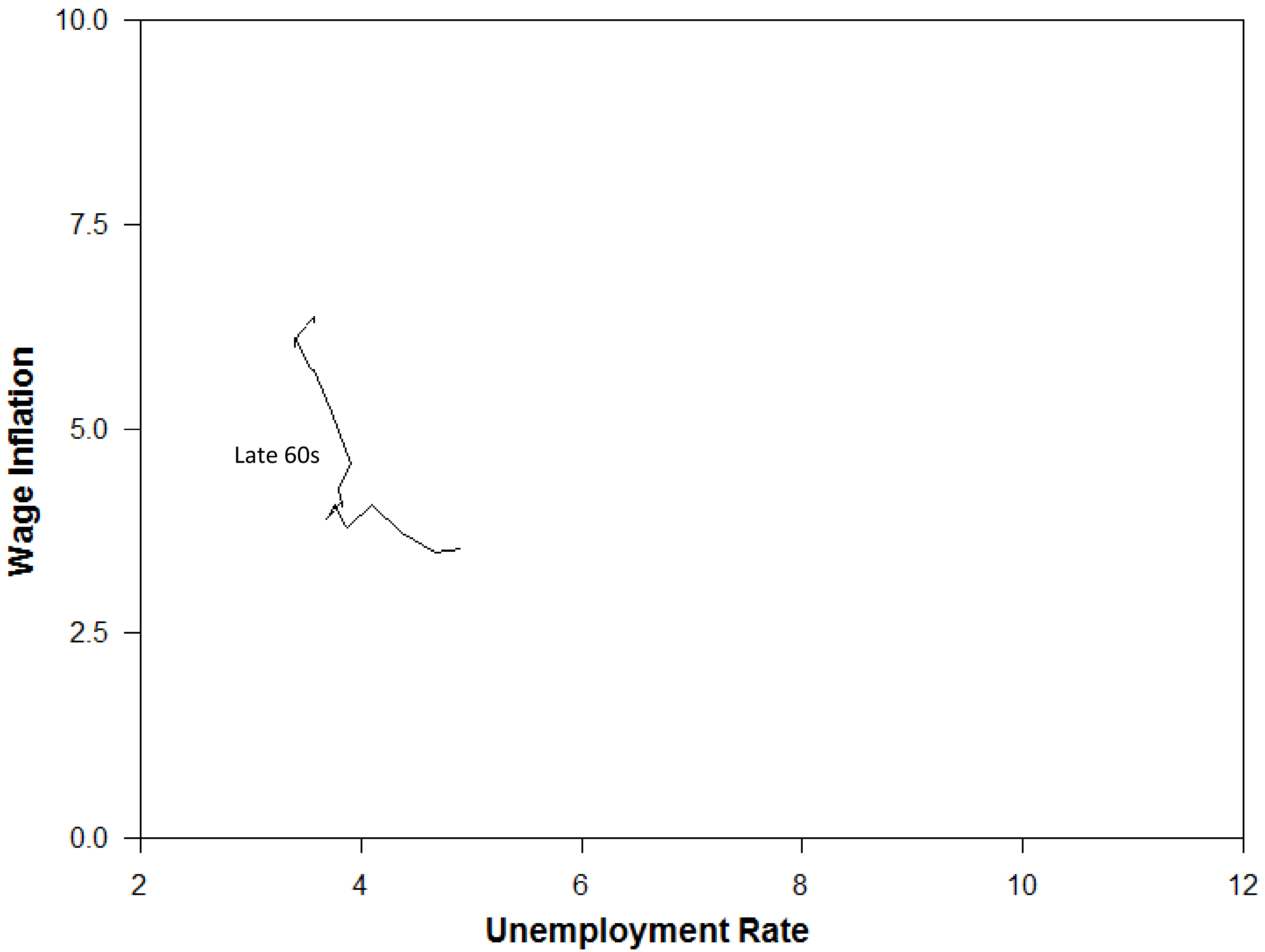


Figure 5. The Wage Phillips Curve over Time



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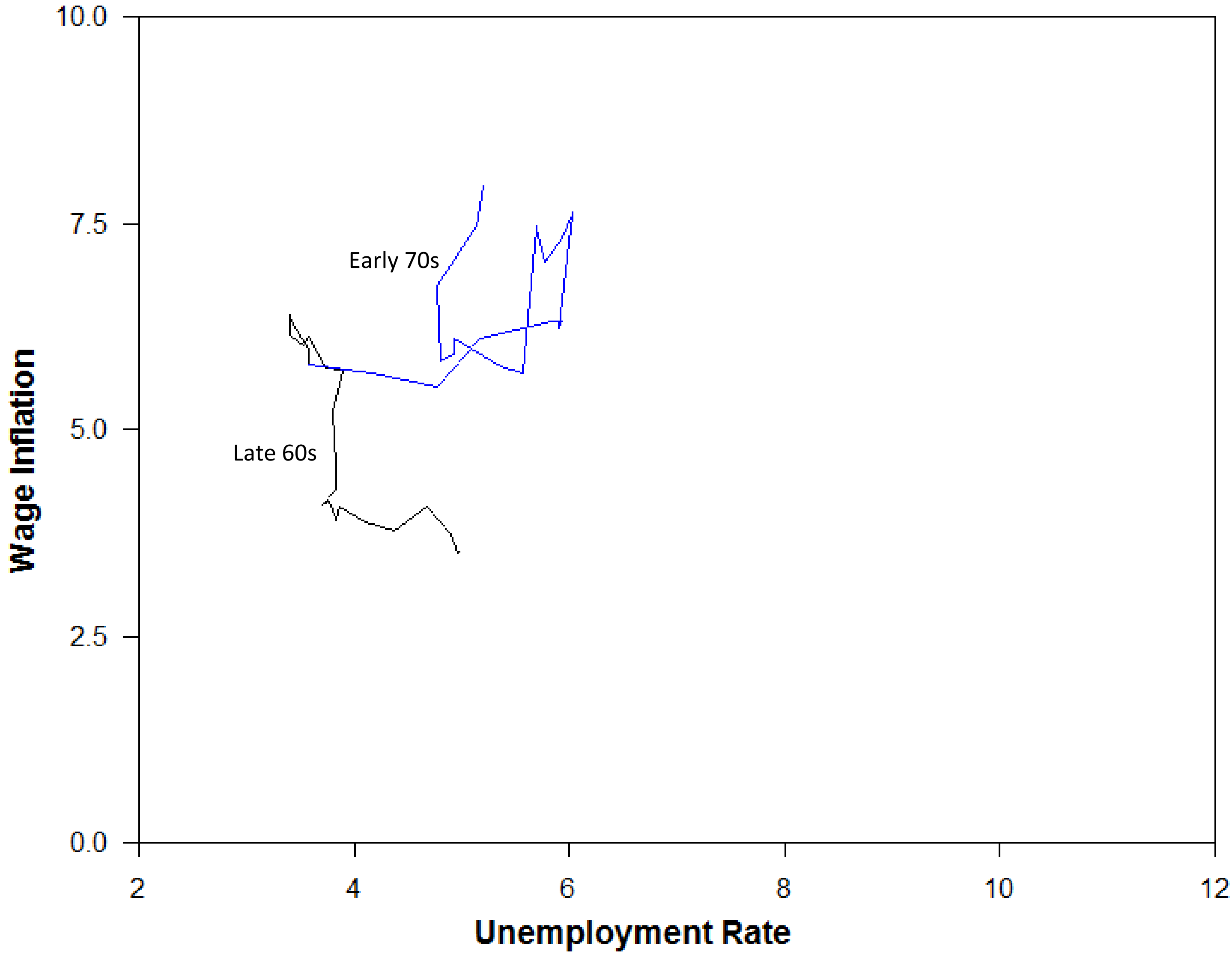

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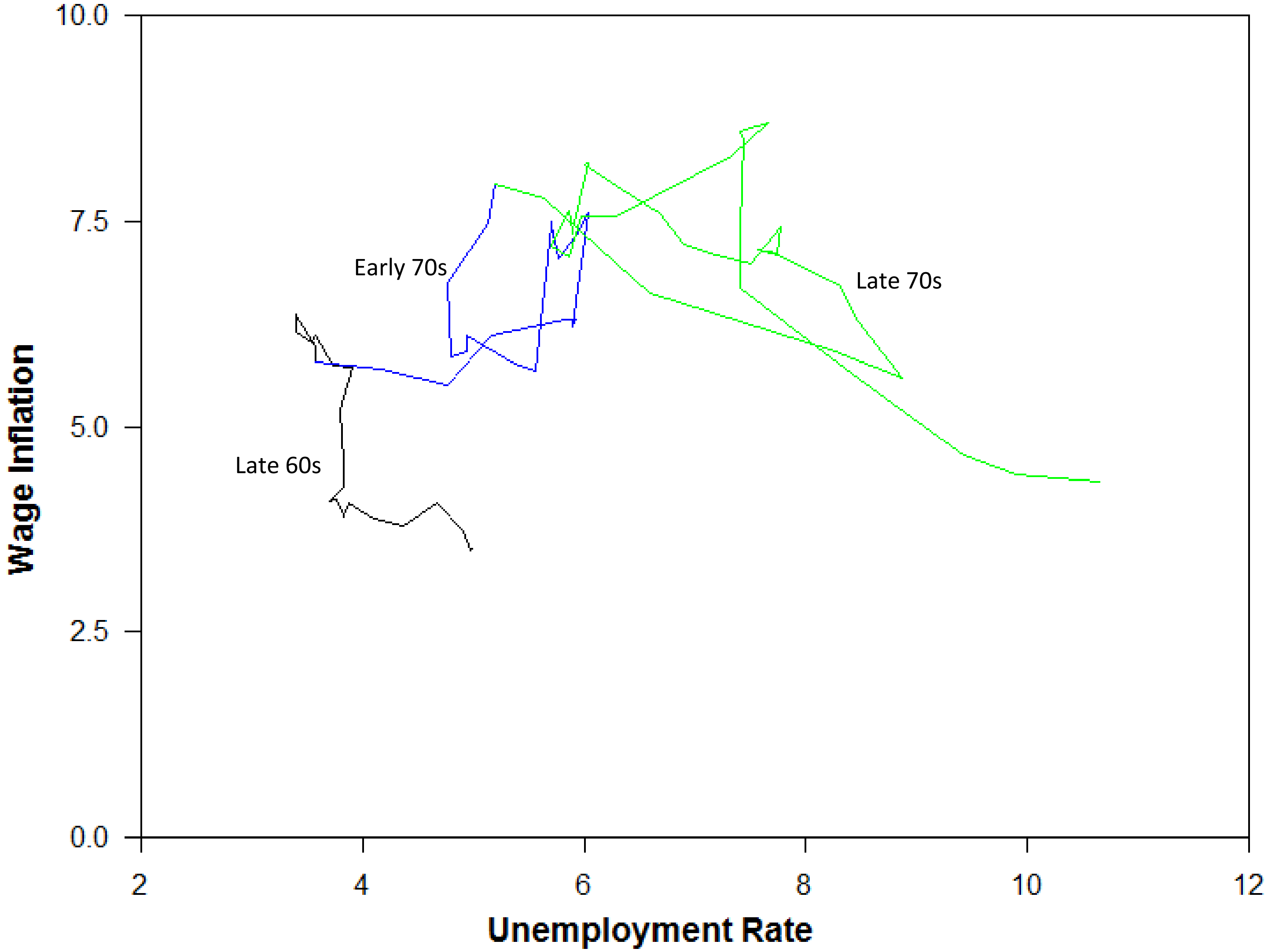

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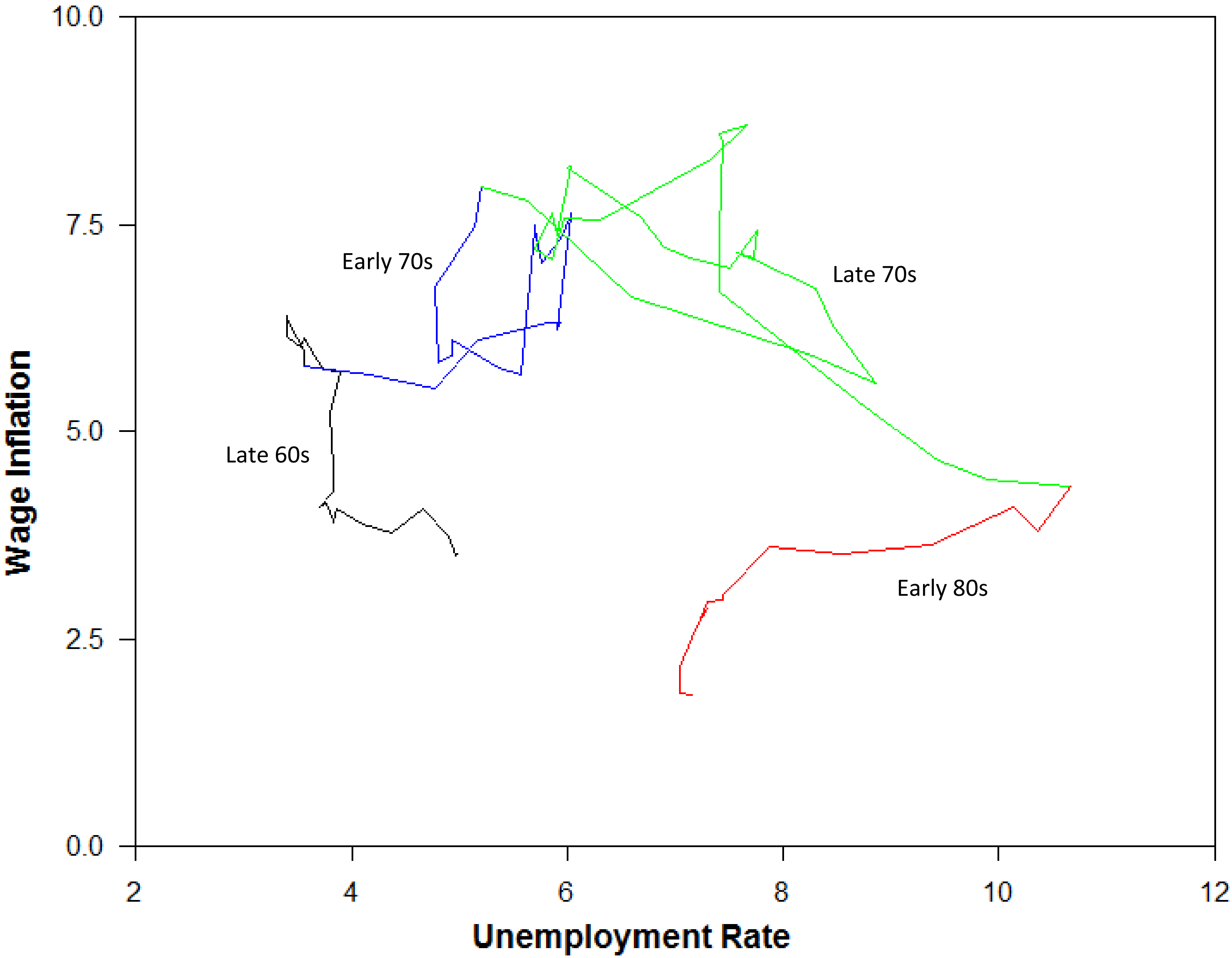


Figure 5. The Wage Phillips Curve over Time

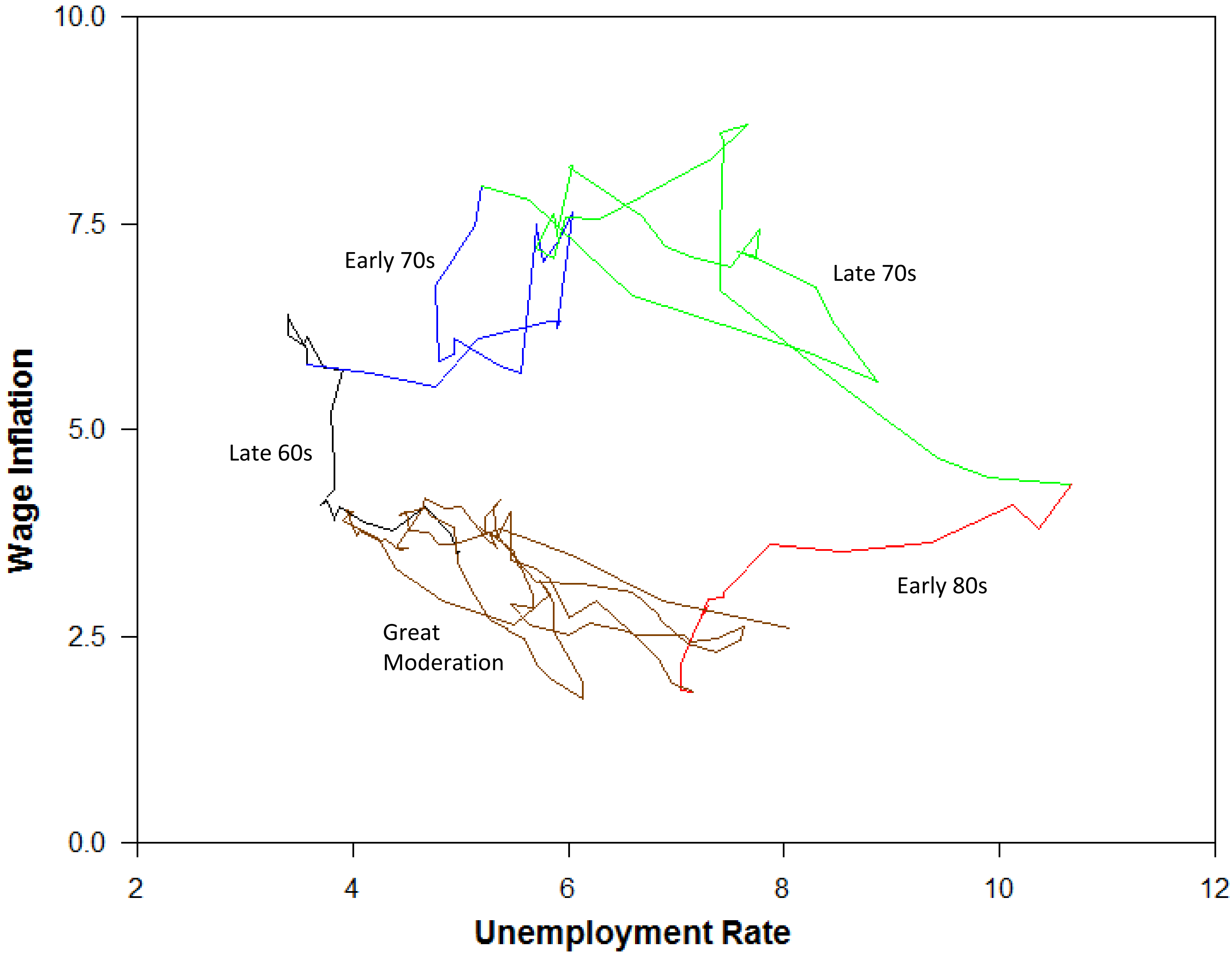


Table 1. Estimated Wage Inflation Equations: Earnings-based

	(1)	(2)	(3)	(5)	(6)	(7)	(8)
u_t	-0.001 (0.019)	-0.030^{*} (0.017)	-0.079^{**} (0.015)	-0.177 (0.114)	-0.377^{**} (0.083)	-0.334^{**} (0.095)	-0.552^{**} (0.076)
u_{t-1}				0.153 (0.112)	0.304^{**} (0.078)	0.294^{**} (0.095)	0.453^{**} (0.073)
π_{t-1}		0.415^{**} (0.043)		0.427^{**} (0.052)		0.503^{**} (0.036)	
$\pi_{t-1}^{(4)}$			0.565^{**} (0.038)		0.611^{**} (0.041)		0.687^{**} (0.038)
$p-value$				0.71	0.52	0.67	0.06
$\theta_w \ (\varphi = 1)$				0.788^{**} (0.083)	0.629^{**} (0.059)	0.755^{**} (0.061)	0.607^{**} (0.063)
$\theta_w \ (\varphi = 5)$				0.896^{**} (0.044)	0.805^{**} (0.036)	0.879^{**} (0.033)	0.792^{**} (0.039)

Table 2. Estimated Wage Inflation Equations: Compensation-based

	(1)	(2)	(3)	(5)	(6)	(7)	(8)
u_t	-0.015 (0.028)	-0.046^{*} (0.024)	-0.087^{**} (0.028)	-0.227^{**} (0.099)	-0.387^{**} (0.125)	-0.241^{**} (0.091)	-0.397^{**} (0.101)
u_{t-1}				0.189^{**} (0.096)	0.310^{**} (0.116)	0.189^{**} (0.090)	0.301^{**} (0.098)
π_{t-1}		0.500^{**} (0.046)		0.505^{**} (0.046)		0.522^{**} (0.046)	
$\pi_{t-1}^{(4)}$			0.578^{**} (0.058)		0.610^{**} (0.060)		0.642^{**} (0.052)
$p-value$				0.57	0.79	0.54	0.66
θ_w $(\varphi=1)$				0.709^{**} (0.086)	0.637^{**} (0.059)	0.675^{**} (0.069)	0.569^{**} (0.057)
θ_w $(\varphi=5)$				0.853^{**} (0.049)	0.780^{**} (0.043)	0.833^{**} (0.040)	0.767^{**} (0.037)

Fundamental vs. Actual Wage Inflation

- "Fundamental" wage inflation:

$$\begin{aligned} \widetilde{\pi}_t^w(\Theta) &\equiv \gamma \overline{\pi}_{t-1}^p - \lambda_w \varphi \sum_{k=0}^{\infty} \beta^k E\{u_{t+k} | \mathbf{z}_t\} \\ &= \gamma \overline{\pi}_{t-1}^p - \lambda_w \varphi \mathbf{e}_1' (\mathbf{I} - \beta \mathbf{A})^{-1} \mathbf{z}_t \end{aligned}$$

where

$$\Theta \equiv [\gamma, \theta_w, \beta, \epsilon_w, \varphi]$$

$$\mathbf{z}_t = [u_t, \pi_t^w - \gamma \overline{\pi}_{t-1}^p, ..., u_{t-q}, \pi_{t-q}^w - \gamma \overline{\pi}_{t-1-q}^p]$$

$$\mathbf{z}_t = \mathbf{A} \; \mathbf{z}_{t-1} + \varepsilon_t$$

- If the model is "true":

$$\widetilde{\pi}_t^w(\Theta) = \pi_t^w$$

Fundamental vs. Actual Wage Inflation

- Calibration:

  $\beta = 0.99$
  $\varphi = 1$ or 5
  ϵ_w set to imply $u^n = 0.05$, given φ

- Estimation of θ_w and γ, by minimizing $\sum_{t=0}^{T}(\pi_t^w - \widetilde{\pi}_t^w(\Theta))^2$

Table 3. Estimated Parameters using Minimum Distance Estimator

	Earnings				*Compensation*			
	π_{t-1}		$\pi_{t-1}^{(4)}$		π_{t-1}		$\pi_{t-1}^{(4)}$	
	$\varphi=1$	$\varphi=5$	$\varphi=1$	$\varphi=5$	$\varphi=1$	$\varphi=5$	$\varphi=1$	$\varphi=5$
γ	0.52 (0.013)	0.52 (0.017)	0.83 (0.130)	0.81 (0.110)	0.58 (0.020)	0.59 (0.030)	0.80 (0.170)	0.79 (0.107)
θ_w	0.65 (0.013)	0.82 (0.008)	0.52 (0.080)	0.74 (0.020)	0.64 (0.035)	0.81 (0.020)	0.54 (0.060)	0.75 (0.002)
$\rho(\widetilde{\pi}_t^w, \pi_t^w)$	0.82	0.82	0.91	0.91	0.77	0.78	0.77	0.76

Figure 6. Actual vs. Fitted Wage Inflation 1964Q1-2007Q4

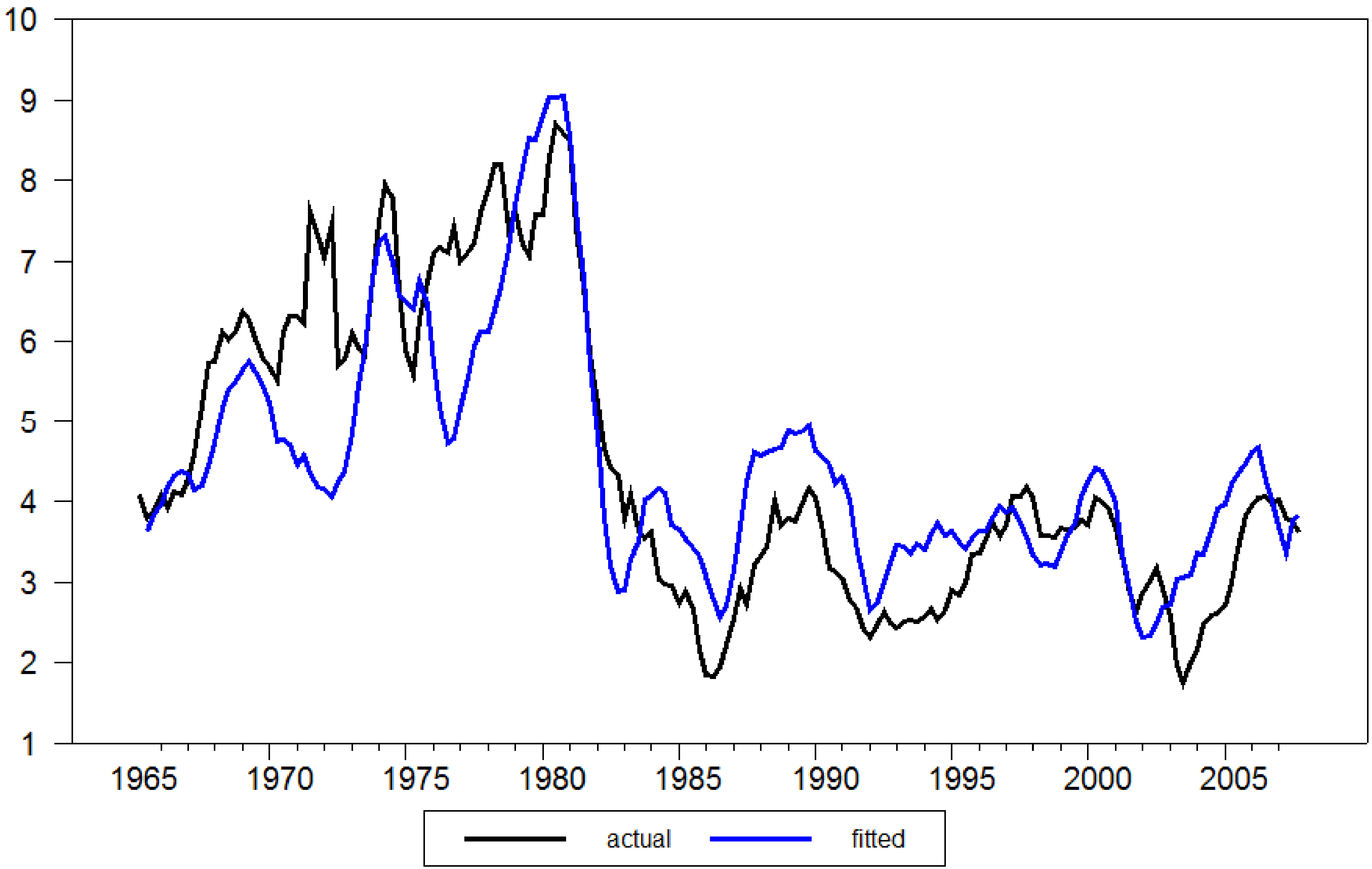


Figure 7. Actual vs. Fundamental Wage Inflation

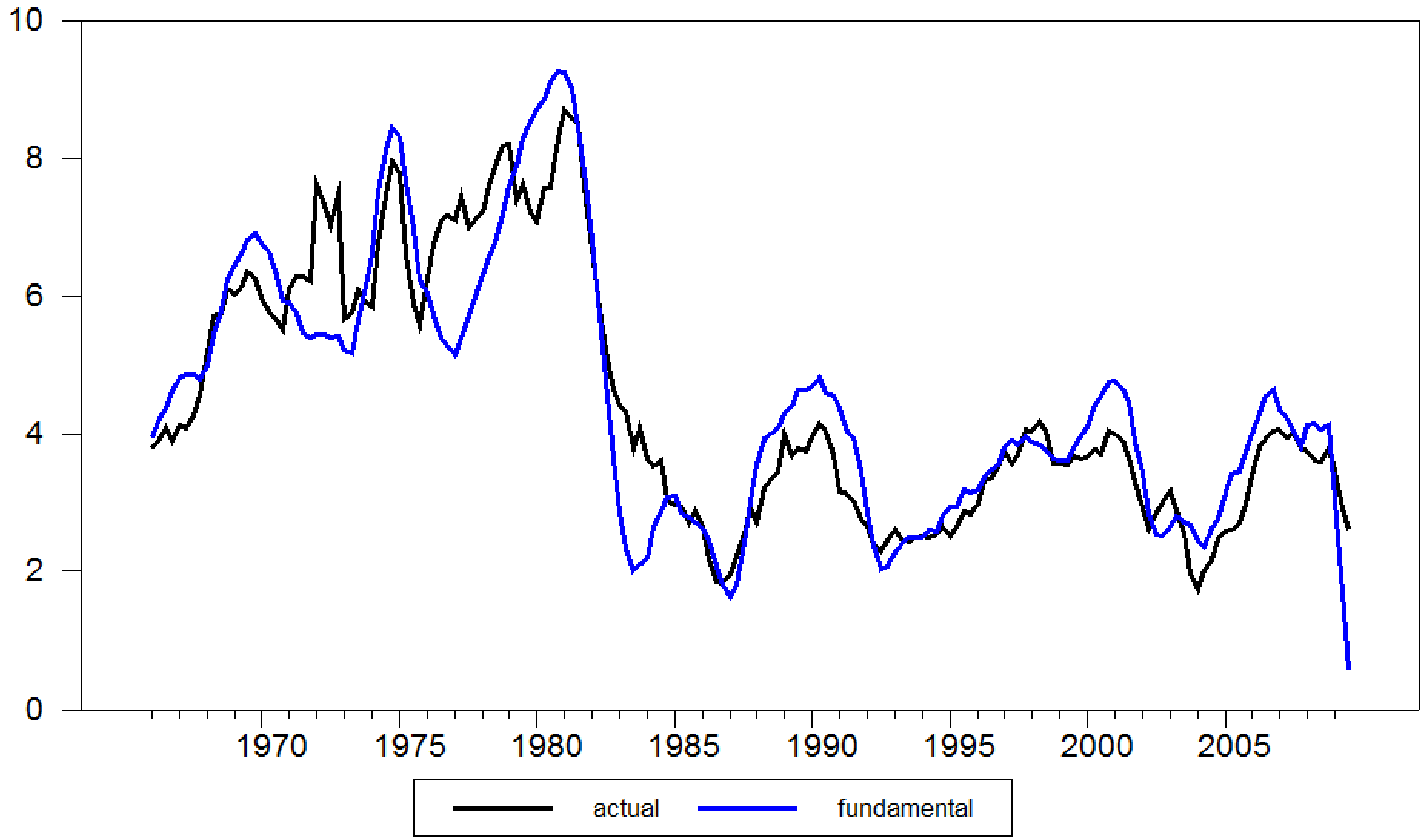
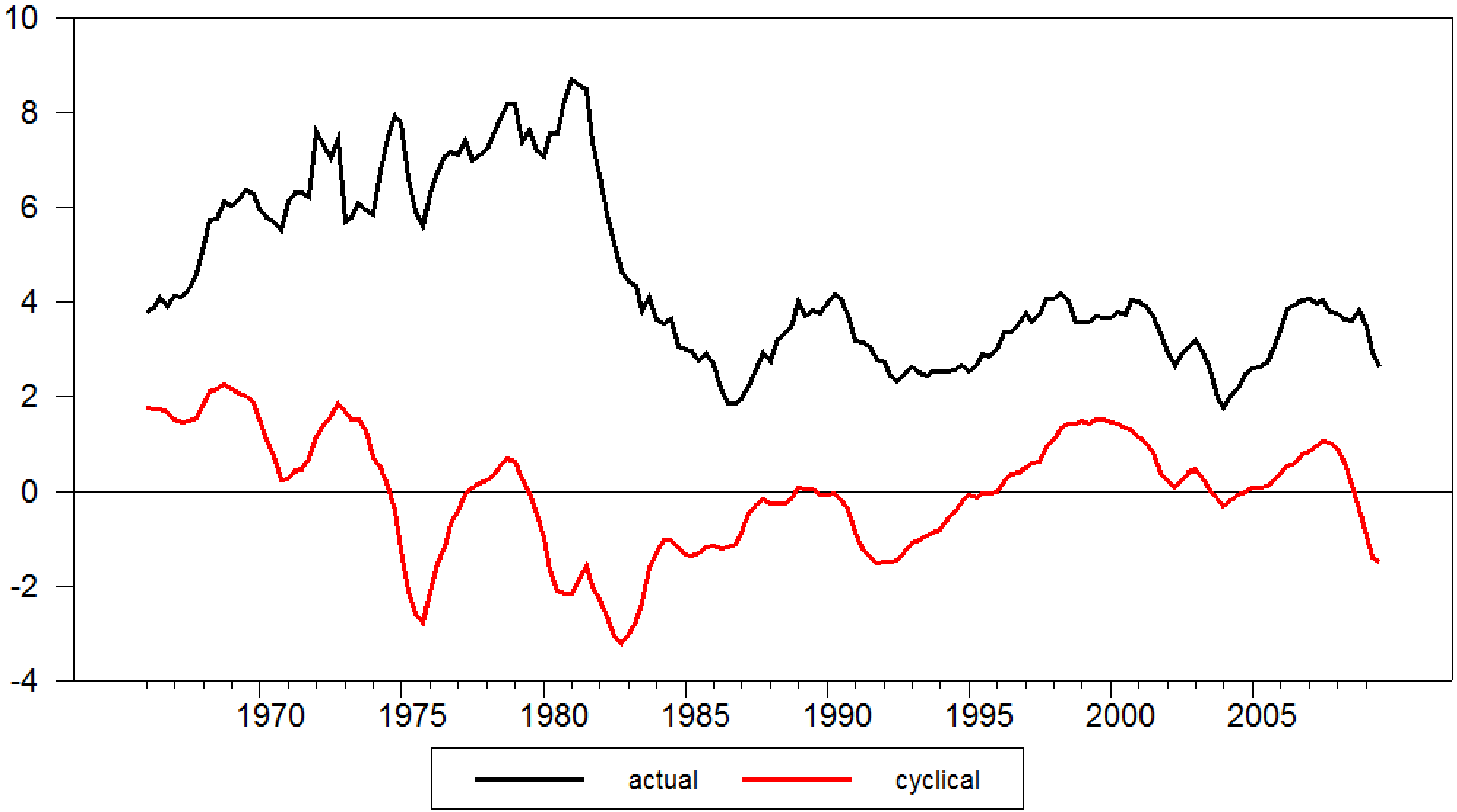


Figure 8. Wage Inflation and its Cyclical Component



Concluding remarks

- Microfounded model of the relation between wage inflation and unemployment $\Longrightarrow$ New Keynesian Wage Phillips Curve
- Good performance in accounting for patterns wage inflation (given unemployment), even under the maintained assumption of a constant natural rate
- Other applications of the same approach:

- accounting for the volatility and persistence of unemployment
- unemployment, the output gap and the costs of fluctuations
- unemployment and monetary policy design
- estimation of a medium-scale DSGE model with unemployment (with Smets and Wouters).