How Sticky Wages In Existing Jobs Can Affect Hiring

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1 Introduction

• Wages change relatively infrequently
  — Daly and Hobijn (2014), CPS, year-over-year some with no change
  — Barattieri, Basu, Gottschalk (2010), SIPP, hourly-paid wage duration 17 months

• Depart from sticky-wage literature by firms/workers bargaining over effort/output
  — If wages stay high after negative shock; ask more of workers
  — Reduces payoff to hiring—G.E. effect—Is stronger if aggregate labor demand less elastic
• Treat Mortensen-Pissarides model with wages flexible for new hires, but sticky within

  — Wages more cyclical for new matches (Pissarides, 2009)

• In M-P model wage stickiness in existing jobs doesn’t matter—Not true in our model

• Can get wide difference in effort by vintage, impact short-lived

• If constrain workers to have same effort/pace, impact much larger

  — Get considerable wage inertia/unemployment volatility
• Difficult to measure cyclicality of effort

• Lazear, Shaw, and Stanton (2013) examine productivity of 20,000 workers at services company for June 2006 to May 2010: increase in local unemployment rate of 5 percentage points increases productivity 3.75%

• Anger (2011) unpaid overtime (extra) hours highly countercyclical for German workers for 1984 to 2004

• ATUS: See more workers taking work home
• Model consistent with little productivity/wage response in recessions
  — 2007 to 2009, 10% decline in hours compared to 6% in output

• Goes part way in rationalizing Shimer puzzle
  — Gives bigger response in employment to productivity shock
  — Makes measured TFP respond much less to that shock

• Examine whether consistent with behavior of TFP across industries
  — Stratify industries by measures of wage stickiness
  — Stickier wages yields countercyclical TFP, more cyclical hours
1959 - 1986

1987- 2012
Model

- Diamond-Mortensen-Pissarides matching model

- Exogenous Separation

- Staggering Wage Contracts

- Wages Flexible for Newly Matched Workers

- Effort is chosen through Nash Bargaining
Workers’ Preferences

\[ E_0 \sum_{t=0}^{\infty} \beta^t \left\{ c_t + \psi \frac{(1 - e_t)^{1-\gamma} - 1}{1 - \gamma} \right\}, \]

- \( c \): consumption

- \( e \): effort

- \( \frac{e}{1-e^\gamma} \): Frisch elasticity of effort w.r.t. wage
Firms’ Production Technology

\[ y_t = z_t e_t^\alpha (k_t e_t)^{1-\alpha}, \]

- \( z_t \): aggregate productivity
- \( k_t \): capital per effort, equated over firms
- Aggregate capital fixed over cycle
Matching Technology

\[ M(u_t, v_t) = \chi u_t^{1/2} v_t^{1/2}, \]

\[ \theta_t = \frac{v_t}{u_t}, \]

Each period jobs are destroyed with exogenous probability \( \delta \).
**Staggered Wage Contract**

- When a match is formed, the wage is set according to a Nash bargaining.

- Wage is fixed for $T$ periods.
Choice of Labor Effort

- Effort is determined according to the Nash bargaining.

- We consider three cases:
  - Effort level is fixed
  - Effort level is chosen individually
  - Common level of effort is chosen
Value of Employed whose wage contract is $j$-period old

For $j = 0, 1, \ldots, T - 2$,

$$W_j(w_j; z, \mu) = w_j + \psi \frac{(1 - e)^{1-\gamma} - 1}{1 - \gamma}$$

$$+ \beta \left\{ (1 - \delta) E[W_{j+1}(w_j; z', \mu') | z] + \delta E[U(z', \mu') | z] \right\}.$$

subject to

$$z' \sim F(z' | z) = \text{Prob}(z_{t+1} \leq z' | z_t = z)$$

$$\mu' = T(\mu, z)$$
where the transition operator $T$ is characterized as:

$$
\begin{pmatrix}
  w'_0 \\
  w'_1 \\
  \vdots \\
  w'_{T-1}
\end{pmatrix}
= 
\begin{pmatrix}
  w^*(z', \mu') \\
  w_0 \\
  \vdots \\
  w_{T-2}
\end{pmatrix},
$$

(1)

$$
\begin{pmatrix}
  N'_0 \\
  N'_1 \\
  \vdots \\
  N'_{T-1}
\end{pmatrix}
= 
\begin{pmatrix}
  (1 - \delta)N_{T-1} + M(u, v) \\
  (1 - \delta)N_0 \\
  \vdots \\
  (1 - \delta)N_{T-2}
\end{pmatrix},
$$

(2)

where $w^*(z', \mu')$ is newly-employed worker’s wage in the next period.
For matched who will newly negotiate wage next period, (i.e., \( j = T - 1 \)):

\[
W_{T-1}(w_{T-1}; z, \mu) = w_{T-1} + \psi \frac{(1 - e)^{1-\gamma} - 1}{1 - \gamma} \\
+ \beta \left\{ (1 - \delta)E[W_0(w^*; z', \mu')|z] + \delta E[U(z', \mu')|z] \right\}.
\]
Value of a Job matched with a worker whose wage contract is $j$-period old

For $j = 0, 1, ..., T - 2$,

$$J_j(w_j; z, \mu) = \alpha y - w_j + \beta(1 - \delta)E[J_{j+1}(w_j; z', \mu')|z].$$

For the job whose wage will be negotiated next period (i.e., $j = T - 1$)

$$J_{T-1}(w_{T-1}; z, \mu) = \alpha y - w_{T-1} + \beta(1 - \delta)E[J_0(w^*; z', \mu')|z],$$
Value of Unemployed (standard)

\[ U(z, \mu) = b + \beta \left\{ p(\theta) E[W_0(w^*; z', \mu')|z] + (1 - p(\theta)) E[U(z', \mu')|z] \right\}. \]

Free Entry Condition (standard)

Firms post vacancies until expected value of hire equals cost of vacancy:

\[ \kappa = q(\theta) \beta E[J_0(w^*; z', \mu')|z]. \]
Nash Bargaining over Wages of New Bargains

Wage for new matches, $w^*(z, \mu)$, is determined by Nash bargain between set of workers and firm:

$$w^*(z, \mu) = \arg\max_w \left( J_0(w; z, \mu) \right)^{1/2} \left( W_0(w; z, \mu) - U(z, \mu) \right)^{1/2}.$$ 

First order condition for $w^*(z, \mu)$ is

$$J_0(w^*; z, \mu) = W_0(w^*; z, \mu) - U(z, \mu).$$
Choice of Effort

Given the wage $w_j$, effort determined by Nash bargaining. If by vintage:

$$e^*_j(w_j, z, \mu) = \arg\max_{e_j} \left( J_j(e_j; w_j, z, \mu) \right)^{1/2} \left( W_j(e_j; w_j, z, \mu) - U(z, \mu) \right)^{1/2}$$

First order condition for $e^*(z, \mu)$ is

$$\psi(1 - e_j)^{-\gamma} J_j(e_j; w_j, z, \mu) = \alpha z k^{1-\alpha} \left( W_j(e_j; w_j, z, \mu) - U(z, \mu) \right)$$

For $w_j = w^*(z, \mu)$ have efficient effort

$$\psi(1 - e_j)^{-\gamma} = \alpha z k^{1-\alpha}$$
Model with Common Level of Effort

We also consider the model with common level of effort across workers.

- Maybe unrealistic to operate at varying work rules across employee.
- Complementarity of labor across workers
Bargaining over the Common Level of Effort

The common effort level, $e(z, \mu)$, is determined by Nash bargaining over weighted average of surpluses across worker vintages.

$$e^*(z, \mu) = \arg\max_e \left( J \right)^{1/2} \left( W - U \right)^{1/2},$$

$$J = \sum_{j=0}^{T-1} \left( \frac{N_j}{\sum_{j=0}^{T-1} N_j} \right) J_j,$$

$$W - U = \sum_{j=0}^{T-1} \left( \frac{N_j}{\sum_{j=0}^{T-1} N_j} \right) (W_j - U).$$
Calibration

- Imposed Parameters

- Targeted Parameters
Calibration: Imposed Parameters

- $\beta = 0.99$. Labor elasticity: $\alpha = 0.64$. Rental Rate: $r + d = 3.5\%$.

- Frisch Elasticity of Effort: $\frac{1}{\gamma}(\frac{1-e)}{e}) = 1$; $\psi$ so S.S. effort, $e = 1/2$.

- Contract length: $T = 4$.

- Benefit $b$ so replacement rate $b \left/ \left( w_{ss} + \psi \frac{(1-e)^{1-\gamma} - 1}{1-\gamma} \right) \right. = 70\%$. 
Calibration: Targeted Parameters

- Normalize $\theta = 1$

- Vacancy posting cost and $\delta = 4\%$ to get S.S. $u = 6.25\%$ and finding rate = 60\% (given replacement rate and free entry condition).
Impulse Responses to a 1% Decrease in Productivity

We will show models with:

- **Fixed Effort (Flexible wage and Sticky wage)**

- **Endogenous Effort**
  - Flexible wage
  - Sticky wage with individual effort level
  - Sticky wage with common effort level
Models with Fixed Effort
Wages for New Bargains ($w_0$)

- **Sticky Wage Fixed Effort**
- **Flexible Wage Fixed Effort**
Models with Variable Effort:

We consider cases with:

- Benchmark \((T = 4, \gamma = 1, \alpha = 0.64)\)
- Longer Contract Length \((T = 8)\)
- Smaller Frisch Elasticity \((\gamma = 2)\)
- Smaller Labor Demand Elasticity \((\alpha = 0.28)\)
Benchmark \((T = 4, \gamma = 1, \alpha = 0.64)\)
Aggregate Wage ($W$)
Employment (N)

% deviation from steady state

Sticky Wage Individual Effort
Flexible Wage Endogenous Effort
Benchmark \( (T = 4, \gamma = 1, \alpha = 0.64) \)
New Matches (M)
Longer Contract Length ($T = 8$)

Aggregate Wage ($W$)
Smaller Frisch Elasticity ($\gamma = 2$)
Smaller Labor Demand Elasticity ($\alpha = 0.28$)
2 Model Helps Explain Volatility of Unemployment for Measured Productivity

- Partly by making employment respond more
- Partly by making measured productivity less cyclical than shock
Productivity Shock = Measured TFP in US
Unemployment (Model vs US Data)

deviation from steady state (%)

Flexible Wage Endognous Effort
U.S. Data
Unemployment (Model vs US Data)

deviation from steady state (%)

Sticky Wage Common Effort

U.S. Data
Measured TFP (Model vs US Data)
Productivity Shock = 1.92* Measured TFP in US
Measured TFP (Model vs US Data)

% deviation from steady state

Sticky Wage Common Effort ($Z = 1.92 \times \text{TFP}$)
U.S. Data

-3 -2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5
Unemployment (Model vs US Data)

deviation from steady state (%)

Sticky Wage Common Effort ($Z = 1.92 \times TFP$)

U.S. Data


-1
-0.5
0
0.5
1
1.5
2
2.5

deviation from steady state (%)

Frisch Elast = 1/2

Productivity Shock = 1.42* Measured TFP in US
Unemployment (Model vs US Data)

- Sticky Wage Common Effort (Z=1.42*TFP)
- U.S. Data

Deviation from steady state (%)
3 Industry Wage and TFP Patterns

- Examine cyclicality of hours, TFP, and wages by stickiness

\[
\begin{pmatrix}
  n_{it} \\
y_{it} - x_{it} \\
w_{it}
\end{pmatrix} = \alpha Y_t + \beta [s_{it} - \bar{s}_{it}] Y_t + \text{error}_{it}
\]

- U.S. KLEMS Data for 60 Industries 1987-2010

- Measure wage stickiness by industry from frequency of wage changes in SIPP data
U.S. Klems Data

- 60 Industries annually for 1987-2010: 24 Goods producing/36 Services
  - Nominal and real output and inputs
  - Calculate real value added and value added TFP
  - Modify TFP for capital utilization and worker composition
Correlation Cyclical Relative Wage and TFP

- Highly correlated for (HP) industry cycle
  - Only in proportion to labor’s share

- TFP does not predict hours
Industry Wage and TFP Fluctuations

Dependent Variable = TFP for Value Added

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wage</td>
<td>0.54</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>-0.07</td>
<td>0.24</td>
</tr>
<tr>
<td>Wage*Labor’s Share</td>
<td>1.12</td>
<td>0.30</td>
</tr>
</tbody>
</table>

60 industries for 24 years. Weighted by value added. Include full set of year dummies.
Measuring Wage Stickiness

- Use 1990 to 2001 SIPP panels
  - Advantages of SIPP
  - Measure 4 and 8-month frequencies of change

- Allow for measurement error—assume change exactly reversed signifies error
  - Do under Calvo or Taylor: \[ \alpha_C = \frac{\Delta_8 - \Delta_4}{1 - \Delta_4} \]
## Frequency of Wage Changes SIPP, 1990-2011

<table>
<thead>
<tr>
<th></th>
<th>4-month</th>
<th>8-month</th>
<th>Error</th>
<th>Calvo</th>
<th>Taylor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990-93 Panels (1990-95)</td>
<td>0.69</td>
<td>0.78</td>
<td>0.33</td>
<td>0.30</td>
<td>0.23</td>
</tr>
<tr>
<td>1996 Panel (1996-99)</td>
<td>0.74</td>
<td>0.83</td>
<td>0.34</td>
<td>0.38</td>
<td>0.28</td>
</tr>
<tr>
<td>2001 Panel (2001-04)</td>
<td>0.74</td>
<td>0.82</td>
<td>0.37</td>
<td>0.33</td>
<td>0.25</td>
</tr>
<tr>
<td>Average 1990-2001 Panels</td>
<td>0.71</td>
<td>0.81</td>
<td>0.35</td>
<td>0.33</td>
<td>0.25</td>
</tr>
</tbody>
</table>
## Cyclicality by Industry Wage Stickiness

RHS variable is Duration (months)\*Aggregate Real GDP

<table>
<thead>
<tr>
<th></th>
<th>Hours</th>
<th>TFP</th>
<th>Wage</th>
</tr>
</thead>
<tbody>
<tr>
<td>All 60 Industries</td>
<td>0.08</td>
<td>-0.14</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>(.06)</td>
<td>(.09)</td>
<td>(.07)</td>
</tr>
<tr>
<td>24 Goods Industries</td>
<td>0.16</td>
<td>-0.41</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>(.10)</td>
<td>(.14)</td>
<td>(.08)</td>
</tr>
<tr>
<td>14 Durables Industries</td>
<td>0.13</td>
<td>-0.82</td>
<td>-0.13</td>
</tr>
<tr>
<td></td>
<td>(.08)</td>
<td>(.26)</td>
<td>(.14)</td>
</tr>
</tbody>
</table>
## Cyclicality by Wage Stickiness for 24 Goods Industries

RHS variable is $\text{Duration(months)} \times \text{Aggregate Real GDP}$

<table>
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<tr>
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<th>Hours</th>
<th>TFP</th>
<th>Wage</th>
</tr>
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<tbody>
<tr>
<td><strong>12 Low-Labor-Share</strong></td>
<td>0.12</td>
<td>−0.25</td>
<td>0.10</td>
</tr>
<tr>
<td>Goods Industries</td>
<td>(.07)</td>
<td>(.08)</td>
<td>(.08)</td>
</tr>
<tr>
<td><strong>12 High-Labor-Share</strong></td>
<td>0.09</td>
<td>−0.98</td>
<td>−0.16</td>
</tr>
<tr>
<td>Goods Industries</td>
<td>(.10)</td>
<td>(.33)</td>
<td>(.15)</td>
</tr>
</tbody>
</table>
Conclusion

- Breaks irrelevance of sticky wage for current workers

- Matters quantitatively when tie effort levels—gives a lot of wage inertia
  - Bigger employment response
  - Mutes procyclical productivity

- Industry wage stickiness matters for cyclicality of TFP for industries with important labor share