Turbulence and Unemployment in Matching Models

Isaac Baley  
UPF & Barcelona GSE

Lars Ljungqvist  
Stockholm & NYU

Thomas Sargent  
NYU & Hoover Institution

Society for Economic Dynamics, Edinburgh  
June, 2017
How does skill obsolescence affect unemployment?

- **Turbulence**: risk of skill obsolescence following job separations
  - skill-biased technical change
  - rising occupation mobility
  - evolution of industry structure

- **Debate**:
  - Does turbulence increase/decrease unemployment?
  - How does turbulence interact with institutions? (e.g. welfare state)
  - How does turbulence affect incentives for employed vs. unemployed?
Does turbulence increase/decrease unemployment?

- **Job rejection channel**
  - Turbulence after exogenous separations *increases* unemployment
  - Low-skilled unemployed with generous unemployment benefits *reject* jobs
  - Explanation for European unemployment dynamics

- **Job retention channel**
  - Turbulence after endogenous separations *decreases* unemployment
  - High-skilled *employees* hold onto their jobs to avoid turbulence
  - Challenge to the turbulence mechanism

- Turbulence affects incentives of employed/unemployed in *opposite* ways
Two frameworks, two opposite conclusions

• In dHHR’s matching framework:
  ▶ “Strikingly, allowing turbulence following endogenous separations to be only 5% of the turbulence following exogenous separations, generates a strong negative turbulence-unemployment relationship.”

• We extend LS’s matching framework to include endogenous separations and find that:
  ▶ Turbulence following endogenous separations can reach 40% of the turbulence following exogenous separations and still feature a strong positive turbulence-unemployment relationship.

• Puzzle:
  ▶ Disparate results in relatively similar frameworks
  ▶ It is not about endogenous separations, but other features
Our contribution

• We identify key differences across frameworks

• Provide a solution to puzzle

• Important to settle the debate, as a first step towards...
  ▶ Identifying channels from data, for a quantitative examination
  ▶ Revisiting unemployment dynamics during 1980s-1990s
  ▶ (Potentially) explaining current labor dynamics
    (secular decline in labor flows, jobless recoveries, etc,...)
Plan of Attack

I) Matching framework with various turbulence channels

II) Document the turbulence puzzle

III) Sources of disparate outcomes and verdict
Plan of Attack

I) Matching framework with various turbulence channels

II) Document the turbulence puzzle

III) Sources of disparate outcomes and verdict
Workers

- **Demography and preferences**
  - Unit mass of workers, employed \((e)\) and unemployed \((u)\)
  - Continuum of potential firms w/free entry
  - Workers are risk neutral and value consumption
- **Two skill levels:** low \((l)\) or high \((h)\)
  - Skill accumulation through work experience
  - Skill deterioration through turbulence
- **Two dimensions of heterogeneity** \((i,j)\):
  - current skill level \(i\)
  - skill level at last job \(j\), determines unemployment benefits
    - \(\text{benefits}_j = \phi \times \text{average wage within skill } j\)
Employment relationships

- **Labor market**
  - Firms post vacancies paying recruiting cost
  - Random matching determines job finding rate $\lambda$
  - Job opportunity $= \text{draw } z \sim f_i(z)$, indexed by skill $i$

- **Firm-worker relationship**
  - Relationship produces $z$ per period
  - Nash bargaining splits surplus and determines wages
  - Subject to skill transitions

- **Government**
  - Taxes output to pay for benefits
Skill transition 1

- **Exogenous layoff** $\rho^x$
  
  - Upon layoff, **skill deterioration** $\gamma^{d,x}$ (layoff turbulence)

- **Rejection channel:** high rejection rate of $u_{lh}$ increases $u$
Skill transition 2

- **Switch** productivity $\gamma^s$ or **Upgrade** skills $\gamma^u$
- Relationship continues or endogenously breaks (quits)
  - Upon quits, **skill deterioration** $\gamma^d$ (quit turbulence)

- **Retention channel**: low rejection rate of $e_{hh}$ decreases $u$
Skill transition 3

- **Match** with a firm $\lambda$
- Relationship may be formed or not
  - Upon failed match, **skill deterioration** $\gamma^e$ (match turbulence)

- **Acceptance channel:** low rejection rate of $u_{hh}$ decreases $u$
Plan of Attack

I) Matching framework with various turbulence channels

II) Document the turbulence puzzle

III) Sources of disparate outcomes and verdict
We follow original calibrations

- **Equilibrium**: Focus on steady state
- **Calibration**: From dHHR (2005) and LS (2007)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Target</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replacement rate</td>
<td>$\phi = 0.7$</td>
<td>European average</td>
<td>70%</td>
</tr>
<tr>
<td>Exogenous separation</td>
<td>$\rho^x = 0.005$</td>
<td>Time to layoff</td>
<td>25 years</td>
</tr>
<tr>
<td>Skill upgrade</td>
<td>$\gamma^u = 0.0125$</td>
<td>Time to upgrade</td>
<td>10 years</td>
</tr>
<tr>
<td>Productivity switch</td>
<td>$\gamma^s = 0.05$</td>
<td>Productivity duration</td>
<td>2.5 years</td>
</tr>
<tr>
<td>Productivity premium</td>
<td>$E[z_h]/E[z_l] = 2$</td>
<td>Experience effect</td>
<td>$\times 2$</td>
</tr>
</tbody>
</table>

- Other parameters (preferences, matching) are standard
- Match average unemployment, separations, inflow and outflow rates
- **Turbulence**: Range for $\gamma^d, x, \gamma^d, \gamma^e$
The Puzzle

- Turbulence – Unemployment Relationship
  - y-axis: unemployment rate
  - x-axis: turbulence after exogenous separation: $\gamma^{d,x}$
  - each line: turbulence after endogenous separation $\gamma^d = \epsilon \gamma^{d,x}$

(a) LS framework

(b) dHHR framework
The Puzzle

- Turbulence – Unemployment Relationship \( (\epsilon = \gamma^d / \gamma^{d,x}) \)

- \( \epsilon = 0 \), no turbulence after endogenous separations
  
  ▶ Positive relationship in both frameworks

![Graphs showing the relationship between Exogenous Turbulence and Unemployment rate in (a) LS framework and (b) dHHR framework.](image-url)
The Puzzle

- Turbulence – Unemployment Relationship \( (\epsilon = \gamma^d / \gamma^{d,x}) \)
- \( \epsilon \in \{0.01, \ldots, 0.5\} \) vary turbulence after endogenous separations
  - In dHHR: negative relationship appears with tiny exposure
  - In LS: positive relationship survives to large exposure

(a) LS framework

(b) dHHR framework
The Puzzle

• Turbulence – Unemployment Relationship \((\epsilon = \gamma^d / \gamma^{d,x})\)

• \(\epsilon \in \{0.01, \ldots, 0.5\}\) vary exposure after endogenous separations
  - In dHHR: negative relationship appears with tiny exposure
  - In LS: positive relationship survives to large exposure

![Graphs showing unemployment rate vs. exogenous turbulence for LS and dHHR frameworks.](image)
The Puzzle

- Turbulence – Unemployment Relationship ($\epsilon = \gamma^d / \gamma^{d,x}$)
- $\epsilon \in \{0.01, \ldots, 0.5\}$ vary exposure after endogenous separations
  - In dHHR: negative relationship appears with tiny exposure
  - In LS: positive relationship survives to large exposure

(a) LS framework
(b) dHHR framework
The Puzzle

- Turbulence – Unemployment Relationship \( (\epsilon = \gamma^d / \gamma^{d,x}) \)
- \( \epsilon \in \{0.01, \ldots, 0.5\} \) vary exposure after endogenous separations
  - In dHHR: negative relationship appears with tiny exposure
  - In LS: positive relationship survives to large exposure

![Graphs showing unemployment rate vs. exogenous turbulence](image)

(a) LS framework

(b) dHHR framework
The Puzzle

- Turbulence – Unemployment Relationship \((\epsilon = \gamma^d / \gamma^{d,x})\)
- \(\epsilon \in \{0.01, \ldots, 0.5\}\) vary exposure after endogenous separations
  - In dHHR: negative relationship appears with tiny exposure
  - In LS: positive relationship survives to large exposure

\[
\begin{array}{c|c|c|c|c|c|c}
\hline
\text{Exogenous Turbulence } \gamma^{d,x} & 0 & 0.2 & 0.4 & 0.6 & 0.8 & 1 \\
\hline
\text{Unemployment rate (\%)} & 8 & 10 & 12 & 14 & 16 & 18 \\
\hline
\end{array}
\]

(a) LS framework

(b) dHHR framework
Plan of Attack

I) Matching framework with various turbulence channels

II) Document the turbulence puzzle

III) Sources of disparate outcomes and verdict
Potential sources of disparate outcomes

1. **Exogenous vs. endogenous matching**
   - Not quantitatively important (in paper)

2. **Timing of skill consummation following upgrades**
   - Not quantitatively important (in paper)

3. **Turbulence during job market encounters $\gamma^e$**

4. **Support and shape of productivity distributions**
Turbulence during encounters

- **LS**: no exposure for $u_{hh}$, $\gamma^e = 0$

- **dHHR**: same exposure for $u_{hh}$ as $e_{hh}$, $\gamma^e = \gamma^d$

**Acceptance channel** $u_{hh}$

(a) LS: No exposure $\gamma^e = 0$

(b) dHHR: Equal exposure $\gamma^e = \gamma^d$
Turbulence during encounters

- **LS:** no exposure for $u_{hh}$, $\gamma^e = 0$
- **dHHR:** same exposure for $u_{hh}$ as $e_{hh}$, $\gamma^e = \gamma^d$

### Rejection channel $u_{lh}$

(a) **LS:** No exposure $\gamma^e = 0$
(b) **dHHR:** Equal exposure $\gamma^e = \gamma^d$
Turbulence during encounters

- **LS:** no exposure for $u_{hh}$, $\gamma^e = 0$
- **dHHR:** same exposure for $u_{hh}$ as $e_{hh}$, $\gamma^e = \gamma^d$

**Retention channel** $e_{hh}$

(a) LS: No exposure $\gamma^e = 0$  
(b) dHHR: Equal exposure $\gamma^e = \gamma^d$
Turbulence during encounters

Verdict: Suppression of $u$ by compounded turbulence risk is a key explanation for puzzle $\checkmark$

(a) LS: No exposure $\gamma^e = 0$

(b) LS: Equal exposure $\gamma^e = \gamma^d$
Potential sources of disparate outcomes

1. Exogenous vs. endogenous matching
   - Not quantitatively important (in paper)

2. Timing of skill consummation following upgrades
   - Not quantitatively important (in paper)

3. Turbulence during job market encounters $\gamma^e$

4. Support and shape of productivity distributions
Productivity distributions

- **LS’s distribution**: wide support
  - Large incentives for endog. separation

- **dHHR’s distribution**: narrow support
  - Small incentives for endog. separation

(a) LS: Normal with wide support
(b) dHHR: Uniform with narrow support
Productivity distributions

- **LS’s distribution**: Large incentives for endogenous separations
- **dHHR’s distribution**: Little incentives for endogenous separations

**Verdict**: Suppression of $u$ by reducing incentives for mobility is a key explanation for puzzle ✓

![Graphs showing unemployment rate vs. exogenous turbulence for different ε values for two distributions: (a) LS: wide Normal, (b) LS: narrow uniform)]
Answer to puzzle

Little incentive for endog. separations (narrow support) + Compounded turbulence risk ($\gamma^e = \gamma^d$)

Endogenous turbulence acts very strongly on job retention incentives!
Plan of Attack

I) Matching framework with various turbulence channels

II) Document the turbulence puzzle

III) Sources of disparate outcomes and verdict

- Layoff taxes as tell-tale signs of labor mobility
Layoff taxes as tell-tale signs of labor mobility

- **Layoff tax** $\Omega$ to be paid after a separation
  - Suppress unemployment by locking-in workers in their jobs

- Changes in layoff tax in tranquil times (no turbulence)
  - **LS**: Mobility active for very large $\Omega$
  - **dHHR**: Mobility shuts down for small $\Omega$

(a) LS in tranquil times
(b) dHHR in tranquil times
Conclusion and further work

• **We have solved the turbulence puzzle**
  ▶ Positive turbulence-unemployment relationship is robust to endogenous separations
  ▶ Key: Incentives for labor mobility and instances of the risk

• **Next steps:**
  ▶ Rigorous quantitative exercise
    • Reemployment wages, hazard rates
    • Elasticity of labor mobility wrt. layoff taxes
  ▶ Turbulence and business cycle dynamics

• **Use turbulence to explain...**
  ▶ Secular decline in job flows, jobless recoveries, volatility of flow rates
Back Up Slides

A  Model
   1  Details about match surpluses
   2  Detail about continuation values
   3  Detail about outside options
   4  Detail about wage setting
   5  Detail about worker flows
   6  Detail about government
   7  Detail about equilibrium

B  Effective workers’ bargaining power
   1  Type of matching
   2  Timing of skill consummation

C  Layoff taxes
   1  Details about layoff tax implementation
   2  Layoff taxes in LS
   3  Layoff taxes in dHHR

D  Starting from dHHR
A.1) Detail about match surpluses

- **Match Surplus** from relationship with type \((i,j)\) and current \(z\)

\[
s_{ij}(z) = (1 - \tau)z + g_i(z) - \left[ b_j + \omega^w_{ij} - \mu + \omega^f \right]
\]

- **Nash Bargaining** determines wages, worker’s bargaining power \(\pi\)

\[
p_{ij}(z) + g^w_i(z) = \pi s_{ij}(z) + b_j + \omega^w_{ij} - \mu + \omega^f
\]

- **Reservation Productivity** = lowest \(z\) that makes a match profitable

  ▶ Mutual agreement to form a match if surplus \(s_{ij}(z)\) is positive

\[
s_{ij}(z_{ij}) = 0
\]

- **Rejection Rate** = mass of productivity draws below \(z_{ij}\)

\[
\nu_{ij} = \int_{-\infty}^{z_{ij}} df_i(y)
\]
A.1) Detail about match surpluses

- Distinguish new hires with $s_{ij}^o(z)$ vs. already hired $s_{ij}(z)$

- Low-skilled employed and unemployed with benefit entitlement $j$

  $$s_{ij}^o(z) = s_{ij}(z) = (1 - \tau)z + g_l(z) - [b_j + \omega_{ij}^w - \mu + \omega^f]$$

  $j = l, h$

- High-skilled employed

  $$s_{hh}(z) = (1 - \tau)z + g_h(z) - [b_h + (1 - \gamma^d)\omega_{hh}^w + \gamma^d \omega_{lh}^w - \mu + \omega^f]$$

  endogenous turbulence I

- High-skilled unemployed

  $$s_{hh}^o(z) = (1 - \tau)z + g_h(z) - [b_h + (1 - \gamma^e)\omega_{hh}^w + \gamma^e \omega_{lh}^w - \mu + \omega^f]$$

  endogenous turbulence II
A.2) Detail about match continuation values

- **Joint continuation of a match with a low-skilled worker**
  
  (Layoff) \( g_l(z) = \beta \left[ \rho^x (b_l + \omega^w_{ll} - \mu + \omega^f) \right] \)
  
  (No changes) \( + (1 - \rho^x)(1 - \gamma^u)(1 - \gamma^s)((1 - \tau)z + g_l(z)) \)
  
  (Switch) \( + (1 - \rho^x)(1 - \gamma^u)\gamma^s(E_{ll} + \nu_{ll}(b_l + \omega^w_{ll} - \mu + \omega^f)) \)
  
  (Upgrade) \( + (1 - \rho^x)\gamma^u(E_{hh} + \nu_{hh}(b_h + (1 - \gamma^d)\omega^w_{hh} + \gamma^d\omega^w_{lh}) - \mu + \omega^f) \)

  where \( E_{ij} = \int_{z_{ij}}^{\infty} [(1 - \tau)y + g_j(y)] df_i(y) \)

- **Joint continuation of a match with a high-skilled worker**
  
  (Layoff) \( g_h(z) = \beta \left[ \rho^x (b_h + \omega^w_{hh} - \mu + \omega^f) \right] \)
  
  (No changes) \( + (1 - \rho^x)(1 - \gamma^u)(1 - \gamma^s)((1 - \tau)z + g_h(z)) \)
  
  (Switch) \( + (1 - \rho^x)\gamma^u(E_{hh} + \nu_{hh}(b_h + (1 - \gamma^d)\omega^w_{hh} + \gamma^d\omega^w_{lh} - \mu + \omega^f) \)

  where \( E_{ij} = \int_{z_{ij}}^{\infty} [(1 - \tau)y + g_j(y)] df_i(y) \)
A.3) Detail about outside options

- **Value of unemployment:**  \( b_j + \omega_{ij}^w \)

\[
\omega_{ij}^w = \beta \left[ \lambda^w(\theta) \int_{z_{ij}}^{\infty} \pi s_{ij}^o(y) \ df_i(y) \right] + \left( b_j + \omega_{ij}^w \right) \quad j = l, h
\]

- **Value of vacancy:**  \( -\mu + \omega^f \)

\[
\omega^f = \beta \left[ \sum_{(i,j)} \lambda_{ij}^f(\theta) \int_{z_{ij}}^{\infty} (1 - \pi) s_{ij}(y) \ df_i(y) - \mu + \omega^f \right]
\]
A.4) Details about wages

• Wages $p_{ij}(z)$ determined through Nash Bargaining

$$\max_{p_{ij}(z)} \left[ (1 - \tau)z - p_{ij}(z) + g^f(z) + \mu - \omega_f \right]^{1 - \pi} \left[ p_{ij}(z) + g^w_i(z) - b_j - \omega^w_{ij} \right]^{\pi}$$

where $g^w_i(z)$ and $g^f(z)$ are the worker and firm continuation values.

• Low-skilled employed and unemployed with benefit entitlement $j$

$$p_{il}(z) + g^w_i(z) = \pi s_{lj}(z) + b_j + \omega^w_{lj}, \quad j = l, h$$

• High-skilled employed (and upgraded low-skilled employed)

$$p_{hh}(z) + g^w_h(z) = \pi s_{hh}(z) + b_h + (1 - \gamma^d)\omega^w_{hh} + \gamma^d\omega^w_{lh}$$

• High-skilled unemployed

$$p_{hh}^o(z) + g^w_h(z) = \pi s_{hh}^o(z) + b_h + (1 - \gamma^e)\omega^w_{hh} + \gamma^e\omega^w_{lh}$$

endogenous turbulence I

endogenous turbulence II
A.5) Detail about worker flows

\[
\begin{align*}
\Delta u_{ll} &= \rho^r + (1 - \rho^r) \left\{ \rho^x + (1 - \rho^x)(1 - \gamma^u)\gamma^s \nu_{ll} \right\} e_{ll} \\
&\quad - \rho^r u_{ll} - (1 - \rho^r) \lambda (1 - \nu_{ll}) u_{ll} \\
\end{align*}
\]

\[
\begin{align*}
\Delta u_{lh} &= (1 - \rho^r) \left\{ \rho^x \gamma^{d,x} e_{hh} + (1 - \rho^x) \nu_{hh} \gamma^d (\gamma^s e_{hh} + \gamma^u e_{ll}) + \lambda \nu^o_{hh} \gamma^e u_{hh} \right\} \\
&\quad - \rho^r u_{lh} - (1 - \rho^r) \lambda (1 - \nu_{lh}) u_{lh} \\
\end{align*}
\]

\[
\begin{align*}
\Delta u_{hh} &= (1 - \rho^r) \left\{ \rho^x (1 - \gamma^{d,x}) e_{hh} + (1 - \rho^x) \nu_{hh} (1 - \gamma^d) (\gamma^s e_{hh} + \gamma^u e_{ll}) \right\} \\
&\quad - \rho^r u_{hh} - (1 - \rho^r) \lambda (1 - \nu^o_{hh} + \nu^o_{hh} \gamma^e) u_{hh} \\
\end{align*}
\]

\[
\begin{align*}
\Delta e_{ll} &= (1 - \rho^r) \lambda \left\{ (1 - \nu_{ll}) u_{ll} + (1 - \nu_{lh}) u_{lh} \right\} \\
&\quad - \rho^r e_{ll} - (1 - \rho^r) \left[ \rho^x + (1 - \rho^x) (\gamma^u + (1 - \gamma^u) \gamma^s \nu_{ll}) \right] e_{ll} \\
\end{align*}
\]

\[
\begin{align*}
\Delta e_{hh} &= (1 - \rho^r) \left\{ \lambda (1 - \nu^o_{hh}) u_{hh} + (1 - \rho^x) \gamma^u (1 - \nu_{hh}) e_{ll} \right\} \\
&\quad - \rho^r e_{hh} - (1 - \rho^r) [\rho^x + (1 - \rho^x) \gamma^s \nu_{hh}] e_{hh} \\
\end{align*}
\]
A.6) Benefits, taxes and gov budget

- **Benefits**: fraction $\phi$ of average wage within skill level $\bar{p}_j$

  $$b_j = \phi \bar{p}_j \text{ where } \bar{p}_j = \sum_k \frac{e_{jk}}{e_j} \int_{z_{jk}}^{\infty} p_{jk}(y) df_j(y) \frac{1 - f_j(z_{jk})}{1 - f_j(z_{jk})}$$

- **Income Taxes**: fraction $\tau$ of match’s output

  $$t_i(z) = \tau z, \quad t_i = \tau \bar{z}_i \text{ where } \bar{z}_i = \sum_k \frac{e_{ik}}{e_i} \int_{z_{ik}}^{\infty} y df_i(y) \frac{1 - f_i(z_{ik})}{1 - f_i(z_{ik})}$$

- **Balanced Government Budget**

  unemployment benefits = tax revenues

  $$\phi(\bar{p}_l u_{ll} + \bar{p}_h (u_{lh} + u_{hh})) = \tau (\bar{z}_l e_l + \bar{z}_h e_h)$$

  gov. expenditure  gov. revenues
A.7) Detail about equilibrium

- A **steady state equilibrium** is given by:
  - tightness \( \theta \); job finding rate \( \lambda^w(\theta) \); vacancy filling rate \( \lambda^f_{ij}(\theta) \);
  - match surpluses \( s_{ij}(z) \); productivity thresholds \( z_{ij} \); rejection rates \( \nu_{ij} \);
  - wages \( p_{ij}(z) \); benefits \( b_j \);
  - future values for unemployment \( \omega^w_{ij} \), vacancies \( \omega^f \), and matches \( g_{i}(z) \)
  - tax rate \( \tau \)

- such that the following conditions hold:
  - **Zero profits:** \( \omega^f(\theta) = \mu \)
  - **Zero surplus:** \( s(z_{ij}) = 0 \quad \forall \ ij \)
  - **Nash bargaining:** \( p_{ij}(z) = b_j + \omega_{ij} - \mu + \omega^f + \pi s_{ij}(z) - g^w_{i}(z) \)
  - **Balanced budget:** \( b_l u_{ll} + b_h (u_{lh} + u_{hh}) = \tau (\bar{z}_l e_l + \bar{z}_h e_h) \)
  - **Zero net worker flows:** \( \Delta u_{ij} = \Delta e_{ij} = 0 \quad \forall \ ij \)
Back Up Slides

A Model

1. Details about match surpluses
2. Detail about continuation values
3. Detail about outside options
4. Detail about wage setting
5. Detail about worker flows
6. Detail about government
7. Detail about equilibrium

B Effective workers’ bargaining power

1. Type of matching
2. Timing of skill consummation

C Layoff taxes

1. Details about layoff tax implementation
2. Layoff taxes in LS
3. Layoff taxes in dHHR

D Starting from dHHR
B.1) Type of Matching

- **LS’s endogenous tightness:** \( \lambda^w(\theta) = A\theta^{1-\alpha} \)
  - Turbulence decreases firm profitability, vacancy posting and tightness
  - Lower tightness decreases meeting rate, increasing \( u \)

- **dHHR’s exogenous tightness:** \( \lambda^w(1) = \lambda \) constant
  - Turbulence does not affect constant meeting rate
  - Shuts down matching channel, suppressing \( u \)

![Graphs showing endogenous and exogenous tightness](image-url)
B.1) Type of Matching (cont...)

- **LS’s endogenous tightness:** \( \lambda^w(\theta) = A\theta^{1-\alpha} \)

- **dHHR’s exogenous tightness:** \( \lambda^w(1) = \lambda \) constant

**Verdict:** Suppression of \( u \) driven by fixed vacancies does not make the dHHR puzzle to erupt ×

(a) Endogenous tightness \((\theta = \nu/u)\)

(b) Exogenous tightness \((\theta = 1)\)
B.2) Timing of skill consummation (cont...)

- **LS’s immediate upgrade**: $e_{ll}$ become $e_{hh}$ in the same period
  - Stable worker’s bargaining power
- **dHHR’s delayed upgrade**: $e_{ll}$ must wait one period to become $e_{hh}$
  - Erodes workers’ bargaining power

**Verdict**: Suppression of $u$ by eroding workers’ bargaining power does not make the dHHR puzzle to erupt \(\times\)

![Graphs showing unemployment rate vs. exogenous turbulence](image-url)
Back Up Slides

A Model

1. Details about match surpluses
2. Detail about continuation values
3. Detail about outside options
4. Detail about wage setting
5. Detail about worker flows
6. Detail about government
7. Detail about equilibrium

B Effective workers’ bargaining power

1. Type of matching
2. Timing of skill consummation

C Layoff taxes

1. Details about layoff tax implementation
2. Layoff taxes in LS
3. Layoff taxes in dHHR

D Starting from dHHR
C.1) Details about layoff taxes

- Consider **layoff tax** $\Omega$ to be paid after a separation
  - Once a worker is hired, firms are the only ones liable for the layoff tax

- Surplus w/incumbent incorporates tax (**wedge with newly hired**)
  \[
  s_{ij}(z_{ij}) = -\Omega \quad \text{vs.} \quad s_{ij}^0(z_{ij}) = 0
  \]
  - Two-tier wage structure (Mortensen and Pissarides, 1994)

- Government revenue now equals income taxes plus layoff taxes
  \[
  \text{revenue} = \tau(\bar{z}_le_l + \bar{z}_he_h) + \text{seps} \times \Omega
  \]

- **Experiment:** changes in layoff tax in tranquil times (no turbulence)
  - $\Omega$ expressed as % of average yearly output in laissez-faire economy
C.2) Layoff taxes in LS

- High-skilled mobility active even for very large layoff taxes.
  - With $\Omega = 100\%$ of yearly output, rejection is still 12%.

- Strong incentives for labor mobility.
  - Allows turbulence to affect outcomes.

---

![Graphs showing the effects of layoff taxes on unemployment rate, rejection rates, job separations, and unemployment duration.](image)
C.3) Layoff taxes in dHHR

- High-skilled mobility shuts down for small layoff taxes.
  - Rejection rate becomes zero at $\Omega = 14\%$ of yearly output.

- Weak incentives for labor mobility.
  - Turbulence cannot affect outcomes.
Back Up Slides

A Model
1. Details about match surpluses
2. Detail about continuation values
3. Detail about outside options
4. Detail about wage setting
5. Detail about worker flows
6. Detail about government
7. Detail about equilibrium

B Effective workers’ bargaining power
1. Type of matching
2. Timing of skill consummation

C Layoff taxes
1. Details about layoff tax implementation
2. Layoff taxes in LS
3. Layoff taxes in dHHR

D Starting from dHHR
D) Analysis starting from dHHR

1. Effective exposure to turbulence
   - Turbulence during job market encounters

2. Incentives for labor mobility in tranquil times
   - Productivity distributions

3. Effective workers’ bargaining power
   - Exogenous vs. endogenous matching
   - Timing of skill consumption following upgrades
D.1) Turbulence during job market encounters

- **dHHR’s exposure:** same as high-skilled employed $\gamma^e = \gamma^d$
- **LS’s exposure:** non, $\gamma^e = 0$

**Verdict:** Accrual of $u$ driven by eliminating compounded exposure to turbulence does not eliminate the dHHR puzzle $\times$

Given low incentives for mobility, the effect is not quantitatively large

---

---

(a) Equal exposure $\gamma^e = \gamma^d$

(b) No exposure $\gamma^e = 0$
D.2) Productivity distributions

- **dHHR’s distribution**: Uniform with narrow support, $z_i^{\text{max}} - z_i^{\text{min}} = 1$
  - Little incentives for endogenous separations (not profitable)
- **LS’s distribution**: Truncated Normal with wide support, $z_i^{\text{max}} - z_i^{\text{min}} = 4$
  - Incentives for voluntary endogenous separations (enough space for improvement)

**Verdict**: Accrual of $u$ driven by increasing incentives to quit does not fully eliminate the dHHR puzzle $\times$
D.3) Type of matching

- **dHHR’s exogenous tightness**: $\lambda^w(1) = \lambda$ constant
- **LS’s endogenous tightness**: $\lambda^w(\theta) = A\theta^{1-\alpha}$

**Verdict**: Accrual of $u$ driven by endogenous vacancy creation does not eliminate the dHHR puzzle $\times$

(a) Exogenous tightness ($\theta = 1$)

(b) Endogenous tightness ($\theta = v/u$)
D.4) Timing of skill consummation

- **dHHR’s delayed consummation**: Erodes workers’ bargaining power
- **LS’s immediate consummation**: Boosts workers’ bargaining power

**Verdict**: Accrual of $u$ driven by enhancing workers’ bargaining power does not eliminate the dHHR puzzle $\times$

(a) Delayed consummation

(b) Immediate consummation
Solution: \( \text{dHHR} + \) wide support + \((\gamma^e = 0)\)

Robust incentives for voluntary quits (wide support) + Turbulence risk only on impact \((\gamma^e = 0)\)

Lots of labor mobility, turbulence generates unemployment!

(a) Original dHHR

(b) dHHR + wide Normal + \((\gamma^e = 0)\)