Challenges for New Keynesian Models with Sticky Wages

In Preparation for the Handbook of Macroeconomics

April 23, 2015

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Introduction

This survey

1. Build DSGE model w/ several distinct wage concepts.
2. Review evidence on wages.
3. How do measured wages react to monetary shocks?
4. Implications for wage dynamics in DSGE model.
“The” Wage

Different Wage Concepts in Empirical Literature

1. Average Hourly Earnings
“The” Wage

Different Wage Concepts in Empirical Literature

1. Average Hourly Earnings

2. Composition Corrected Wages
   • Solon, Barsky and Parker (1994)
   • Elsby, Shin and Solon (2014)
“The” Wage

Different Wage Concepts in Empirical Literature

1. Average Hourly Earnings

2. Composition Corrected Wages

3. New Hire Wages
   • Hall (2005)
   • Pissarides (2009)
   • Gertler and Trigari (2008)
   • Haefke, Sonntag and van Rens (2013)
   • Martins, Solon and Thomas (2012)
“The” Wage

Different Wage Concepts in Empirical Literature

1. Average Hourly Earnings
2. Composition Corrected Wages
3. New Hire Wages
4. Implicit Contracts and Long-Term Employment
   • Barro (1977)
   • Kudlyak (2014)
“The” Wage

Different Wage Concepts in Empirical Literature

1. Average Hourly Earnings
2. Composition Bias
3. New Hire Wages
4. Implicit Contracts and Long-Term Employment
Wage Dynamics in DSGE Models
Wage Dynamics in DSGE Models

Standard DSGE framework (CEE)

- Rep. household (with habit formation)
- Variable capital utilization
- Increasing ret. to scale
- Investment adjustment costs
- Sticky prices
Wage Dynamics in DSGE Models

Wage setting / labor supply

• Composition bias
• Sticky *allocative* wage
• Remitted wage vs. allocative wage
Wage Dynamics in DSGE Models

Composition Bias
Wage Dynamics in DSGE Models

Composition Bias

Household utility:

\[ u(C_t) - \phi \frac{N_t^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}} \]

Total hours

\[ N_t = \int_0^A n_t(a) \phi(a) da \]

Type-specific wage: \[ w_t^1(a) = W_t^1 a \]
Wage Dynamics in DSGE Models

Composition Bias

Critical productivity type

\[ \hat{a}_t = \frac{1}{\phi N_t^\eta \frac{\lambda_t W_t}{1}} \]
Wage Dynamics in DSGE Models

Composition Bias

Critical productivity type

\[ \hat{a}_t = \frac{1}{\phi N_t^{\eta}} \]

\[ N_t = \int_0^A n_t(a) \varphi(a) \, da \]
Wage Dynamics in DSGE Models

Composition Bias

Critical productivity type

\[ \hat{a}_t = \frac{1}{\phi N_t^\eta \lambda_t W_t^1} \]

\[ N_t = \int_{\hat{a}_t}^A \phi(a) \, da \]
Wage Dynamics in DSGE Models

Composition Bias

Effective labor:

\[ L_t^1 = \int_{\hat{a}_t}^{A} a \varphi(a) \, da \]

Units of effective labor are sold at compound wage \( W_t^1 \).
Wage Dynamics in DSGE Models

Composition Bias

Average wage
Wage Dynamics in DSGE Models

Composition Bias

Average wage

\[
\bar{W}_t = \frac{\int w_t^1(a)n_t(a)\varphi(a)\,da}{N_t} = \frac{W_t^1L_t^1}{N_t}
\]
Wage Dynamics in DSGE Models

Composition Bias

\[ \tilde{W}_t - \tilde{W}_t^1 = - \left[ 1 - \frac{\hat{a}W^1}{\bar{W}} \right] \tilde{N}_t \]
Wage Dynamics in DSGE Models

Composition Bias

\[ \tilde{\mathcal{W}}_t - \tilde{\mathcal{W}}^1_t = - \left[ 1 - \frac{\hat{\alpha}W_1}{\bar{W}} \right] \tilde{N}_t \]
Wage Dynamics in DSGE Models

*Allocative Wages vs. Remitted Wages*
Wage Dynamics in DSGE Models

*Allocative Wages vs. Remitted Wages*

 Allocative wage may be sticky. $X_t$
Wage Dynamics in DSGE Models

Allocative Wages vs. Remitted Wages

Allocative wage may be sticky. $X_t$

$$\tilde{\pi}_t^X = \gamma^X \left[ \tilde{W}_t^1 - \tilde{X}_t \right] + \beta E_t \left[ \tilde{\pi}_{t+1}^X \right]$$

with

$$\gamma^X = \frac{(1 - \theta_x)(1 - \theta_x \beta)}{\theta_x}$$
Wage Dynamics in DSGE Models

*Allocative Wages vs. Remitted Wages*

Remitted wage
Wage Dynamics in DSGE Models

**Allocative Wages vs. Remitted Wages**

Remitted wage

- periodically renegotiated \((s)\)
- ensures same expected nominal payment (PDV).
Wage Dynamics in DSGE Models

Allocative Wages vs. Remitted Wages

Remitted wage

\[ PDV_t^W = E_t \left[ \sum_{j=0}^{\infty} \left[ \beta (1 - s) \right] j \frac{\lambda_{t+j}}{\lambda_t} X_{t+j} \right] \]
Wage Dynamics in DSGE Models

Allocative Wages vs. Remitted Wages

Remitted wage

\[ PDV_t^W = E_t \left[ \sum_{j=0}^{\infty} \left[ \beta (1 - s) \right]^j \frac{\lambda_{t+j}}{\lambda_t} X_{t+j} \right] \]

\[ = W_t^{\text{New}} E_t \left[ \sum_{j=0}^{\infty} \left[ \beta (1 - s) \right]^j \frac{\lambda_{t+j}}{\lambda_t} \right] \]
Wage Dynamics in DSGE Models

Allocative Wages vs. Remitted Wages

Average hourly earnings (all workers)

\[ AHE_t = AHE_{t-1} (1 - s) + H_t W^\text{New}_t \]
Measured Wages
Measured Wages

1. Average Hourly Earnings (AHE)
2. Composition Adjusted Wages
3. Wages of New Hires
4. The “User Cost of Labor” (Kudlyak, 2014)
Measured Wages

1. Average Hourly Earnings (AHE)
2. Composition Adjusted Wages
3. Wages of New Hires
4. The “User Cost of Labor” (Kudlyak, 2014)
The User Cost of Labor
The User Cost of Labor

Assume:

• Constant renegotiation hazard, $s$

• Constant discount factor
The User Cost of Labor

\[ PDV^W_t = w_{t,t} + E_t \left[ \sum_{\tau=t+1}^{\infty} \left( \beta (1 - s) \right)^{\tau-t} w_{t,\tau} \right] \]
The User Cost of Labor

\[ PDV_t^W = w_{t,t} + E_t \left[ \sum_{\tau=t+1}^{\infty} (\beta(1-s))^{\tau-t} w_{t,\tau} \right] \]

\[ = MP_t^N + E_t \left[ \sum_{\tau=t+1}^{\infty} (\beta(1-s))^{\tau-t} MP_{\tau}^N \right] = PDV_t^{MP} \]
The User Cost of Labor

\[ PDV_t^W - \beta (1 - s) PDV_{t+1}^W \]
The User Cost of Labor

\[ PDV_t^W - \beta (1 - s) PDV_{t+1}^W = MP_t^N \]
The User Cost of Labor

\[ UC_t = PDV_t^W - \beta (1 - s) PDV_{t+1}^W = MP_t^N \]
The User Cost of Labor

\[ UC_t = E_t \left( PDV_t^W - \beta (1 - s) PDV_{t+1}^W \right) \]

\[ PDV_t^W = w_{t,t} + E_t \left[ \sum_{\tau=t+1}^{\infty} \left( \beta (1 - s) \right)^{\tau-t} w_{t,\tau} \right] \]
Measuring the User Cost

\[ \hat{UC}_t = \hat{w}_{t,t} + E_t \left[ \sum_{\tau=t+1}^{t+7} (\beta(1-s))^{\tau-t} [\hat{w}_{t,\tau} - \hat{w}_{t+1,\tau}] \right] \]

DATA:


Real wages (CPI).
Measuring the User Cost

Estimate, using data from NLSY79 to estimate worker fixed effects/control composition bias:

$$\ln w_{t,\tau}^i = c + \alpha^i + \zeta^\tau + \Psi X_{\tau}^i + \sum_{d_0=1}^{T} \sum_{d=d_0}^{T} \chi_{d_0,d} D_{d_0,d}^i + \epsilon_i^\tau$$
Measuring the User Cost

Estimate, using data from NLSY79 to estimate worker fixed effects/control composition bias:

\[
\ln w_{t,\tau}^i = c + \alpha^i + \zeta_T + \Psi X^i_T + \sum_{d_0=1}^T \sum_{d=d_0}^T \chi_{d_0,d}^i D_{d_0,d}^i + \varepsilon_{\tau}^i
\]

\(\chi_{t,\tau}^i\): wage paths for different cohorts
Measuring the User Cost

Estimate, using data from NLSY79 to estimate worker fixed effects/control composition bias:

\[
\ln w_{t,\tau}^i = c + \alpha^i + \zeta_{\tau} + \Psi X_{\tau}^i + \sum_{d_0=1}^{T} \sum_{d=d_0}^{T} \chi_{d_0,d} D_{d_0,d}^i + \varepsilon_{\tau}^i
\]

Construct

\[
\hat{w}_{t,\tau} = \exp\left(\hat{c} + \hat{\zeta}_{\tau} + \hat{\Psi} \bar{X} + \hat{\chi}_{t,\tau}\right)
\]
Average Hourly Earnings
NLSY77 Original Sample (Kudlyak)
Measuring the User Cost

Estimate, using data from NLSY79 to estimate worker fixed effects/control composition bias:

\[
\ln w_{t,\tau}^i = c + \alpha^i + \zeta \tau + \Psi X^i_\tau + \sum_{d_0=1}^T \sum_{d=d_0}^T \chi_{d_0,d} D_{d_0,d}^i + \varepsilon^i_{\tau}
\]

Construct

\[
\hat{w}_{t,\tau} = \exp\left(\hat{c} + \hat{\zeta} \tau + \hat{\Psi} \bar{X} + \hat{\chi}_{t,\tau}\right)
\]
Constructing the User Cost of Labor (UCL)

New Hire Wage

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New Hire Wage
Constructing the User Cost of Labor (UCL)

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Constructing the User Cost of Labor (UCL)

New Hire Wage

UCL
Wages and Monetary Shocks
Wages and Monetary Shocks

Semi-Structural VAR Shocks (CEE)

\[ A(L)Y_t = B\varepsilon_t \]

B is lower triangular.

4 lags as in CEE 1999, 2005
Wages and Monetary Shocks

Semi-Structural VAR Shocks (CEE)

\[ Y_t = \begin{bmatrix} Y_t^I & r_t^f & Y_t^{II} \end{bmatrix}' \]

\( Y^I \) includes GDP, C, I, P, AHE/P, and Y/N

\( Y^{II} \) includes Real Corp. Profit and Money Growth
Wages and Monetary Shocks

Semi-Structural VAR Shocks (CEE)

Additional variables $Y^{III}$ new wage series (UCL, NH)

$$A(L)Y_t = B\varepsilon_t$$
Wages and Monetary Shocks

Semi-Structural VAR Shocks (CEE)

Additional variables \( Y^{III} \) new wage series (UCL, NH)

\[
\begin{bmatrix}
A(L) & 0 \\
a(L) & b(L)
\end{bmatrix}
\begin{bmatrix}
Y_t \\
Y_{t}^{III}
\end{bmatrix}
=
\begin{bmatrix}
B\epsilon_t \\
e_t
\end{bmatrix}
\]
Wage Dynamics in DSGE Models

Calibrated Model

• Christiano et al. (2005)
• Del Negro et al. (2013)
# Wage Dynamics in DSGE Models

## Calibrated Model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Baseline Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frisch Labor Supply Elasticity</td>
<td>3.00</td>
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<tr>
<td>Habit Weight</td>
<td>0.65</td>
</tr>
<tr>
<td>Price Rigidity</td>
<td>0.95</td>
</tr>
<tr>
<td>Wage (X) Rigidity</td>
<td>0.50</td>
</tr>
<tr>
<td>Investment Adjustment Cost</td>
<td>3.00</td>
</tr>
<tr>
<td>Utilization Elasticity</td>
<td>0.01</td>
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</tbody>
</table>
Wage Dynamics in DSGE Models

User Cost Experiment
Wage Dynamics in DSGE Models

Composition Bias Experiment
Wage Dynamics in DSGE Models

Composition Bias Experiment

<table>
<thead>
<tr>
<th>L/N Ratio</th>
<th>1</th>
<th>3.00</th>
<th>5.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comp. Elast.</td>
<td>0</td>
<td>0.10</td>
<td>0.20</td>
</tr>
</tbody>
</table>
Conclusion

Tension between micro wage data and business cycle mechanisms.

Shadow wage seems to be much more responsive than is conventionally assumed in standard DSGE models.

Greater emphasis on price rigidity rather than wage rigidity required to match VAR evidence.