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
    \[ \Rightarrow \text{New Keynesian Wage Phillips Curve (NKWPC)} \]

- 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:
  \[
  U_t(C_t, \{N_t(i)\}, \chi_t) = \log C_t - \chi_t \int_0^1 \int_0^{N_t(i)} j^\varphi \, dj \, di
  \]
  \[
  = \log C_t - \chi_t \int_0^1 \frac{N_t(i)^{1+\varphi}}{1 + \varphi} \, di
  \]

  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:

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

- Optimal wage setting rule:

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

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

- Wage inflation equation

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

where $\mu_t^w \equiv (w_t - p_t) - (c_t + \varphi n_t + \zeta_t)$ 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 \((i, j)\):
  \[
  \left( \frac{1}{C_t} \right) \left( \frac{W_t(i)}{P_t} \right) \geq \chi_t j^\phi
  \]

- Marginal participant in market for type-\(i\) labor, \(L_t(i)\):
  \[
  \frac{W_t(i)}{P_t} = \chi_t C_t L_t(i)^\phi
  \]

- Taking logs and integrating over \(i\),
  \[
  w_t - p_t = c_t + \phi l_t + \zeta_t
  \]

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**
  \[
  \mu_t^w = (w_t - p_t) - (c_t + \varphi n_t + \zeta_t) \\
  = (w_t - p_t) - (c_t + \varphi l_t + \zeta_t) + \varphi (l_t - n_t) \\
  = \varphi u_t
  \]

- **Under flexible wages:**
  \[ \mu^w = \varphi u^n \]

  \[ \Rightarrow \quad u^n: \text{natural rate of unemployment} \]

- **A New Keynesian Wage Phillips Curve:**
  \[
  \pi_t^w = \beta E_t \{ \pi_{t+1}^w \} - \lambda_w \varphi (u_t - u^n)
  \]

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Figure 1. The Wage Markup and the Unemployment Rate

\[ w_t - p_t \]

\[ \mu_t^w \]

\[ u_t \]

Labor supply
\((mrs_t)\)

Labor demand
\((mpn_t - \mu^p_t)\)

Employment
Labor force

Wage

\(n_t\)

\(l_t\)
Allowing for Wage Indexation

- Indexation rule
  \[ w_{t+k|t} = w_{t+k-1|t} + \gamma \pi^p_{t+k-1} + (1 - \gamma) \pi^p + g \]

- Implied wage inflation equation
  \[ \pi^w_t = \alpha + \gamma \pi^p_{t-1} + \beta E_t \{ \pi^w_{t+1} - \gamma \pi^p_t \} - \lambda_w (\mu^w_t - \mu^w) \]

- Implied New Keynesian Wage Phillips Curve
  \[ \pi^w_t = \alpha + \gamma \pi^p_{t-1} + \beta E_t \{ \pi^w_{t+1} - \gamma \pi^p_t \} - \lambda_w \varphi (u_t - u^n) \]
Two Extensions (Galí-Smets-Wouters)

- Time-varying desired wage markups \( \{\bar{\mu}_t^w\} \)

\[
\pi_t^w = \alpha + \gamma \pi_{t-1}^p + \beta E_t \{\pi_{t+1}^w - \gamma \pi_t^p\} - \lambda w \varphi u_t + \lambda w \bar{\mu}_t^w
\]

⇒ overcomes the identification problem raised by Chari et al. (2009)

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

\[
w_t - p_t = z_t + \varphi l_t + \zeta_t
\]

where

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

⇒ unchanged specification of the NKWPC
A Reduced Form Representation of the NKWPC

- **Unemployment process**
  \[ \hat{u}_t = \phi_1 \hat{u}_{t-1} + \phi_2 \hat{u}_{t-2} + \varepsilon_t \]

- **Implied NKWPC**
  \[ \pi^w_t = \alpha + \gamma \pi^p_{t-1} + \psi_0 \hat{u}_t + \psi_1 \hat{u}_{t-1} \] \hspace{1cm} (4)

  where
  \[ \psi_0 \equiv -\frac{\lambda_w \varphi}{1 - \beta(\phi_1 + \beta \phi_2)} \quad \text{and} \quad \psi_1 \equiv -\frac{\lambda_w \varphi \beta \phi_2}{1 - \beta(\phi_1 + \beta \phi_2)} \]

  or, equivalently,
  \[ \pi^w_t = \alpha + \gamma \pi^p_{t-1} - \delta \hat{u}_t - \psi_1 \Delta u_t \] \hspace{1cm} (5)

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

- **In the data:** \( \phi_1 > 1, -1 < \phi_2 < 0 \quad \Rightarrow \psi_0 < 0, \psi_1 > 0, \text{and} \delta > 0 \)

- **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

\[
\bar{\pi}^p_{t-1} = \pi^p_{t-1}
\]

\[
\bar{\pi}^p_{t-1} = \left(\frac{1}{4}\right) \left(\pi^p_{t-1} + \pi^p_{t-2} + \pi^p_{t-3} + \pi^p_{t-4}\right)
\]
Figure 1. Two Measures of Wage Inflation
Empirical Evidence

- A quick glance at the data
- Reduced form estimates

Estimated AR(2) process for unemployment

\[ u_t = 0.22^{**} + 1.66^{**} u_{t-1} - 0.70^{**} u_{t-2} + \varepsilon_t \]

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Figure 2. Wage Inflation and Unemployment

Earnings-based, 1964Q1-2009Q3

Compensation-based, 1948Q1-2009Q3
Figure 3. Wage Inflation and Unemployment over Time

The graph shows the trend of wage inflation and unemployment over time from 1964 to 2009. Wage inflation is represented by the black line, and unemployment by the blue line. The data indicates fluctuations in both metrics with some periods of stability and others of increase or decrease.
Figure 4. Wage Inflation and Unemployment during the Great Moderation
Figure 5. The Wage Phillips Curve over Time

Late 60s
Figure 5. The Wage Phillips Curve over Time
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[Graph showing wage inflation and unemployment rate over time, with labels for Early 70s, Late 70s, and Late 60s periods.]
Figure 5. The Wage Phillips Curve over Time
Figure 5. The Wage Phillips Curve over Time

- Early 70s
- Late 70s
- Late 60s
- Great Moderation
- Early 80s

Wage Inflation vs. Unemployment Rate
Table 1. Estimated Wage Inflation Equations: Earnings-based

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"Fundamental" wage inflation:

\[ \tilde{\pi}_t^w(\Theta) \equiv \gamma \hat{\pi}_{t-1}^p - \lambda_w \varphi \sum_{k=0}^{\infty} \beta^k E\{u_{t+k}|z_t\} \]

\[ = \gamma \hat{\pi}_{t-1}^p - \lambda_w \varphi e_1' (I - \beta A)^{-1} z_t \]

where

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

\[ z_t = [u_t, \pi_t^w - \gamma \hat{\pi}_{t-1}^p, \ldots, u_{t-q}, \pi_{t-q}^w - \gamma \hat{\pi}_{t-1-q}^p] \]

\[ z_t = A \ z_{t-1} + \epsilon_t \]

If the model is "true":

\[ \tilde{\pi}_t^w(\Theta) = \pi_t^w \]
Fundamental vs. Actual Wage Inflation

Calibration:

\[ \beta = 0.99 \]
\[ \varphi = 1 \text{ or } 5 \]
\[ \epsilon_w \text{ set to imply } u^n = 0.05, \text{ given } \varphi \]

Estimation of \( \theta_w \) and \( \gamma \), by minimizing
\[ \sum_{t=0}^{T} (\pi^w_t - \tilde{\pi}^w_t(\Theta))^2 \]
<table>
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<th>Earnings</th>
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<td>$\pi_{t-1}$</td>
<td>$\pi_{t-1}^{(4)}$</td>
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<tr>
<td>$\varphi = 1$</td>
<td>0.52 (0.013)</td>
<td>0.83 (0.130)</td>
</tr>
<tr>
<td>$\varphi = 5$</td>
<td>0.52 (0.017)</td>
<td>0.81 (0.110)</td>
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</table>

| $\gamma$ | 0.65 (0.013) | 0.52 (0.050) | 0.64 (0.035) | 0.54 (0.060) | 0.75 (0.002) |
| $\theta_w$ | 0.82 (0.008) | 0.74 (0.020) | 0.81 (0.020) | 0.77 (0.060) |

$\rho(\tilde{\pi}_{t}^w, \pi_{t}^w)$

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 $\implies$ 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).