Unemployment Fluctuations, Match Quality, and the Wage Cyclicality of New Hires

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June 8, 2014
Motivation

- Less cyclical variation in aggregate wages than labor
- Conventional macro models overpredict the volatility of wages and underpredict the volatility of unemployment
- True also for the search and matching model (Shimer, 2005)
- Common solution: assume some form of wage stickiness
Motivation, cont.

- Aggregate data may not reflect the relevant measure of wage stickiness

- Critical margin for wage stickiness: new hires

- Panel data evidence going back to Bils (1985) suggestive of substantially more cyclical wages for job changers

- Pissarides (2009) interprets evidence in favor of a high degree of wage flexibility for new hires
  - “new hire contract effect”

- Questions efforts to incorporate wage rigidity into macro models
This paper

- Analyze data from 1990-2012 SIPP

- We find evidence consistent with existing literature: more cyclical wages for new hires

What’s new:

1. Estimate separate cyclicality for workers changing jobs with an intervening spell of unemployment
   - No new hire effect for workers coming from unemployment

2. Introduce controls for variation in match quality across jobs
   - No evidence of excess new hire wage cyclicality
This paper, continued

- Conclusions from empirical exercise:
  1. No evidence of excess wage cyclicality for workers coming from unemployment
  2. Wage cyclicality of new hires reflects cyclicality in match quality of job changers as opposed to new hire contract effect

- Build a model consistent with micro and macro evidence

- Key mechanism: workers searching on-the-job more likely to find better jobs during expansions (Barlevy, 2002)

- Quantitative results:
  1. Model consistent with aggregate facts
  2. Simulated data from model generates spurious evidence of new hire wage flexibility comparable to micro estimates
General regression specification from the literature

\[ \log w_{ijt} = x'_{ijt} \pi_x + \pi_u \cdot U_t + \pi_{nu} \cdot \mathbb{I}(new_{ijt}) \cdot U_t + \pi_n \cdot \mathbb{I}(new_{ijt}) + e_{ijt} \]

- \( x_{ijt} \): observables for individual \( i \) in job \( j \) at time \( t \)
- \( U_t \): unemployment rate at \( t \)
- \( \mathbb{I}(new_{ijt}) \): equal to one if individual \( i \) is a new hire in job \( j \) at \( t \)
- \( e_{ijt} \): error term, s.t.
- Unobserved heterogeneity: estimate in first-differences

Key finding: \( \pi_{nu} < 0 \)

Two observations:

1. New hire interaction does not vary by type of job transition
2. New hire wage in FD: difference of first wage on new job and last wage on old job \( \Rightarrow \) scope for composition bias
Data

- Survey of Income and Program Participation, 1990-2012

- Large, representative sample

- Interviews every four months

- High-frequency structure allows for construction of precise measurements of job tenure and wages
Part I: E-E versus E-N-E

- Previous literature does not estimate new hire effect separately for workers experiencing intervening spell of non-employment

- Exception: Haefke, Sonntag, and van Rens (2013)
  - Does not control for unobserved heterogeneity

- Why does it matter?
  - New hire contract effect relevant for workers coming from unemployment
  - More scope for composition effect for workers searching on-the-job (selection)

- Estimate new hire wage cyclicality from person fixed effects, separate $E-E$ from $E-N-E$
# Part I: Results

<table>
<thead>
<tr>
<th></th>
<th>1990-2012 sample</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>UR</td>
<td>$-0.573^{***}$</td>
<td>$-0.580^{***}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(0.0542)$</td>
<td>$(0.0544)$</td>
<td></td>
</tr>
<tr>
<td>UR $\cdot \mathbb{I}(\text{new &amp; EE})$</td>
<td>$-1.229^{***}$</td>
<td>$-1.247^{***}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(0.4033)$</td>
<td>$(0.4035)$</td>
<td></td>
</tr>
<tr>
<td>UR $\cdot \mathbb{I}(\text{new &amp; ENE})$</td>
<td>0.278</td>
<td>$-0.090$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(0.5285)$</td>
<td>$(0.6883)$</td>
<td></td>
</tr>
</tbody>
</table>

$P(\beta_{U,n}^{EE} = \beta_{U,n}^{ENE})$  
0.022  
1.044  

Fixed effects  
Person  
Person  

Longterm unemployed  
Yes  
No  

No. observations  
409,759  
409,759  

No. of fixed effects  
56,603  
56,603  

Robust standard errors in parenthesis  
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Part II: Control for composition

1. *Person Fixed Effects*: we allow for one fixed effect per individual across multiple job spells
   - Identification of new hire interaction coefficient subject to composition bias

2. *Person-Job Fixed Effects*: we allow for a separate fixed effect for each job held by an individual
   - Identification of new hire interaction coefficient constrained to wage variation within a job ⇒ no composition bias
## Part II: Person-Job Fixed Effects

<table>
<thead>
<tr>
<th></th>
<th>1990-2012 sample</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment rate</td>
<td>−0.564***</td>
<td>−0.378***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0541)</td>
<td>(0.0523)</td>
<td></td>
</tr>
<tr>
<td>Unemp. rate · I(new)</td>
<td>−0.843***</td>
<td>−0.266</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.2293)</td>
<td>(0.2616)</td>
<td></td>
</tr>
<tr>
<td>Fixed effects</td>
<td>Person</td>
<td>Person-Job</td>
<td></td>
</tr>
<tr>
<td>No. observations</td>
<td>417,404</td>
<td>399,690</td>
<td></td>
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<td>No. of fixed effects</td>
<td>57,450</td>
<td>66,260</td>
<td></td>
</tr>
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Robust standard errors in parenthesis

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Interpretation

- Evidence consistent with cyclical composition interpretation.
  - No evidence of new hire wage cyclicality from person-job fixed effects estimator
  - No evidence of new hire wage cyclicality for E-N-E job changers from either estimator

- Next: interpret wage growth of job changers with model of equilibrium unemployment
Model

- **Questions:**
  1. What forces generate procyclical match quality for job movers?
  2. Are there other aggregate implications stemming from job changer wage cyclicality?

- **Model characteristics**
  - Essential structure: Gertler and Trigari (2009)
  - Additional ingredients: match quality + on-the-job search (Barlevy, 2002)

- **Transmission mechanism:**
  \[
  \text{aggregate match composition} + \text{variable search intensity} \rightarrow \text{share of job changers making bad-to-good transitions} \\
  \rightarrow \text{job changer wage cyclicality}
  \]
Search environment

- Random matching

- Firm $i$ employs $n_i$ good workers, $b_i$ bad workers, and posts $v_i$ vacancies

- $\bar{u}$ workers in unemployment

- Workers in bad matches search with variable intensity, $s_b$

- Workers in good matches search with fixed intensity, $s_n$
  - Jolivet, Postel-Vinay, Robin (2006); Lentz and Mortensen (2012)

- Exogenous separation probability $1 - \nu$ for all workers
  - Search after separation with intensity $s_u$

- $i.i.d.$ probability $\xi$ that a match is good
Conditional on posting a vacancy, firms accept good and bad matches

Unemployed accept all matches

Workers searching on-the-job accept only good matches

Total searchers

\[
\bar{s} = \underbrace{\bar{u}}_{\text{unemployed at beginning of period } t} + \underbrace{(1 - \nu) \varsigma_u (\bar{n} + \bar{b})}_\text{separated in } t, \text{ searching from } t \text{ accept good and bad} + \underbrace{\nu \bar{s}_b \bar{b} + \nu \bar{s}_n \bar{n}}_{\text{conditional on not separating in } t, \text{ searching on the job in } t \text{ accept only good}}
\]

Denote \( \bar{\gamma}^h \equiv \bar{b}^h / \bar{n}^h \) to be the composition of new hires
Firms

► Technology: \( y = zk^\alpha l^{1-\alpha} \)

► Labor quality: \( l = n + \phi b = (1 + \phi \gamma) n \)
  ► Firm composition: \( \gamma = b/n \)
  ► Inverse productivity premium for bad workers, \( \phi \)

► Total wage bill: \((1 + \phi \gamma)wn\)

► Quadratic hiring costs, proportional to total quality of existing labor force

► Value of a firm, \( F(\gamma, w; s) \) is homogeneous in total units of labor quality:
\[
F(n, \gamma, w, s) = (1 + \phi \gamma)n \ J(\gamma, w, s)
\]

► \( J(\gamma, w, s) \) is the firm’s value of a unit of labor quality

► Vacancy posting decision summarized by hiring rate, \( x(\gamma, w, s) \)
Workers

- Worker value functions
  - Value of a good match, $V^n(\gamma, w, s)$
  - Value of a bad match, $V^b(\gamma, w, s)$
  - Value of unemployment, $U(s)$

- Worker surplus functions
  - Good worker surplus, $H^n(\gamma, w, s) \equiv V^n(\gamma, w, s) - U(s)$
  - Bad worker surplus, $H^b(\gamma, w, s) \equiv V^b(\gamma, w, s) - U(s)$

- FOC for search policy of workers in bad matches, $\varsigma_b$:

$$
\varsigma_0 \varsigma_b^{\eta_s} = \beta \mathbb{E}\left\{ \Lambda(s, s') \bar{p} \xi \left[ \tilde{V}_x^n(s') - \tilde{V}_x^b(s') \right] \right\}
$$
Staggered Nash bargaining

- Probability $1 - \lambda$ of re-bargaining every period
- Firms bargain with good workers over the wage per unit of labor quality

Contract wage $w^*(\gamma, s)$ solves

$$\max_w H^n(\gamma, w, s)^\eta J(\gamma, w, s)^{1-\eta}$$

s.t.

$$w' = \begin{cases} 
  w^*(\gamma, s) \text{ with probability } \lambda \\
  w^*(\gamma', s') \text{ with probability } 1 - \lambda 
\end{cases}$$
Wage growth of job changers

\[ \hat{g}_{JC}^t = \omega_c \hat{g}_t^w + (1 - \omega_c) \hat{c}_t^w \]

where

\[ \hat{g}_t^w = \hat{w}_t - \hat{w}_{t-1}, \quad \partial \omega_c / \partial \phi > 0 \]

and

\[ \hat{c}_t^w = \frac{1}{\tilde{\delta}_{BG} - \tilde{\delta}_{GB}} \left( \tilde{\delta}_{BG} \hat{\delta}_{BG,t-1} - \hat{\delta}_{GB} \tilde{\delta}_{GB,t-1} \right) \]

\[ = \frac{\tilde{\delta}_{BG} + \tilde{\gamma} \tilde{\delta}_{GB}}{(1 + \tilde{\gamma}) (\tilde{\delta}_{BG} - \tilde{\delta}_{GB})} \hat{\gamma}_{t-1}^t + \frac{1 - \left( \tilde{\delta}_{BG} - \tilde{\delta}_{GB} \right)}{(\tilde{\delta}_{BG} - \tilde{\delta}_{GB})} \tilde{\delta}_{BGS} \tilde{\varsigma}_{bt-1}^t \]

- Average firm labor force composition, \( \tilde{\gamma}_{t-1}^t \), is countercyclical
- Average search intensity of bad workers, \( \tilde{\varsigma}_{bt-1}^t \), is procyclical
## Calibration

<table>
<thead>
<tr>
<th>Parameter values</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount factor</td>
<td>( \beta ) 0.997 = 0.99^{1/3}</td>
</tr>
<tr>
<td>Capital depreciation rate</td>
<td>( \delta ) 0.008 = 0.025/3</td>
</tr>
<tr>
<td>Production function parameter</td>
<td>( \alpha ) 0.33</td>
</tr>
<tr>
<td>Technology autoregressive parameter</td>
<td>( \rho_z ) 0.983 = 0.95^{1/3}</td>
</tr>
<tr>
<td>Technology standard deviation</td>
<td>( \sigma_z ) 0.0075</td>
</tr>
<tr>
<td>Elasticity of matches to unemployment</td>
<td>( \sigma ) 0.4</td>
</tr>
<tr>
<td>Bargaining power parameter</td>
<td>( \eta ) 0.5</td>
</tr>
<tr>
<td>Matching function constant</td>
<td>( \sigma_m ) 1.0</td>
</tr>
<tr>
<td>Search cost elasticity</td>
<td>( \eta_s ) 1.0</td>
</tr>
<tr>
<td>Renegotiation frequency</td>
<td>( \lambda ) 0.889 (3 quarters)</td>
</tr>
</tbody>
</table>
### Jointly calibrated parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi$</td>
<td>Inverse productivity premium</td>
<td>0.84</td>
<td>Average E-E wage premium increase (4.5%)</td>
</tr>
<tr>
<td>$\xi$</td>
<td>Prob. of good match</td>
<td>0.42</td>
<td>Fraction E-E with $\Delta w \approx 0$ (0.31)</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>Hiring cost parameter</td>
<td>48.93</td>
<td>UE probability (0.45)</td>
</tr>
<tr>
<td>$\varsigma_0$</td>
<td>Search cost parameter</td>
<td>2.62</td>
<td>E-E probability (0.029)</td>
</tr>
<tr>
<td>$u_b$</td>
<td>Flow value of unemployment</td>
<td>2.70</td>
<td>Replacement rate (0.75)</td>
</tr>
<tr>
<td>$\nu$</td>
<td>Separation probability</td>
<td>0.97</td>
<td>E-U probability (0.026)</td>
</tr>
</tbody>
</table>

- **Steady state/parameter restriction:** $\varsigma_u = \varsigma_n = \tilde{\varsigma}_b$
- **(Note that $\varsigma_0 \Rightarrow \varsigma_i$)**
## Aggregate statistics

<table>
<thead>
<tr>
<th></th>
<th>$y$</th>
<th>$w$</th>
<th>$n + b$</th>
<th>$u$</th>
<th>$v$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relative St. Dev.</strong></td>
<td>1.00</td>
<td>0.52</td>
<td>0.60</td>
<td>5.15</td>
<td>6.30</td>
</tr>
<tr>
<td><strong>Autocorrelation</strong></td>
<td>0.87</td>
<td>0.91</td>
<td>0.94</td>
<td>0.91</td>
<td>0.91</td>
</tr>
<tr>
<td><strong>Correlation with $y$</strong></td>
<td>1.00</td>
<td>0.56</td>
<td>0.78</td>
<td>-0.86</td>
<td>0.91</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$y$</th>
<th>$w$</th>
<th>$n + b$</th>
<th>$u$</th>
<th>$v$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relative St. Dev.</strong></td>
<td>1.00</td>
<td>0.37</td>
<td>0.31</td>
<td>5.35</td>
<td>9.26</td>
</tr>
<tr>
<td><strong>Autocorrelation</strong></td>
<td>0.83</td>
<td>0.94</td>
<td>0.83</td>
<td>0.83</td>
<td>0.76</td>
</tr>
<tr>
<td><strong>Correlation with $y$</strong></td>
<td>1.00</td>
<td>0.74</td>
<td>0.81</td>
<td>-0.81</td>
<td>0.92</td>
</tr>
</tbody>
</table>


Model Economy, $\lambda = 8/9$ (3 quarters)
Employment composition and wage growth
Wage growth and components
## Wage semi-elasticities

<table>
<thead>
<tr>
<th></th>
<th>SIPP</th>
<th>Model, flex</th>
<th>Model, 3Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuing</td>
<td>−0.56</td>
<td>−5.73</td>
<td>−0.45</td>
</tr>
<tr>
<td>New hires</td>
<td>−1.41</td>
<td>−9.44</td>
<td>−1.59</td>
</tr>
</tbody>
</table>
Conclusion

- Evidence consistent with “cyclical composition” interpretation
- No evidence in favor of “new hire cyclical contract” interpretation
- Existing literature has not adequately taken into account compositional effects
- Model is successful at explaining variation in micro data while also capturing aggregate labor market dynamics
Supplementary Slides
Sample selection

- Men, ages 20-60; drop individuals attending school full-time, self employed, armed forces, permanent disabilities; hours $\in [10, 100]$

- We only use wage observation from last month of wave (SIPP seam effect)

- Drop observations where individual holds multiple jobs

- Drop observations with top-coded or imputed wages
Measurement

- We use direct measure of hourly wage when available.
- Otherwise construct hourly wage from job-specific earnings divided by hrs/wk × wks/mth.
- Wages deflated with CPI.
- Unemployment: Males, 20 yrs+.
- Longterm unemployed: duration > 4 months.
- Job tenure: beginning of period retrospective information, then update for each month observed working for pay.
- EE transitions: change in job ID across two months, both months worked for pay.
- ENE transitions: change in job ID, intervening month(s) w/o work for pay.
- New hire: tenure < 4 months.
## Descriptive statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log hourly wage (2000 dollars)</td>
<td>2.70</td>
<td>0.519</td>
</tr>
<tr>
<td>Years of education</td>
<td>13.56</td>
<td>2.802</td>
</tr>
<tr>
<td>Union dummy</td>
<td>0.21</td>
<td>0.404</td>
</tr>
<tr>
<td>Never married</td>
<td>0.20</td>
<td>0.397</td>
</tr>
<tr>
<td>Job tenure (years)</td>
<td>8.04</td>
<td>8.373</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>0.06</td>
<td>0.018</td>
</tr>
<tr>
<td>New hire indicator</td>
<td>0.07</td>
<td>0.252</td>
</tr>
</tbody>
</table>
## Summary statistics: job transitions

<table>
<thead>
<tr>
<th>Panel</th>
<th>EE</th>
<th></th>
<th>ENE</th>
<th></th>
<th>Total</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>1,767</td>
<td>8,647</td>
<td>1,099</td>
<td>4,759</td>
<td>7,111</td>
<td>46,172</td>
</tr>
<tr>
<td>1991</td>
<td>1,170</td>
<td>5,767</td>
<td>848</td>
<td>3,547</td>
<td>5,045</td>
<td>32,178</td>
</tr>
<tr>
<td>1992</td>
<td>1,633</td>
<td>8,866</td>
<td>1,238</td>
<td>5,649</td>
<td>6,645</td>
<td>46,884</td>
</tr>
<tr>
<td>1993</td>
<td>1,634</td>
<td>9,033</td>
<td>1,096</td>
<td>5,342</td>
<td>6,499</td>
<td>46,198</td>
</tr>
<tr>
<td>1996</td>
<td>3,806</td>
<td>21,829</td>
<td>2,406</td>
<td>13,352</td>
<td>9,692</td>
<td>81,110</td>
</tr>
<tr>
<td>2001</td>
<td>2,017</td>
<td>9,832</td>
<td>1,699</td>
<td>7,752</td>
<td>8,176</td>
<td>51,893</td>
</tr>
<tr>
<td>2004</td>
<td>1,545</td>
<td>8,994</td>
<td>1,268</td>
<td>6,922</td>
<td>4,578</td>
<td>38,503</td>
</tr>
<tr>
<td>2008</td>
<td>2,812</td>
<td>16,536</td>
<td>2,537</td>
<td>13,029</td>
<td>9,965</td>
<td>75,171</td>
</tr>
<tr>
<td>Total</td>
<td>16,384</td>
<td>89,504</td>
<td>12,191</td>
<td>60,352</td>
<td>57,711</td>
<td>418,109</td>
</tr>
</tbody>
</table>
Identification

- Source of identification: wage cyclicality of new hires relative to wage cyclicality of continuing workers

- Identifying assumption: new hires are treated as “continuing workers” subsequent to first wage on job

- Data requirement: wage observations after new hire wage

- Average new hire + subsequent wage observations: 4.28
  - EE only: 4.45
  - ENE only: 4.06
Person-Job Fixed Effects, panel time trends

<table>
<thead>
<tr>
<th></th>
<th>1990-2011 sample</th>
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<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>$-0.457^{***}$</td>
<td>$-0.337^{***}$</td>
</tr>
<tr>
<td></td>
<td>(0.0565)</td>
<td>(0.0545)</td>
</tr>
<tr>
<td>Unemp. rate · I(new)</td>
<td>$-0.762^{***}$</td>
<td>$-0.216$</td>
</tr>
<tr>
<td></td>
<td>(0.2286)</td>
<td>(0.2613)</td>
</tr>
<tr>
<td>Fixed effects</td>
<td>Person</td>
<td>Person-Job</td>
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E-E and E-N-E, panel time trends

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<tr>
<td>UR</td>
<td>$-0.465^{***}$</td>
</tr>
<tr>
<td></td>
<td>(0.0564)</td>
</tr>
<tr>
<td>UR \cdot \mathbb{I}(\text{new &amp; EE})</td>
<td>$-1.285^{***}$</td>
</tr>
<tr>
<td></td>
<td>(0.4044)</td>
</tr>
<tr>
<td>UR \cdot \mathbb{I}(\text{new &amp; ENE})</td>
<td>0.174</td>
</tr>
<tr>
<td></td>
<td>(0.5290)</td>
</tr>
<tr>
<td>$P(\beta_{U,n}^{EE} = \beta_{U,n}^{ENE})$</td>
<td>0.027</td>
</tr>
<tr>
<td>Fixed effects</td>
<td>Person</td>
</tr>
<tr>
<td>Longterm unemployed</td>
<td>Yes</td>
</tr>
<tr>
<td>No. observations</td>
<td>409,759</td>
</tr>
<tr>
<td>No. of fixed effects</td>
<td>56,603</td>
</tr>
</tbody>
</table>

Robust standard errors in parenthesis

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
# ENE: PFE vs. PJFE

<table>
<thead>
<tr>
<th></th>
<th>1990-2011 sample</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>UR</td>
<td>$-0.580^{***}$</td>
<td>$-0.376^{***}$</td>
</tr>
<tr>
<td></td>
<td>(0.0544)</td>
<td>(0.0525)</td>
</tr>
<tr>
<td>$UR \cdot \mathbb{I}(\text{new &amp; } EE)$</td>
<td>$-1.247^{***}$</td>
<td>$-0.231$</td>
</tr>
<tr>
<td></td>
<td>(0.4035)</td>
<td>(0.5132)</td>
</tr>
<tr>
<td>$UR \cdot \mathbb{I}(\text{new &amp; } ENE)$</td>
<td>$-0.090$</td>
<td>$1.095$</td>
</tr>
<tr>
<td></td>
<td>(0.6883)</td>
<td>(0.8593)</td>
</tr>
<tr>
<td>$P(\beta^{EE}<em>{U,n} = \beta^{ENE}</em>{U,n})$</td>
<td>0.144</td>
<td>0.185</td>
</tr>
<tr>
<td>$P(\beta^{EE}<em>{U,n} = \beta^{ENE}</em>{U,n} = 0)$</td>
<td>0.008</td>
<td>0.401</td>
</tr>
</tbody>
</table>

Fixed Effects: Person Job

No. of observations: 409,759 393,780

No. of fixed effects: 56,603 65,097

Robust standard errors in parenthesis

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Firm problem

\[ F(n, \gamma, w, s) = \max_{k, x} \left\{ zk^\alpha [(1 + \phi \gamma)n]^{1-\alpha} - \frac{k}{2} x^2 (1 + \phi \gamma)n \right\} \]

\[ - (1 + \phi \gamma) wn - rk + \beta \mathbb{E}\{ \Lambda(s, s') F(n', \gamma', w', s') | w, s) \} \}

- Hiring rate:
  
  \[ x = \frac{(1 + \phi \tilde{\gamma}^h)}{(1 + \phi \gamma)} \frac{\bar{q} \xi u}{n} \]

- Perfectly mobile capital:

  \[ r = \alpha z \tilde{k}^{\alpha-1}, \text{ where } \tilde{k} = \frac{k}{(1 - \phi \gamma)n} \]

- \( F \) homogeneous in \( l \equiv (1 + \phi \gamma)n \):

  \[ F(n, \gamma, w, s) = (1 + \phi \gamma)n \ J(\gamma, w, s) \]
Firm problem, cont.

- $J(w, \gamma, s)$ is the value of a unit of labor force quality at firm $i$

\[
J(\gamma, w, s) = \max_{\tilde{k}, x}\left\{ z\tilde{k}^{\alpha} - \frac{\kappa}{2}x^2 - w - r\tilde{k}\right. \\
+ (\rho + x)\beta\mathbb{E}\left\{ \Lambda(s, s')J(\gamma', w', s') | w, s \right\} \right. \\
\text{where } \rho \text{ is the survival rate of a unit of labor force quality}
\]

- Optimal hiring:

\[
\kappa x = \beta\mathbb{E}\left\{ \Lambda(s, s')J(\gamma', w', s') | w, s \right\} + \omega
\]

where

\[
\omega = (\rho + x)\beta\mathbb{E}\left\{ \frac{\partial J(\gamma', w', s')}{\partial \gamma'} + (1 - \lambda)\frac{\partial J(\gamma', w^*, s)}{\partial w^*} \frac{\partial w^*}{\partial \gamma'} \right\} \frac{\partial \gamma'}{\partial x}
\]
Worker value functions

- Value of a worker in unemployment

\[ U(s) = u_b + \beta \mathbb{E} \left\{ \Lambda(s, s') \left[ \bar{p} \xi \tilde{V}_x^n(s') + \bar{p} (1 - \xi) \tilde{V}^b(s') + (1 - \bar{p}) U(s') \right] \mid s \right\} \]

- \( u_b \) is flow benefit of unemployment
- Costless search for unemployed

- Value of worker in a good match

\[ V^n(\gamma, w, s) = w - \left[ \nu c(\varsigma_n) + (1 - \nu) c(\varsigma_u) \right] + \beta \mathbb{E} \left\{ \Lambda(s, s') \left[ \nu (1 - \varsigma_n \bar{p} \xi) V^n(\gamma', w', s') + \nu \varsigma_n \bar{p} \xi \tilde{V}_x^n(s') + (1 - \nu) \varsigma_u \bar{p} (1 - \xi) \tilde{V}^b(s') + (1 - \nu)(1 - \varsigma_u \bar{p}) U(s') \right] \mid w, s \right\} \]
Worker value functions, cont.

- Value of a worker in a bad match

\[
\bar{V}^b(s) = \max_{\varsigma_b} \left\{ \phi \bar{w} + (1 - \phi)b - \left[ \nu c(\varsigma_b) + (1 - \nu)c(\varsigma_u) \right] 
+ \beta \mathbb{E} \left\{ \Lambda(s, s') \left[ \nu (1 - \bar{\varsigma}_b \bar{p} \xi) \bar{V}^b(s') + \nu \bar{\varsigma}_b \bar{p} \xi \bar{V}_x^n(s') 
+ (1 - \nu)\varsigma_u \bar{p} \xi \bar{V}_x^n(s') + (1 - \nu)\varsigma_u \bar{p} (1 - \xi) \bar{V}^b(s') 
+ (1 - \nu)(1 - \bar{p})U(s')] | s \right\} \right\}
\]

- \(c(\varsigma)\) is the cost of on-the-job search:

\[
c(\varsigma) = \frac{s_0}{1 + \eta_{\varsigma}} \varsigma^{1+\eta_{\varsigma}}
\]

- Optimal search decision:

\[
\varsigma_0 \varsigma_b^{\eta_{\varsigma}} = \beta \mathbb{E} \left\{ \Lambda(s, s') \bar{p} \xi \left[ \bar{V}_x^n(s') - \bar{V}^b(s') \right] \right\}
\]

- Assumption: worker receives union transfer, \(\tau(w, \bar{w}) = \phi(\bar{w} - w)\)
Worker surplus functions

- Worker surplus at good match

\[ H^n(\gamma, w, s) = w - u_b - \left[ \nu c(\varsigma_n) + (1 - \nu) c(\varsigma_u) \right] \]

\[ + \beta \mathbb{E} \left\{ \Lambda(s, s') \left[ \nu (1 - \varsigma_n \bar{p} \xi) H^n(\gamma', w', s') + \nu \varsigma_n \bar{p} \xi \tilde{H}_x^n(s') \right. \right. \]

\[ - \left. \left. \left( 1 - (1 - \nu) \varsigma_u \right) \bar{p} \tilde{H}_x(s') \right] \right\} \mid \gamma, w, s \}

- Worker surplus at bad match

\[ \tilde{H}^b(s) = \phi(\bar{w} - u_b) - \left[ \nu c(\varsigma_b) + (1 - \nu) c(\varsigma_u) \right] \]

\[ + \beta \mathbb{E} \left\{ \Lambda(s, s') \left[ \nu (1 - \varsigma_b \bar{p} \xi) \tilde{H}^b(s') + \nu \varsigma_b \bar{p} \xi \tilde{H}_x^n(s') \right. \right. \]

\[ - \left. \left. \left( 1 - (1 - \nu) \varsigma_u \right) \bar{p} \tilde{H}_x(s') \right] \right\} \mid \gamma, w, s \}

Return
Evolution of aggregate composition

- Aggregate composition:

\[ \gamma_{t+1} = \rho \gamma_t + (1 - \rho) \gamma_h - (\rho - \nu) \xi_{bt} \]

- Composition of new hires:

\[ \gamma_h = \frac{(1 - (1 - \nu)\zeta_u)\tilde{u}}{(1 - \nu)\zeta_u + (1 - (1 - \nu))\tilde{u}} \tilde{u}_t - \tilde{s}_t \]

- Search intensity:

\[ \eta_s \hat{\xi}_t = \mathbb{E} \left\{ \Lambda_{t,t+1} + \hat{p}_t + \frac{\tilde{H}_n}{\tilde{H}_n - \tilde{H}_b} \hat{H}_{t+1} - \frac{\tilde{H}_b}{\tilde{H}_n - \tilde{H}_b} \hat{H}_b \right\} \]
Job flows

- Two types of job-to-job flows:
  1. on-the-job search
  2. separation shock and job finding within same period

- Flow shares:

\[
\delta_{BB} = \frac{(1 - \nu)(1 - \xi)\bar{\varsigma}_u\bar{\gamma}}{(1 - \nu)(1 + \bar{\gamma})\bar{\varsigma}_u + \nu\bar{\xi}(\bar{\varsigma}_n + \bar{\varsigma}_b\bar{\gamma})}
\]

\[
\delta_{BG} = \frac{[(1 - \nu)\bar{\varsigma}_u + \nu\bar{\varsigma}_b]\bar{\xi}\bar{\gamma}}{(1 - \nu)(1 + \bar{\gamma})\bar{\varsigma}_u + \nu\bar{\xi}(\bar{\varsigma}_n + \bar{\varsigma}_b\bar{\gamma})}
\]

\[
\delta_{GB} = \frac{(1 - \nu)(1 - \xi)\bar{\varsigma}_u}{(1 - \nu)(1 + \bar{\gamma})\bar{\varsigma}_u + \nu\bar{\xi}(\bar{\varsigma}_n + \bar{\varsigma}_b\bar{\gamma})}
\]

\[
\delta_{GG} = \frac{[(1 - \nu)\bar{\varsigma}_u + \nu\bar{\varsigma}_n]\bar{\xi}}{(1 - \nu)(1 + \bar{\gamma})\bar{\varsigma}_u + \nu\bar{\xi}(\bar{\varsigma}_n + \bar{\varsigma}_b\bar{\gamma})}
\]

- Share of bad-to-good from on-the-job search:

\[
\delta_{BGS} = \frac{\nu\bar{\varsigma}_b\bar{\xi}\bar{\gamma}}{(1 - \nu)(1 + \bar{\gamma})\bar{\varsigma}_u + \nu\bar{\xi}(\bar{\varsigma}_n + \bar{\varsigma}_b\bar{\gamma})}
\]