Turbulence and Unemployment in Matching Models

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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
    Ljungqvist and Sargent [LS] (1998, 2004, 2007)
  - Low-skilled unemployed with generous unemployment benefits reject jobs
  - Explanation for European unemployment dynamics
- **Job retention channel**
  - Turbulence after endogenous separations decreases unemployment
    den Haan, Haefke and Ramey [dHHR] (2001, 2005)
  - 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

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Workers

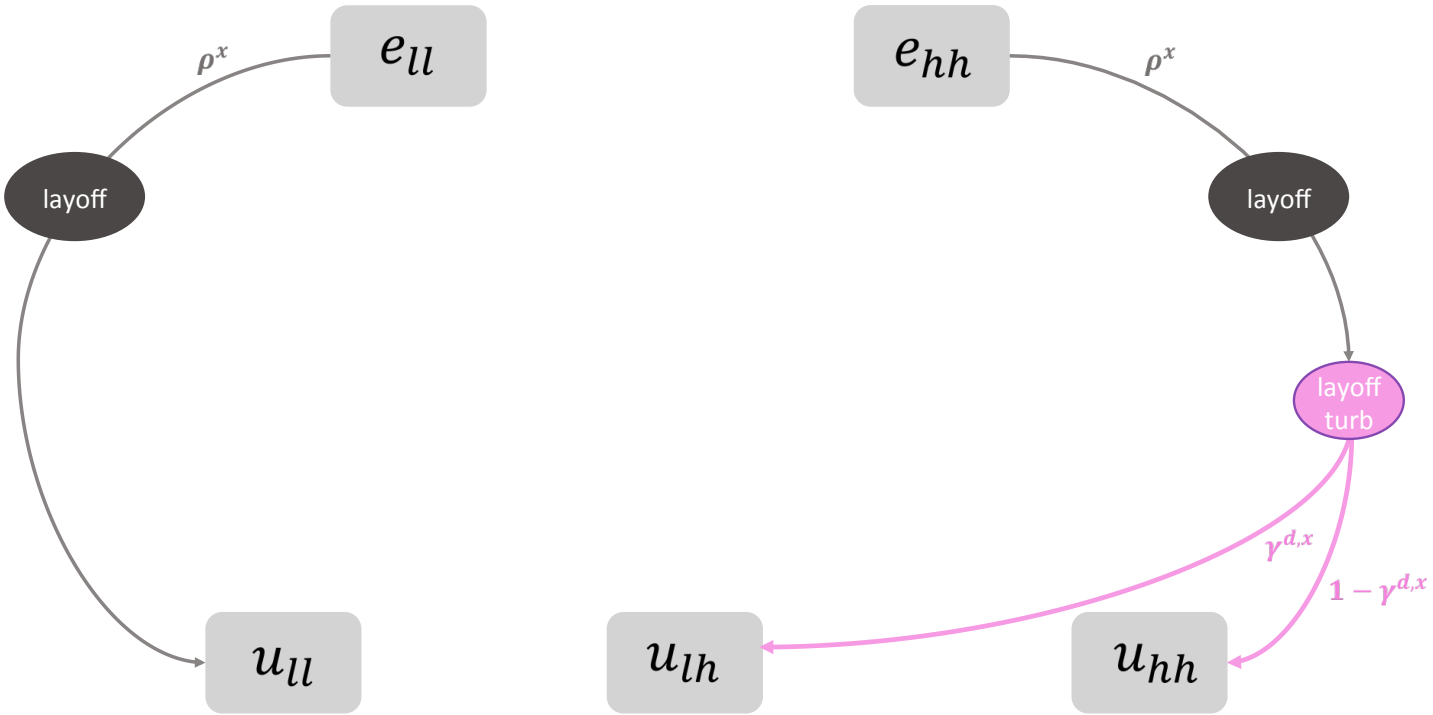
- **Demography and preferences**
  - Unit mass of workers, employed (e) and unemployed (u)
  - Continuum of potential firms w/free entry
  - Workers are risk neutral and value consumption
- **Two skill levels:** low (l) or high (h)
  - Skill accumulation through work experience
  - Skill deterioration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

Employment relationships

- **Labor market**
  - Firms post vacancies paying recruiting cost
  - Random matching determines job finding rate λ
  - Job opportunity = 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

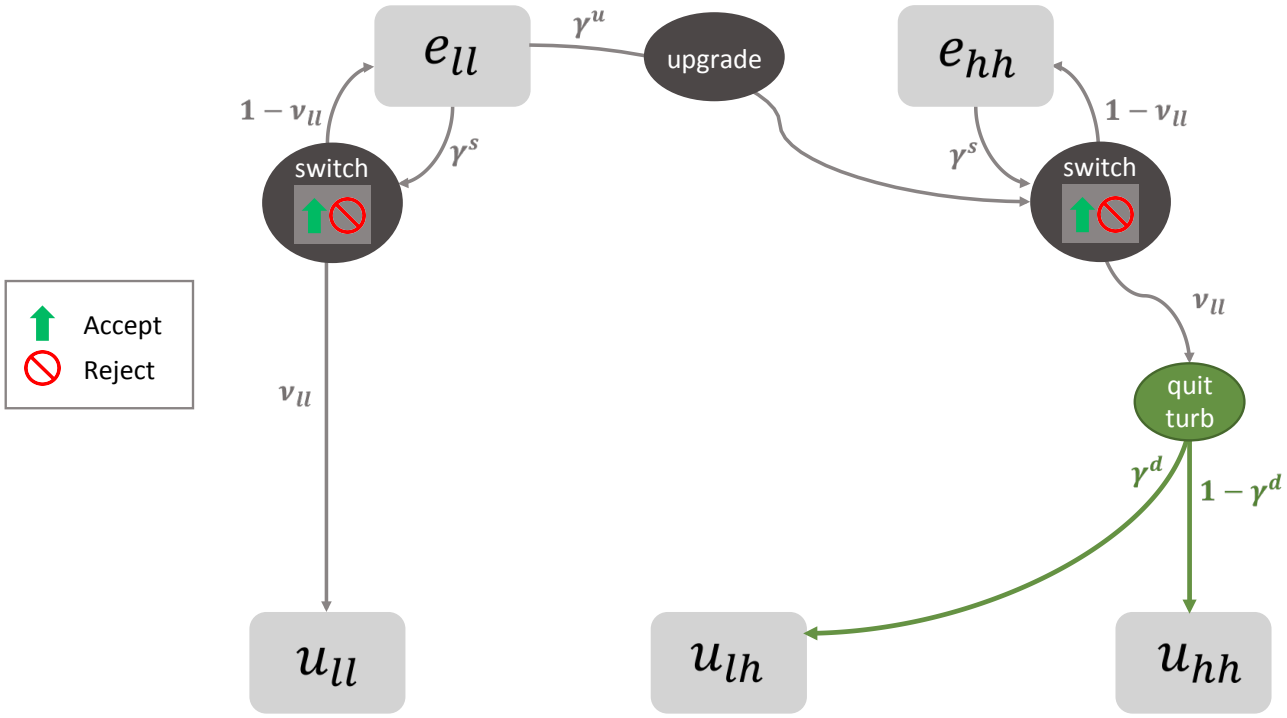
- **Exogenous layoff** ρ^x
  - Upon layoff, **skill deterioration** $\gamma^{d,x}$ (layoff turbulence)



- **Rejection channel:** high rejection rate of u_{lh} increases u

Skill transition 2

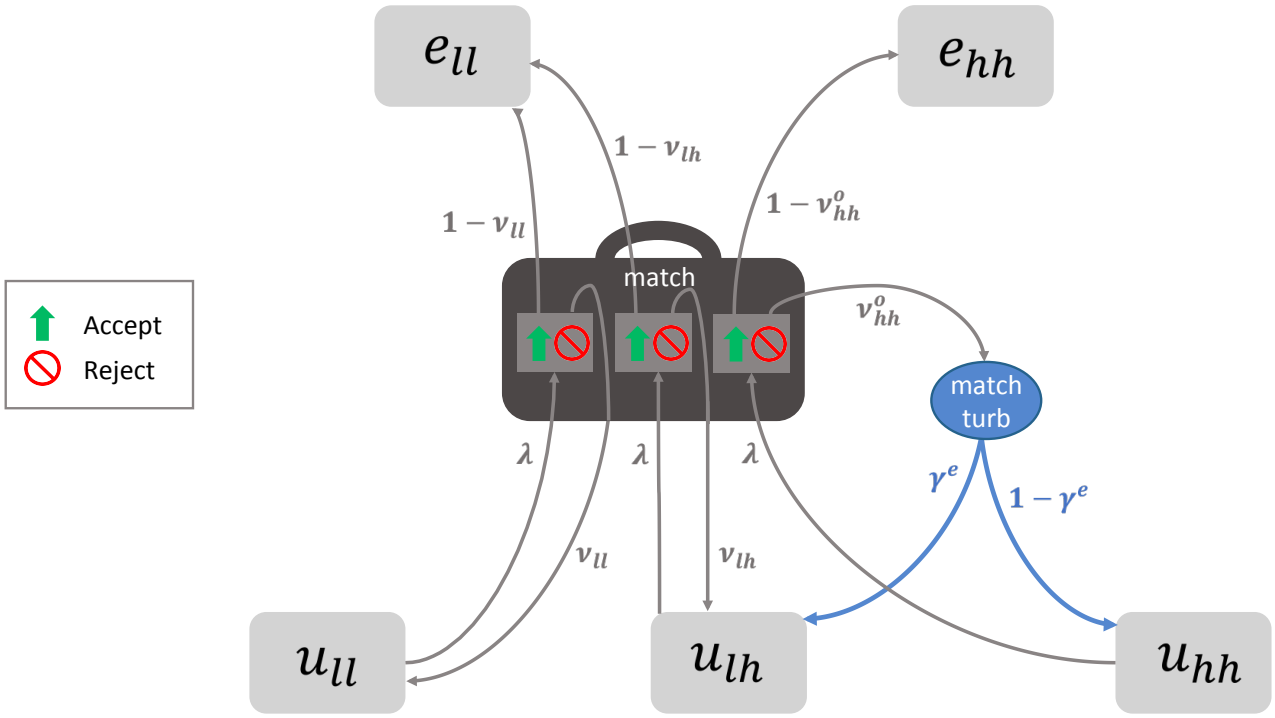
- **Switch** productivity γ^s or **Upgrade** skills γ^u
- Relationship continues or endogenously breaks (quits)
  - Upon quits, **skill deterioration** γ^d (quit turbulence)



- **Retention channel:** low rejection rate of e_{hh} decreases u

Skill transition 3

- **Match** with a firm λ
- Relationship may be formed or not
  - Upon failed match, **skill deterioration** γ^e (match turbulence)



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

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We follow original calibrations

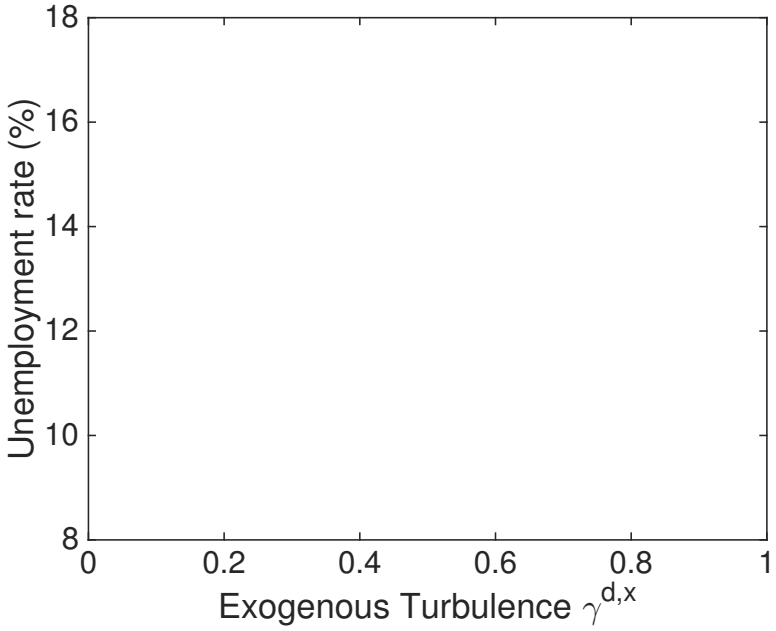
- **Equilibrium**: Focus on steady state
- **Calibration:** From dHHR (2005) and LS (2007)

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

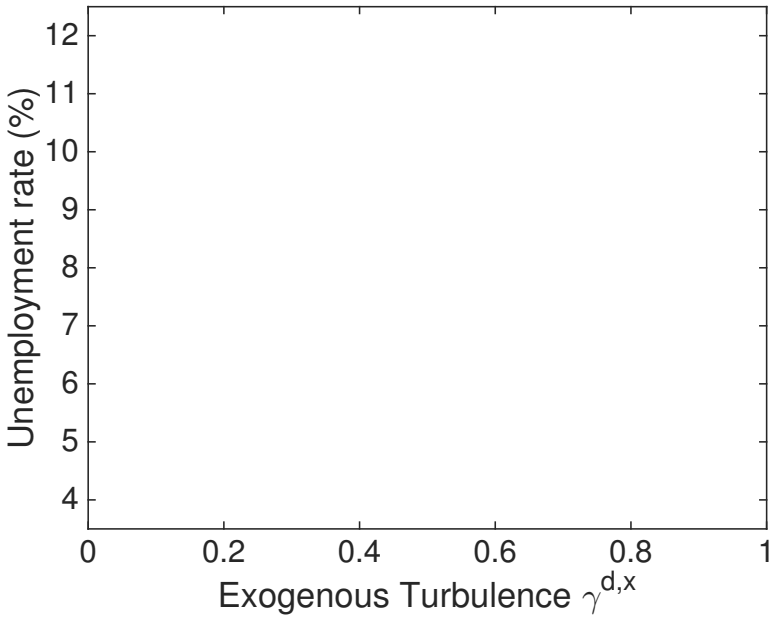
- Other parameters (preferences, matching) are standard
- Match average unemployment, separations, inflow and outflow rates
- **Turbulence:** Range for $\gamma^{d,x}, \gamma^d, \gamma^e$

The Puzzle

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



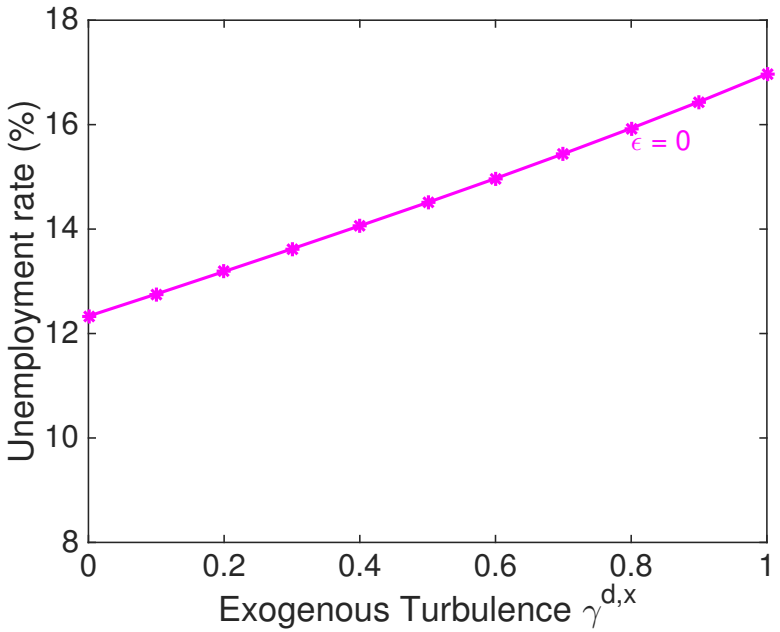
(a) LS framework



(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



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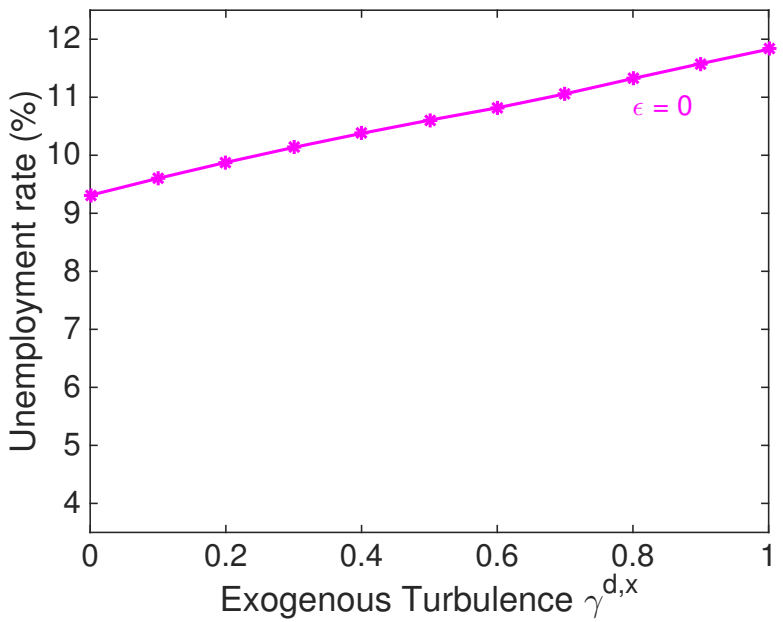
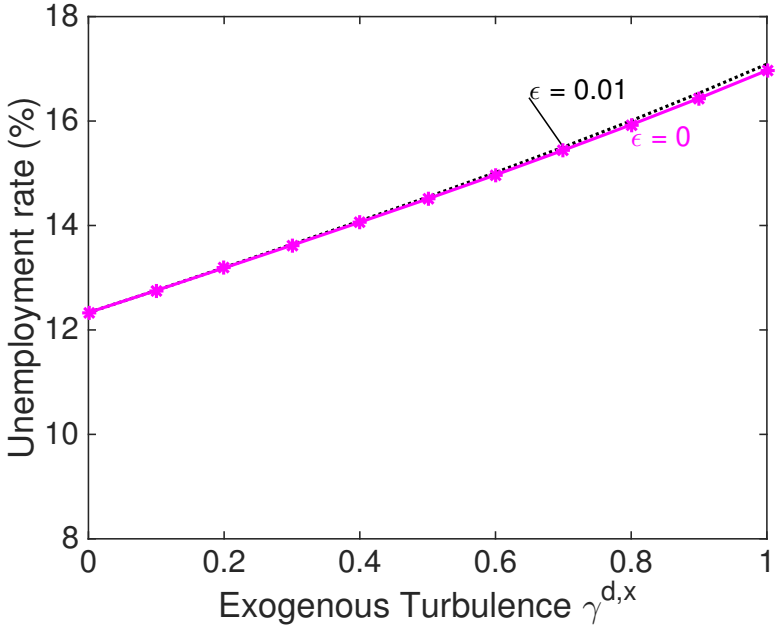


(b) dHHR framework

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



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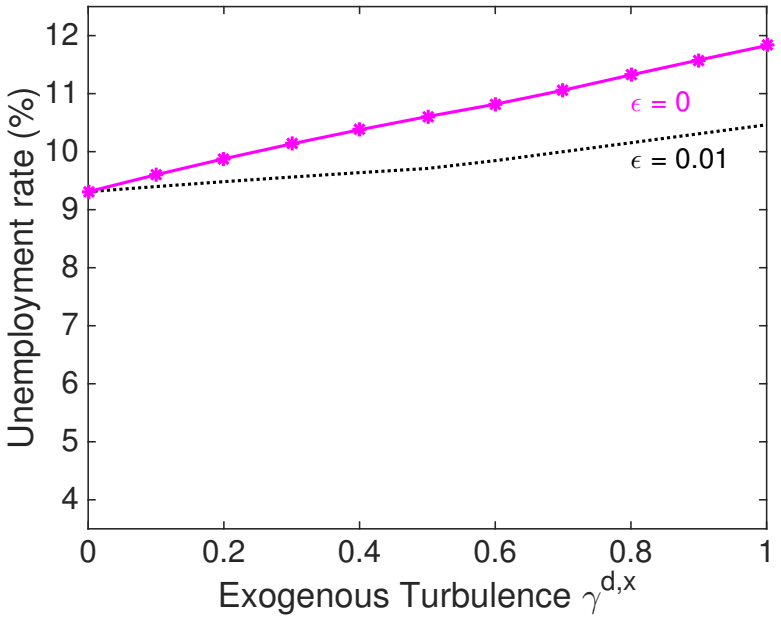

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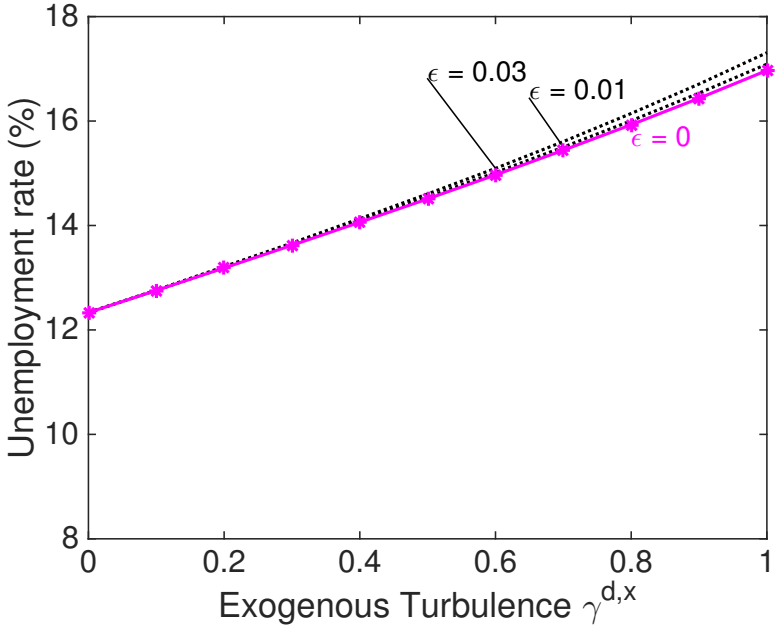

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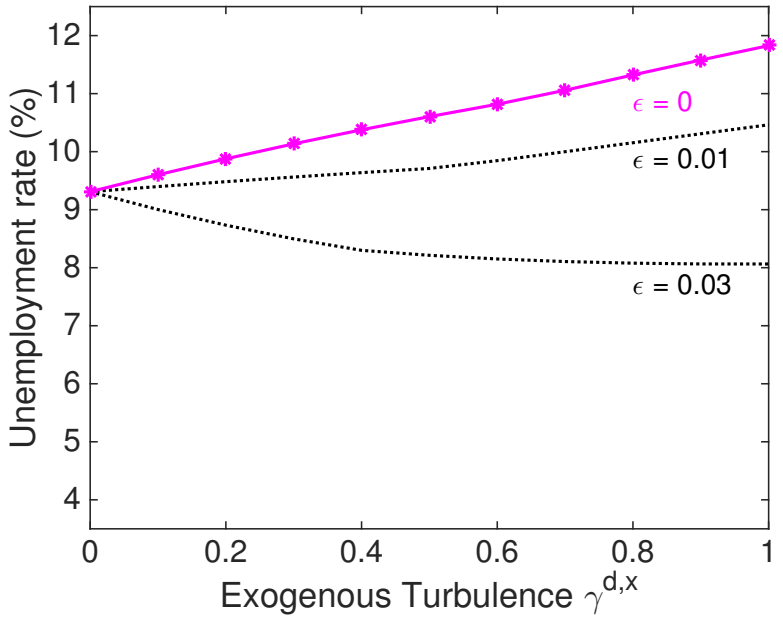

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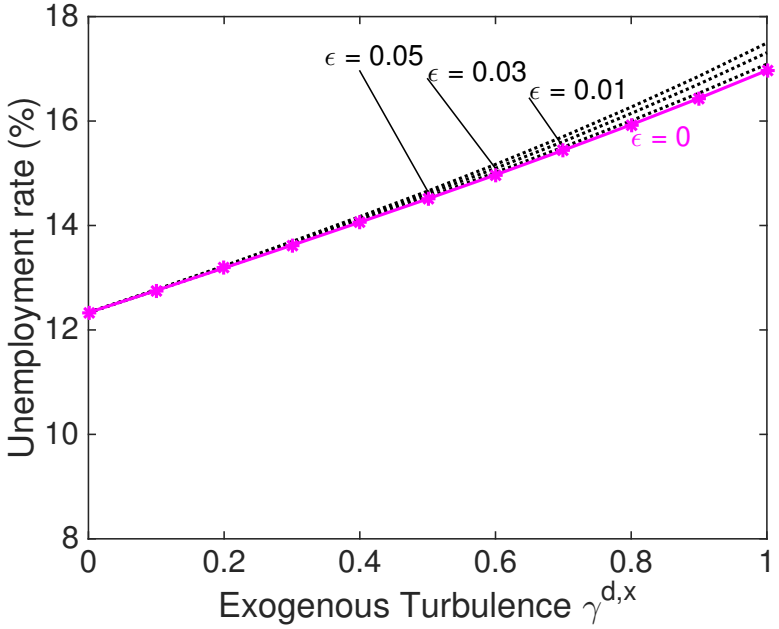

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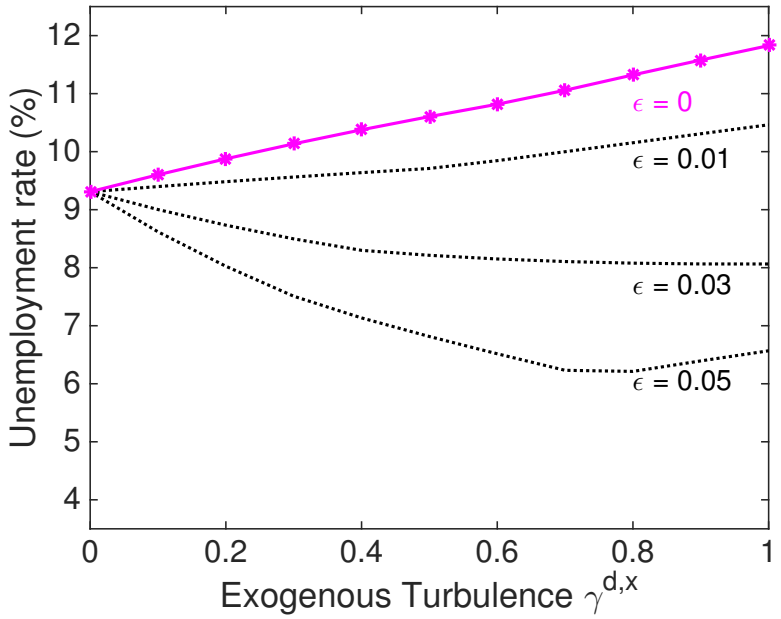

(b) dHHR framework

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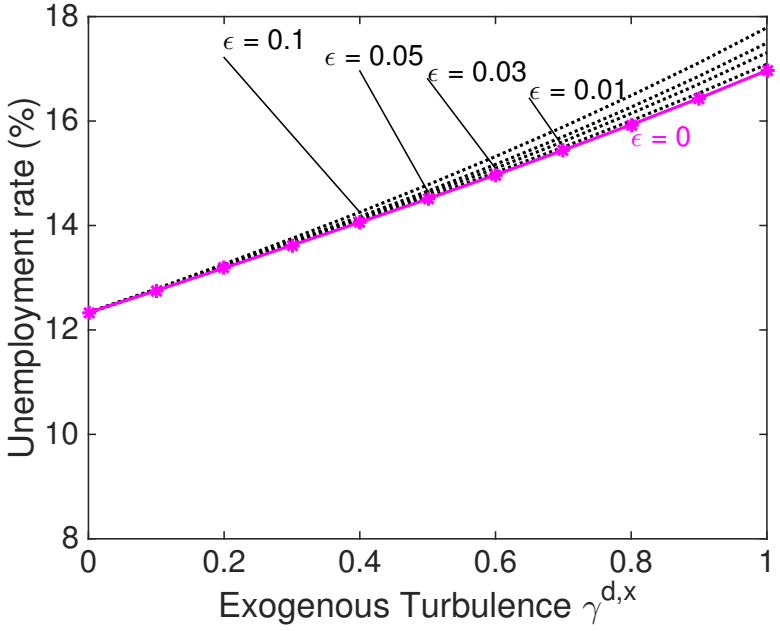

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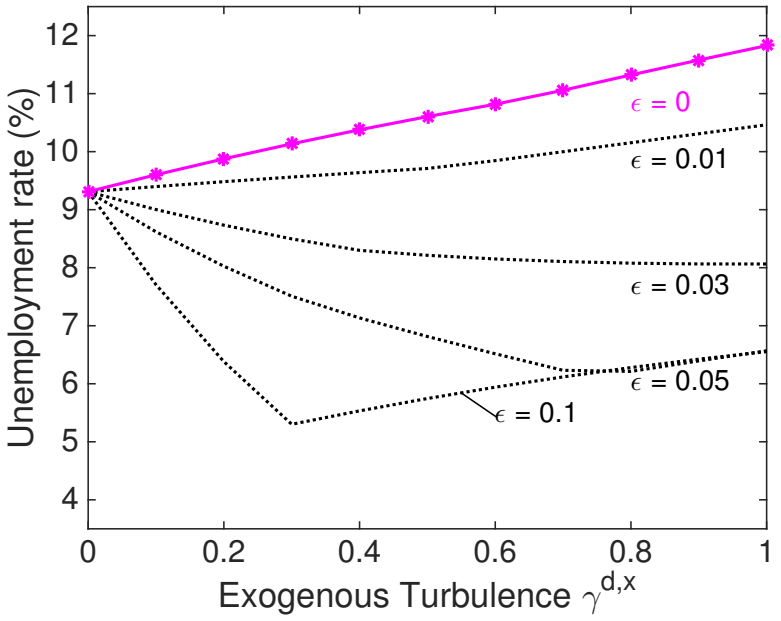

(b) dHHR framework

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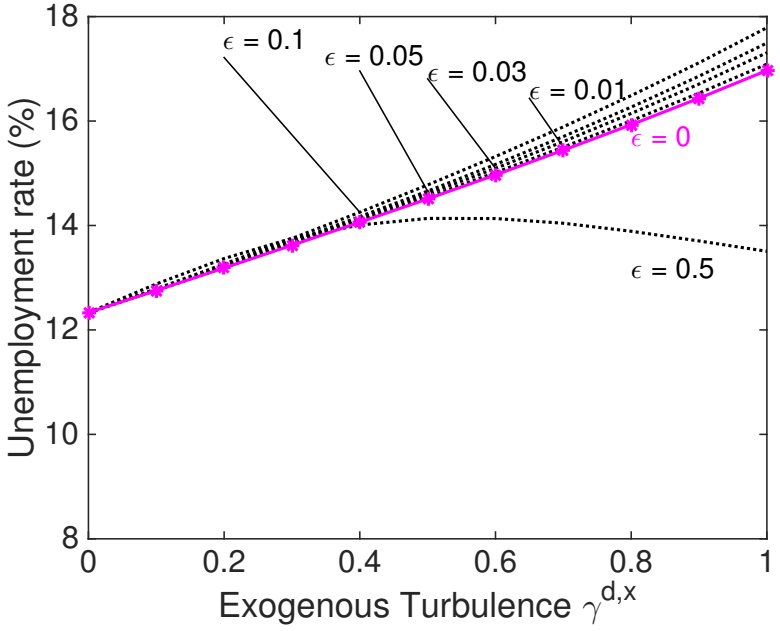

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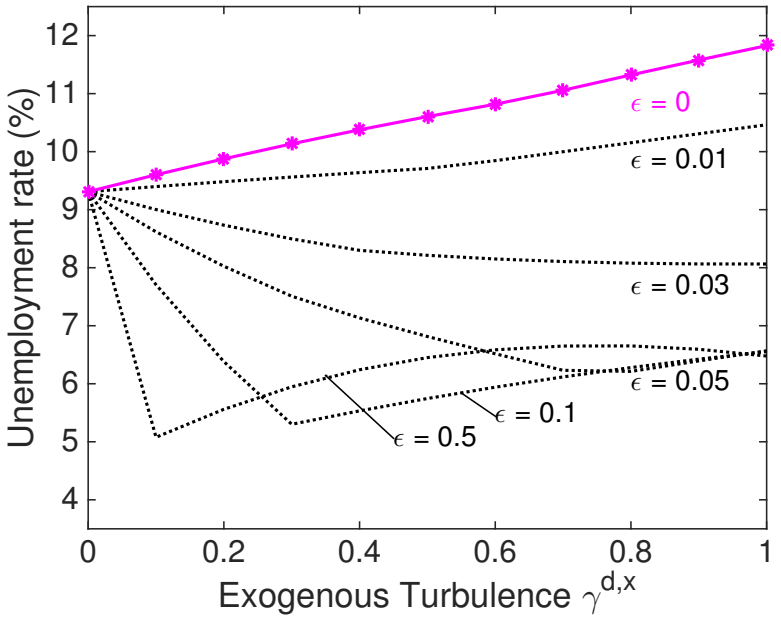


(b) dHHR framework

Plan of Attack

I) Matching framework with various turbulence channels

II) Document the turbulence puzzle

III) **Sources of disparate outcomes and verdict**

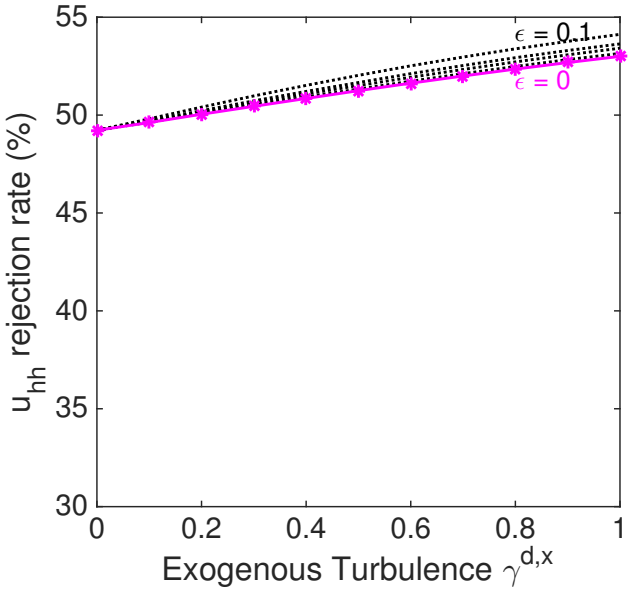
Potential sources of disparate outcomes

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** γ^e
4. **Support and shape of productivity distributions**

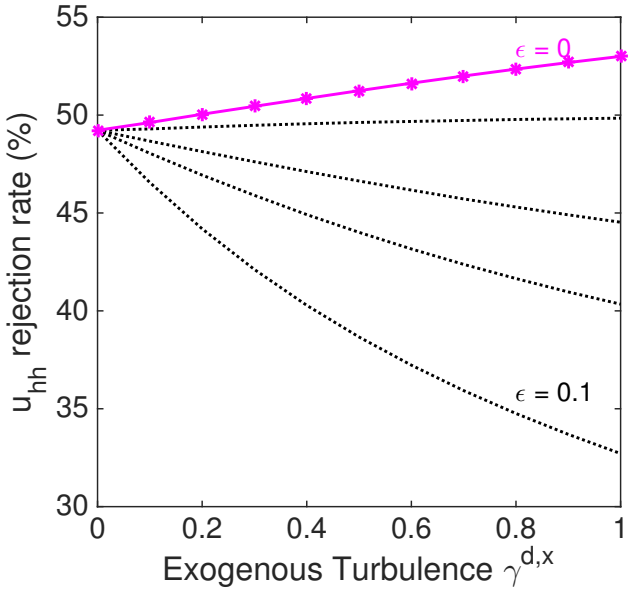
Turbulence during encounters

- **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}, $\gamma^e = 0$
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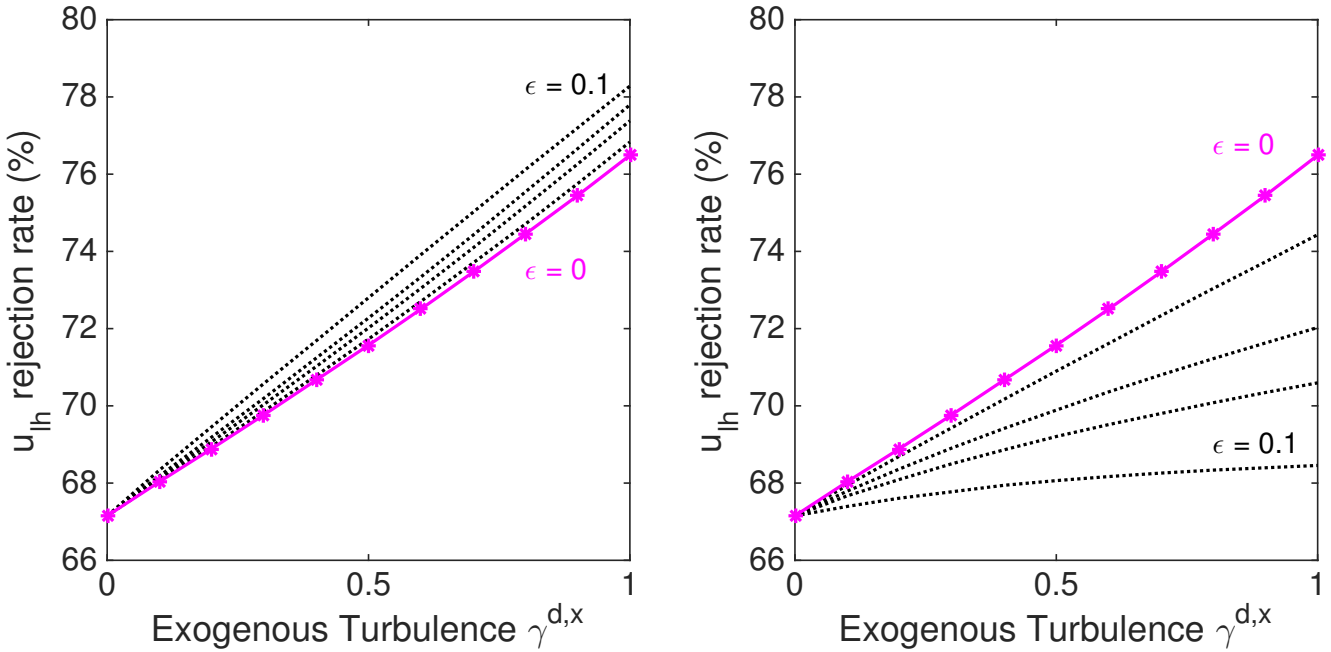
Rejection channel u_{lh}



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

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

Turbulence during encounters

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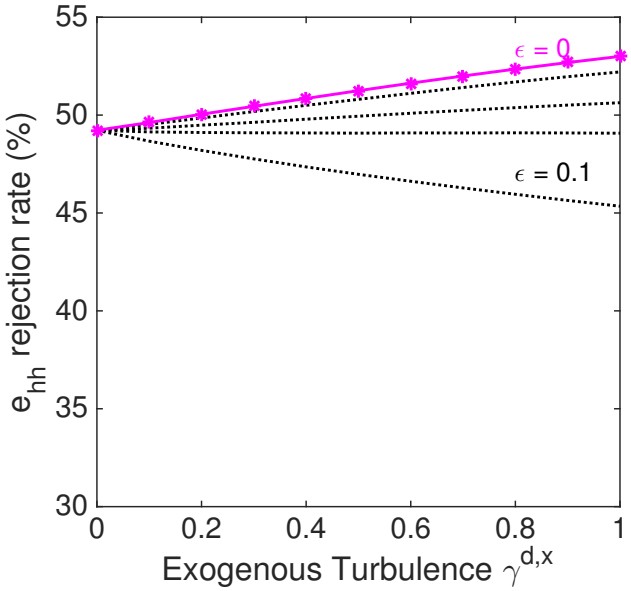
Retention channel e_{hh}



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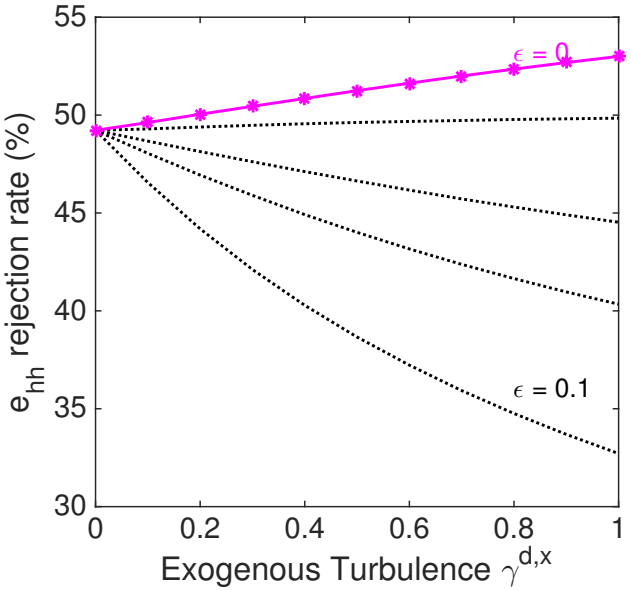
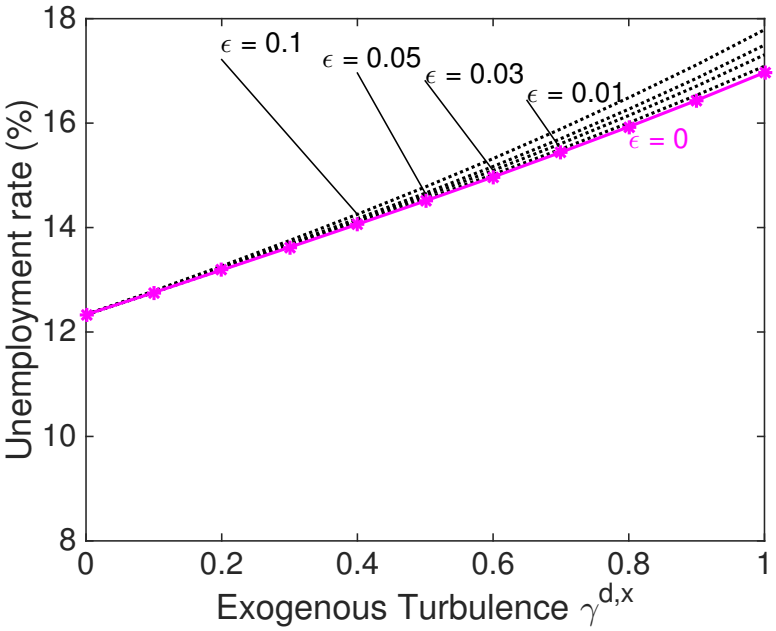


(b) dHHR: Equal exposure $\gamma^e = \gamma^d$

Turbulence during encounters

Verdict: Suppression of u by compounded turbulence risk is a key explanation for puzzle ✓



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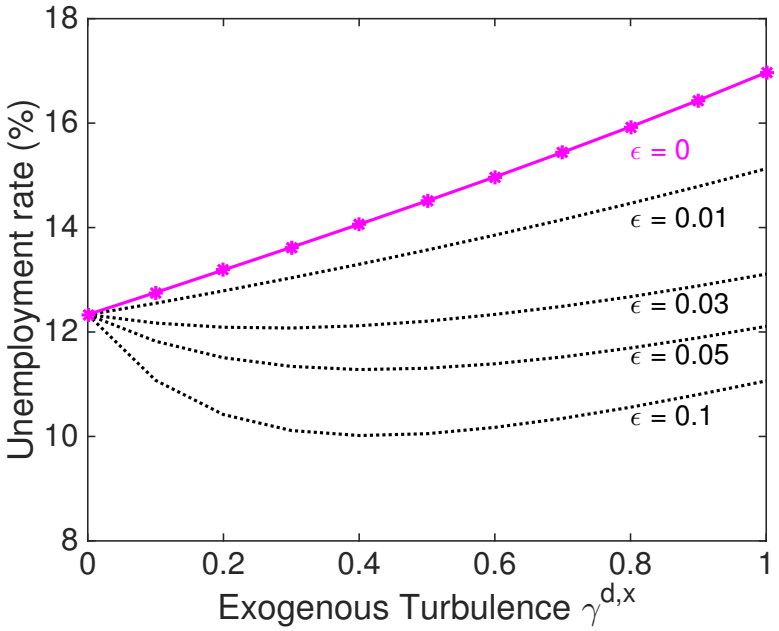


(b) LS: Equal exposure $\gamma^e = \gamma^d$

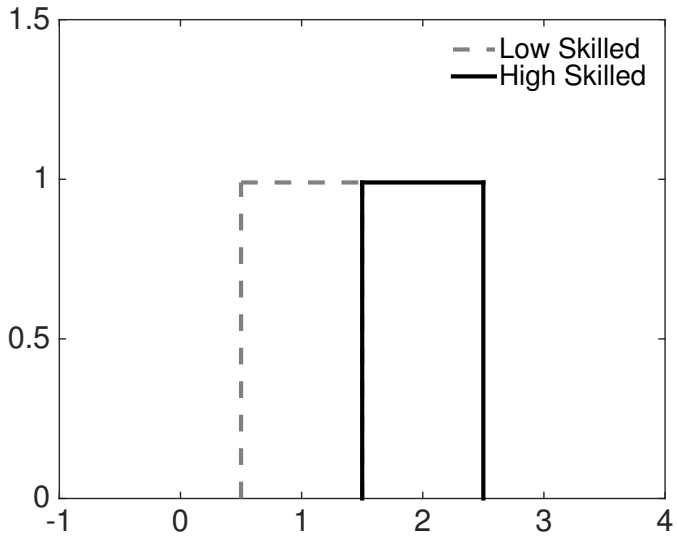
Potential sources of disparate outcomes

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** γ^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

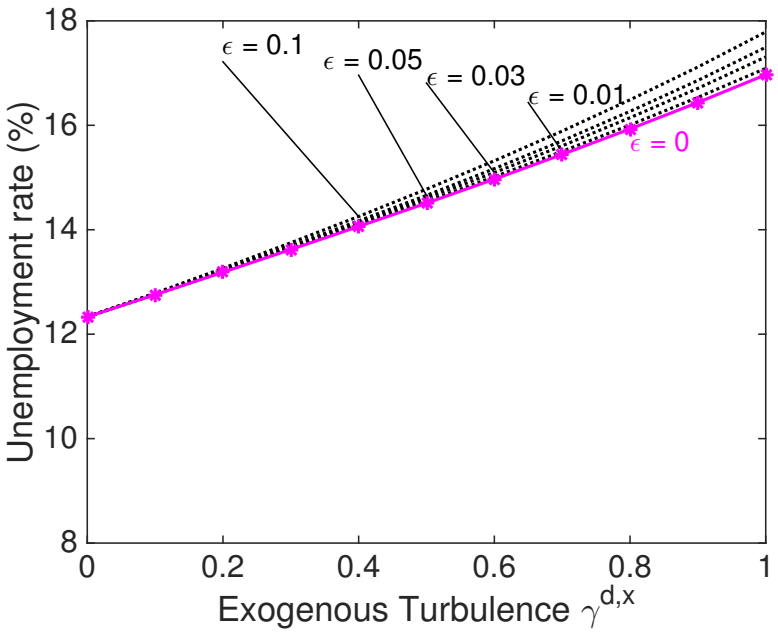


(b) dHHR: Uniform with narrow support

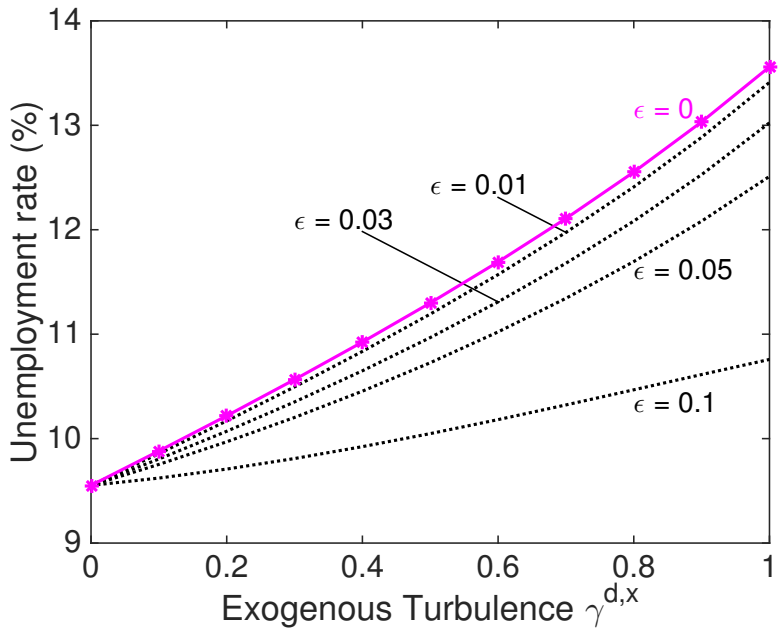
Productivity distributions

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

Verdict: Suppression of u by <u>reducing incentives for mobility</u> is a key explanation for puzzle ✓



(a) LS: wide Normal

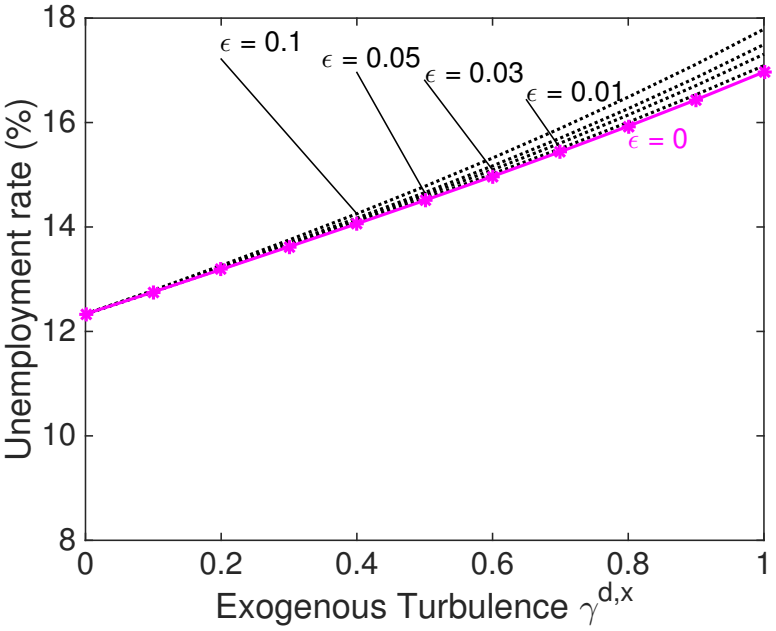


(b) LS: narrow uniform

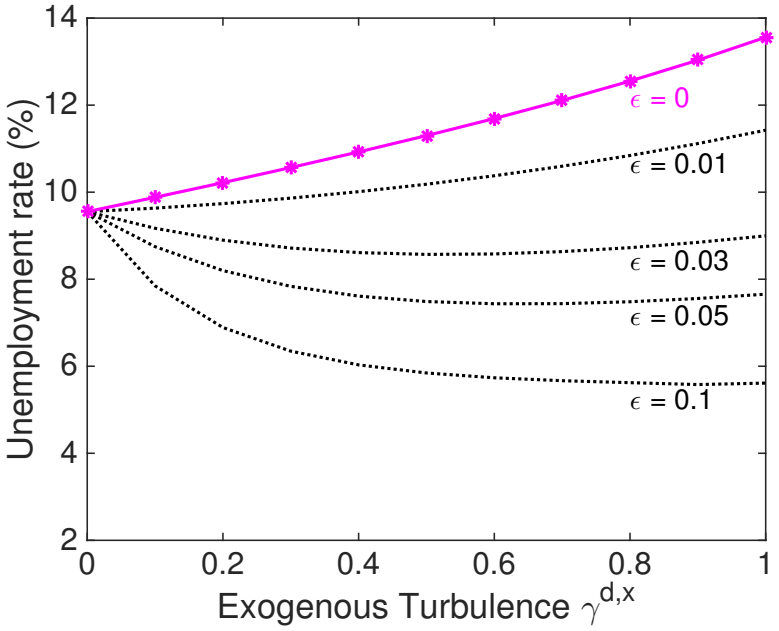
Answer to puzzle

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

Endogenous turbulence acts very strongly on job retention incentives!



(a) LS framework



(b) LS + narrow uniform + ($\gamma^e = \gamma^d$)

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I) Matching framework with various turbulence channels

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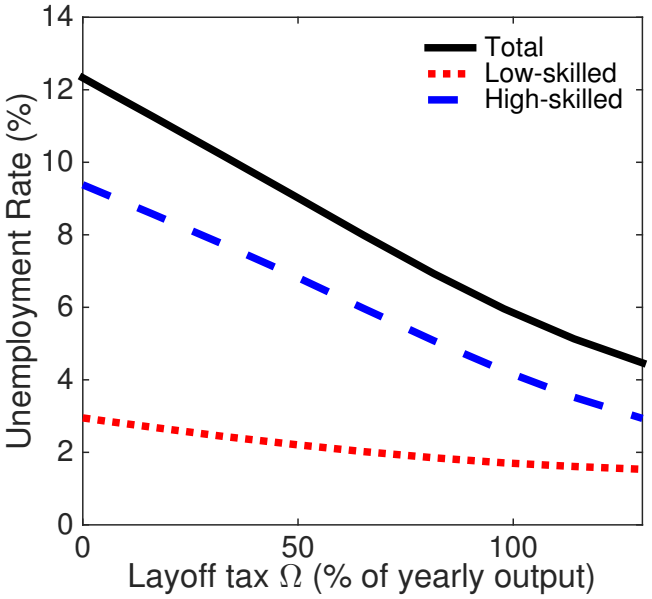
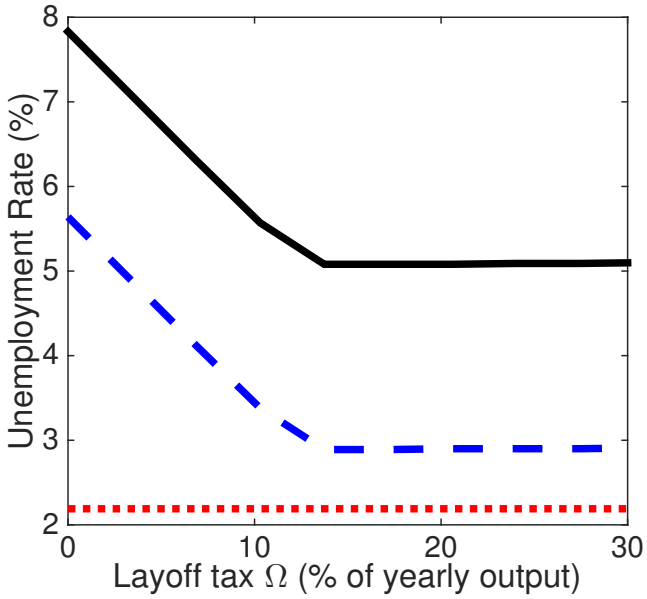
- **Layoff taxes as tell-tale signs of labor mobility**

Layoff taxes as tell-tale signs of labor mobility

- **Layoff tax** Ω 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 Ω
  - **dHHR:** Mobility shuts down for small Ω



(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

Return

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

$$\underbrace{s_{ij}(z)}_{\text{surplus}} = \underbrace{(1-\tau)z}_{\text{current output}} + \underbrace{g_i(z)}_{\text{joint continuation value}} - \underbrace{[b_j + \omega_{ij}^w - \mu + \omega^f]}_{\text{outside options}}$$

- **Nash Bargaining** determines wages, worker's bargaining power π

$$\underbrace{p_{ij}(z)}_{\text{wage}} + \underbrace{g_i^w(z)}_{\text{continuation}} = \underbrace{\pi s_{ij}(z)}_{\text{fraction } \pi \text{ of surplus}} + \underbrace{b_j + \omega_{ij}^w - \mu + \omega^f}_{\text{outside options}}$$

- **Reservation Productivity** = lowest z that makes a match profitable
  - Mutual agreement to form a match if surplus $s_{ij}(z)$ is positive

$$s_{ij}(\underline{z}_{ij}) = 0$$

- **Rejection Rate** = mass of productivity draws below $\underline{z}_{ij}$

$$\nu_{ij} = \int_{-\infty}^{\underline{z}_{ij}} df_i(y)$$

A.1) Detail about match surpluses

Return

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

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

$$s^o_{lj}(z) = s_{lj}(z) = (1-\tau)z + g_l(z) - [b_j + \omega^w_{lj} - \mu + \omega^f], \qquad j = l, h$$

- **High-skilled employed**

$$s_{hh}(z) = (1-\tau)z + g_h(z) - [b_h + \underbrace{(1-\gamma^d)\omega^w_{hh} + \gamma^d\omega^w_{lh}}_{\text{endogenous turbulence I}} - \mu + \omega^f]$$

- **High-skilled unemployed**

$$s^o_{hh}(z) = (1-\tau)z + g_h(z) - [b_h + \underbrace{(1-\gamma^e)\omega^w_{hh} + \gamma^e\omega^w_{lh}}_{\text{endogenous turbulence II}} - \mu + \omega^f]$$

A.2) Detail about match continuation values

Return

- **Joint continuation of a match with a low-skilled worker**

$$
\begin{aligned}
\text{(Layoff)} \quad g_l(z) &= \beta\Big[\rho^x(b_l + \omega_{ll}^w - \mu + \omega^f) \\
\text{(No changes)} &+ (1-\rho^x)(1-\gamma^u)(1-\gamma^s)((1-\tau)z + g_l(z)) \\
\text{(Switch)} &+ (1-\rho^x)(1-\gamma^u)\gamma^s(E_{ll} + \nu_{ll}(b_l + \omega_{ll}^w - \mu + \omega^f)) \\
\text{(Upgrade)} &+ (1-\rho^x)\gamma^u(E_{hh} + \nu_{hh}(b_h + \underbrace{(1-\gamma^d)\omega_{hh}^w + \gamma^d\omega_{lh}^w}_{\text{endogenous turbulence I}}) - \mu + \omega^f)\Big]
\end{aligned}
$$

where $E_{ij} = \int_{\underline{z}_{ij}}^{\infty} [(1-\tau)y + g_j(y)]\, df_i(y)$

- **Joint continuation of a match with a high-skilled worker**

$$
\begin{aligned}
\text{(Layoff)} \quad g_h(z) &= \beta\Big[\rho^x(b_h + \underbrace{\gamma^{d,x}\omega_{lh}^w + (1-\gamma^{d,x})\omega_{hh}^w}_{\text{exogenous turbulence}} - \mu + \omega^f) \\
\text{(No changes)} &+ (1-\rho^x)(1-\gamma^s)((1-\tau)z + g_h(z)) \\
\text{(Switch)} &+ (1-\rho^x)\gamma^s(E_{hh} + \nu_{hh}(b_h + \underbrace{(1-\gamma^d)\omega_{hh}^w + \gamma^d\omega_{lh}^w}_{\text{endogenous turbulence I}}) - \mu + \omega^f)\Big]
\end{aligned}
$$

A.3) Detail about outside options

Return

- **Value of unemployment**: $b_j + \omega^w_{ij}$

$$\omega^w_{lj} = \beta\Big[\underbrace{\lambda^w(\theta)\int_{\underline{z}_{lj}}^{\infty} \pi s^o_{lj}(y)\ df_l(y)}_{\text{match + accept}} + \underbrace{b_j + \omega^w_{lj}}_{\text{match + reject or no match}}\Big] \qquad j = l, h$$

$$\omega^w_{hh} = \beta\Big[\underbrace{\lambda^w(\theta)\int_{\underline{z}_{hh}}^{\infty} \pi s^o_{hh}(y)\ df_h(y)}_{\text{match + accept}} + \underbrace{\lambda^w(\theta)(b_h + (1-\gamma^e)\omega^w_{hh} + \gamma^e\omega^w_{lh})}_{\text{match + reject (endogenous turbulence II)}}$$

$$+ \underbrace{(1-\lambda^w(\theta))(b_h + \omega^w_{hh})}_{\text{no match}}\Big]$$

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

$$\omega^f = \beta\left[\sum_{(i,j)} \lambda^f_{ij}(\theta)\int_{\underline{z}_{ij}}^{\infty}(1-\pi)s_{ij}(y)\ df_i(y) - \mu + \omega^f\right]$$

A.4) Details about wages

Return

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

$$\max_{p_{ij}(z)} \left[(1-\tau)z - p_{ij}(z) + g^f(z) \underbrace{+\mu - \omega^f}_{\text{firm's threat}}\right]^{1-\pi} \left[p_{ij}(z) + g_i^w(z) \underbrace{-b_j - \omega_{ij}^w}_{\text{worker's threat}}\right]^{\pi}$$

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

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

$$p_{ll}(z) + g_l^w(z) = \pi s_{lj}(z) + b_j + \omega_{lj}^w, \qquad j = l, h$$

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

$$p_{hh}(z) + g_h^w(z) = \pi s_{hh}(z) + b_h + \underbrace{(1-\gamma^d)\omega_{hh}^w + \gamma^d \omega_{lh}^w}_{\text{endogenous turbulence I}}$$

- **High-skilled unemployed**

$$p_{hh}^o(z) + g_h^w(z) = \pi s_{hh}^o(z) + b_h + \underbrace{(1-\gamma^e)\omega_{hh}^w + \gamma^e \omega_{lh}^w}_{\text{endogenous turbulence II}}$$

A.5) Detail about worker flows

Return

$$
\begin{aligned}
\Delta u_{ll} &= \rho^r + (1-\rho^r)\left\{\rho^x + (1-\rho^x)(1-\gamma^u)\gamma^s \nu_{ll}\right\} e_{ll} \\
&- \rho^r u_{ll} - (1-\rho^r)\lambda(1-\nu_{ll})u_{ll}
\end{aligned}
$$

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

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

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

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

A.6) Benefits, taxes and gov budget

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

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

- **Income Taxes:** fraction τ of match's output

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

- **Balanced Government Budget**

$$\text{unemployment benefits} = \text{tax revenues}$$

$$\underbrace{\phi(\bar{p}_l u_{ll} + \bar{p}_h(u_{lh} + u_{hh}))}_{\text{gov. expenditure}} = \underbrace{\tau(\bar{z}_l e_l + \bar{z}_h e_h)}_{\text{gov. revenues}}$$

A.7) Detail about equilibrium

Return

- A **steady state equilibrium** is given by:
  - tightness θ; job finding rate $\lambda^w(\theta)$; vacancy filling rate $\lambda^f_{ij}(\theta)$;
  - match surpluses $s_{ij}(z)$; productivity thresholds $\underline{z}_{ij}$; rejection rates ν_{ij};
  - wages $p_{ij}(z)$; benefits b_j;
  - future values for unemployment ω^w_{ij}, vacancies ω^f, and matches $g_i(z)$
  - tax rate τ
- such that the following conditions hold:
  - **Zero profits:** $\omega^f(\theta) = \mu$
  - **Zero surplus:** $s(\underline{z}_{ij}) = 0 \quad \forall\, ij$
  - **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:** $\Delta u_{ij} = \Delta e_{ij} = 0 \quad \forall\, ij$

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B **Effective workers' bargaining power**

1. Type of matching
2. Timing of skill consummation

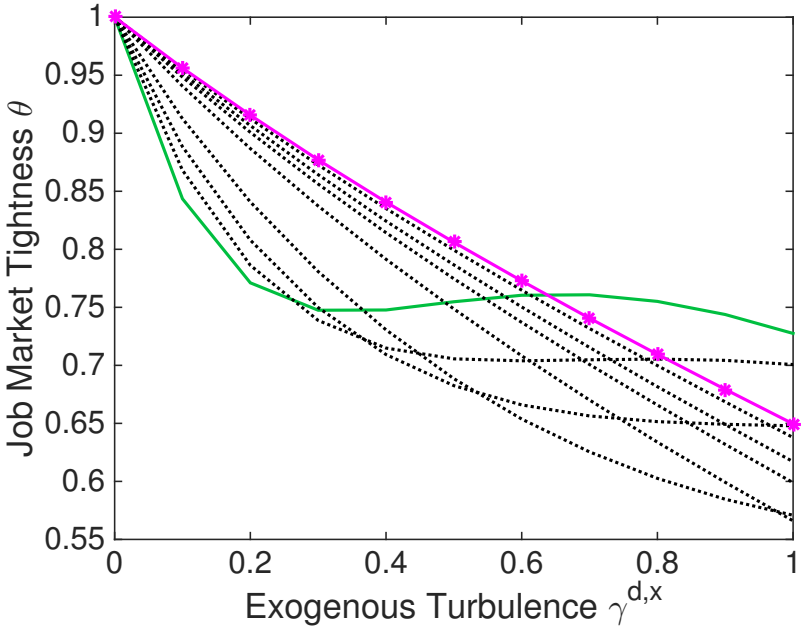
C Layoff taxes

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

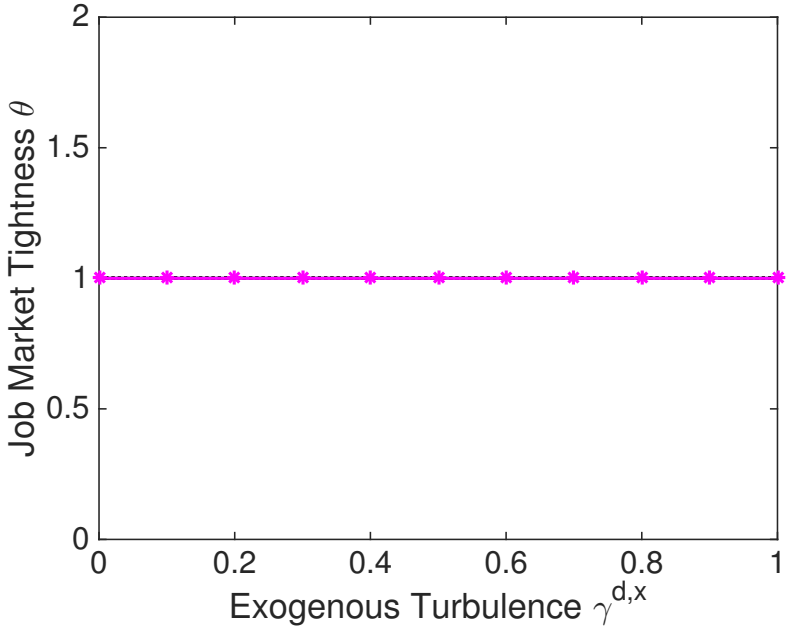
D Starting from dHHR

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



(a) Endogenous tightness ($\theta = v/u$)

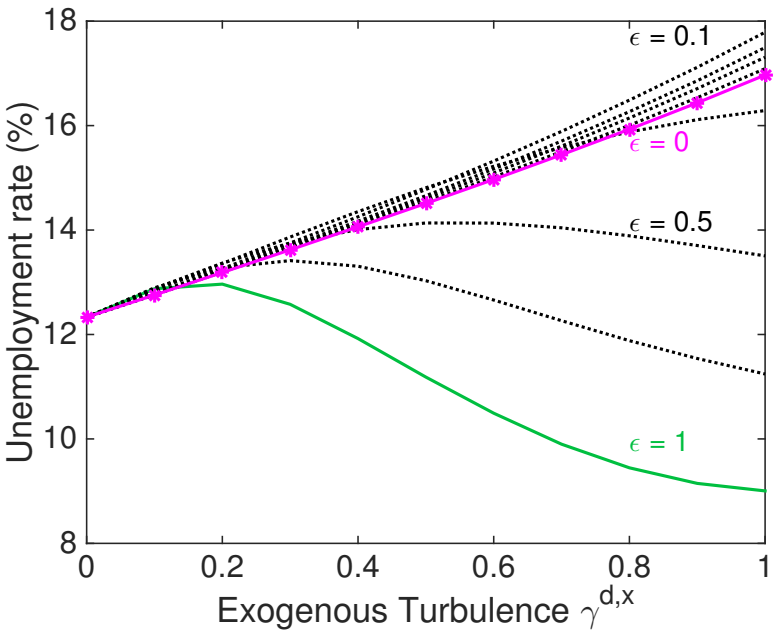


(b) Exogenous tightness ($\theta = 1$)

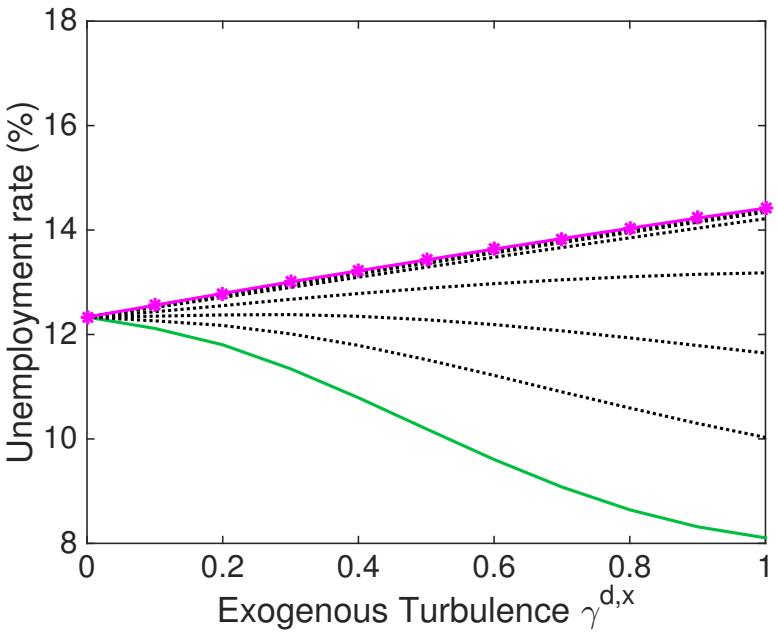
B.1) Type of Matching (cont...)

- **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 <u>fixed vacancies</u> does not make the dHHR puzzle to erupt $\times$



(a) Endogenous tightness ($\theta = v/u$)

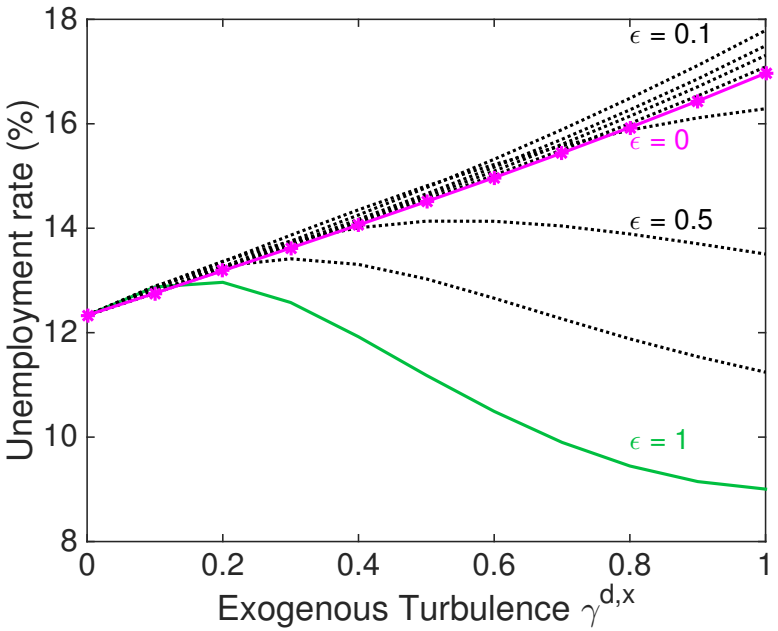


(b) Exogenous tightness ($\theta = 1$)

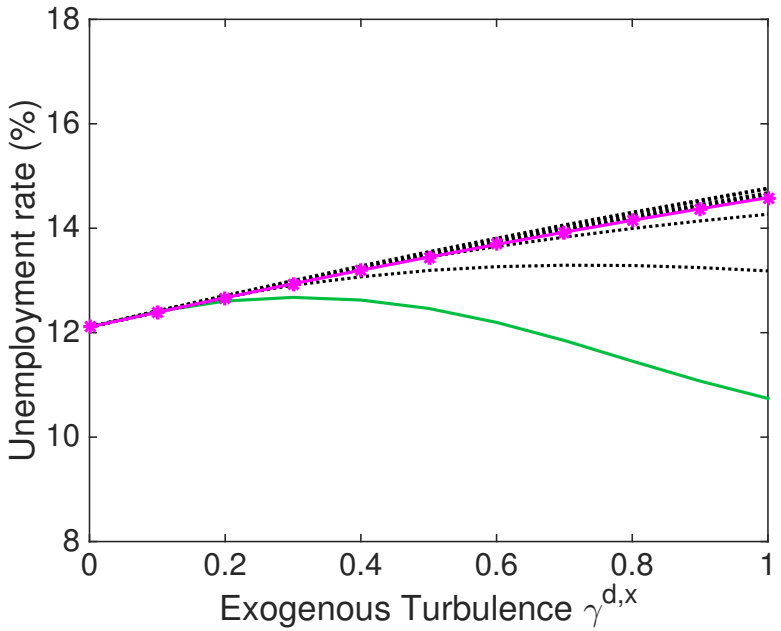
B.2) Timing of skill consummation (cont...)

- **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 <u>eroding workers' bargaining power</u> does not make the dHHR puzzle to erupt $\times$



(a) Immediate consummation



(b) Delayed consummation

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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

Return

- Consider **layoff tax** Ω 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**)

$$s_{ij}(\underline{z}_{ij}) = -\Omega \qquad vs. \qquad s^0_{ij}(\underline{z}_{ij}) = 0$$

  - Two-tier wage structure (Mortensen and Pissarides, 1994)
- Government revenue now equals income taxes plus layoff taxes

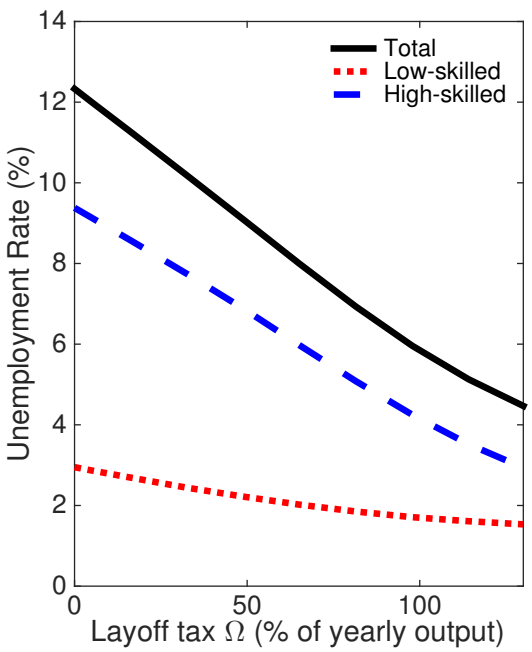
$$revenue = \tau(\bar{z}_l e_l + \bar{z}_h e_h) + seps * \ \Omega$$

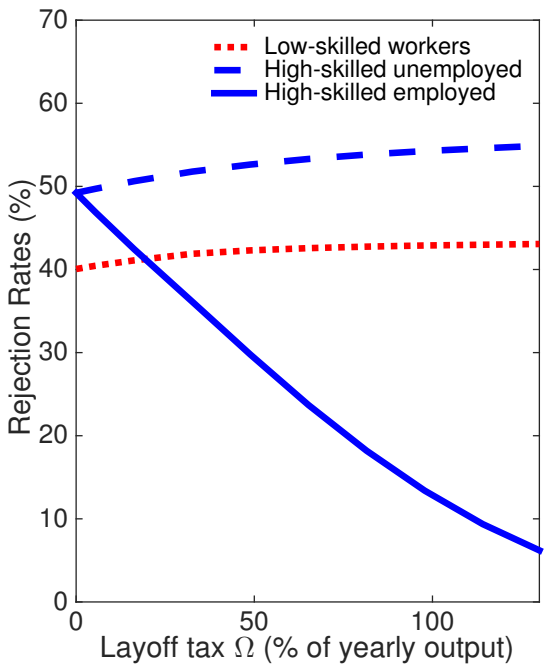
- **Experiment:** changes in layoff tax in tranquil times (no turbulence)
  - Ω expressed as % of average yearly output in laissez-faire economy

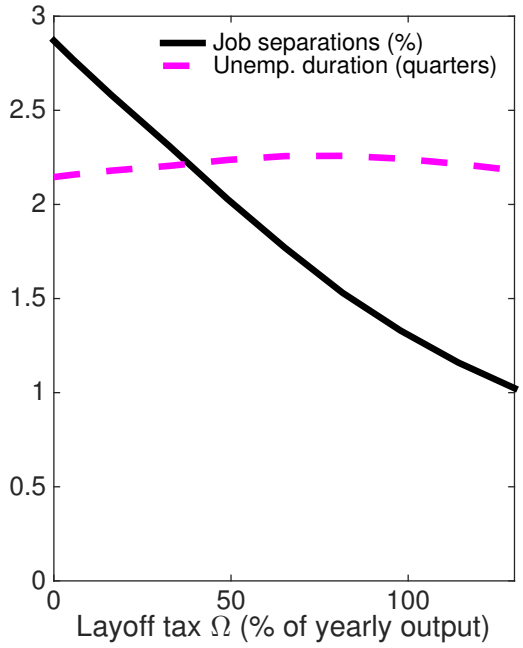
C.2) Layoff taxes in LS

Return

- 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.



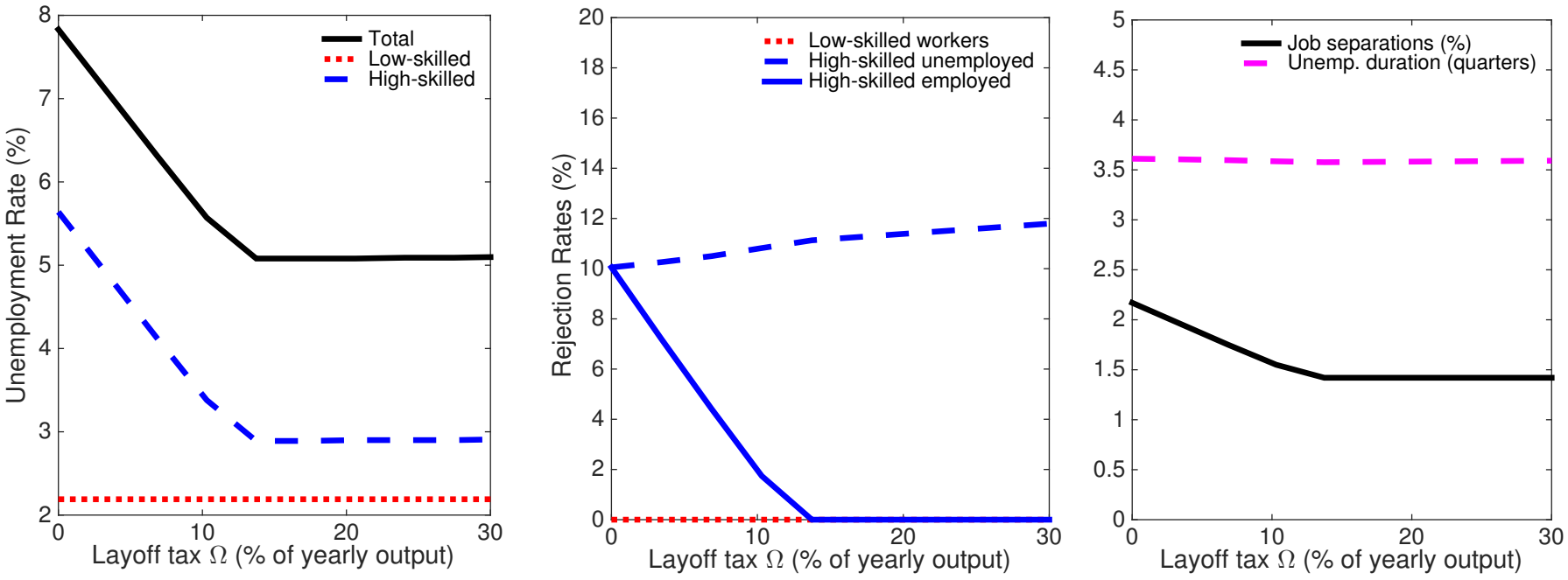




C.3) Layoff taxes in dHHR

Return

- 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.



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B Effective workers' bargaining power

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C Layoff taxes

1. Details about layoff tax implementation
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D **Starting from dHHR**

D) Analysis starting from dHHR

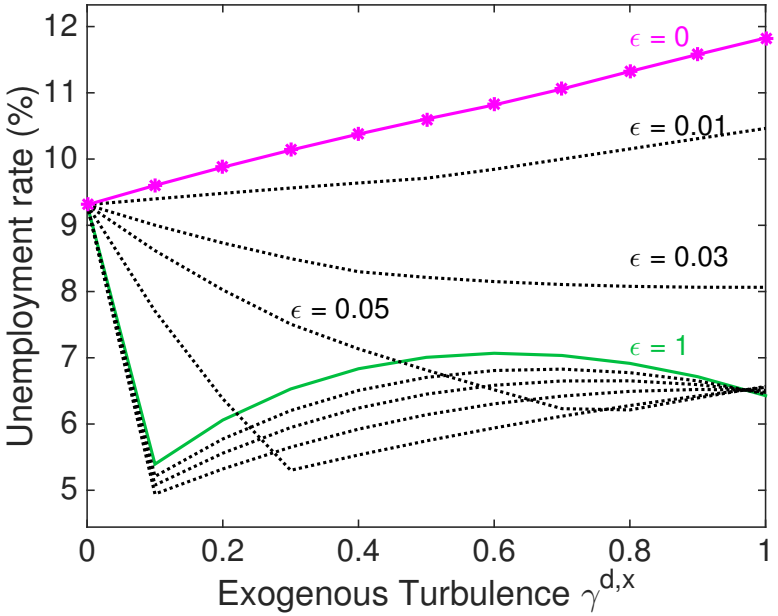
1. **Effective exposure to turbulence**
   - Turbulence during job market encounters
2. **Incentives for labor mobility in tranquil times**
   - Productivity distributions
3. **Effective workers' bargaining power**
   - Exogenous vs. endogenous matching
   - Timing of skill consummation following upgrades

D.1) Turbulence during job market encounters

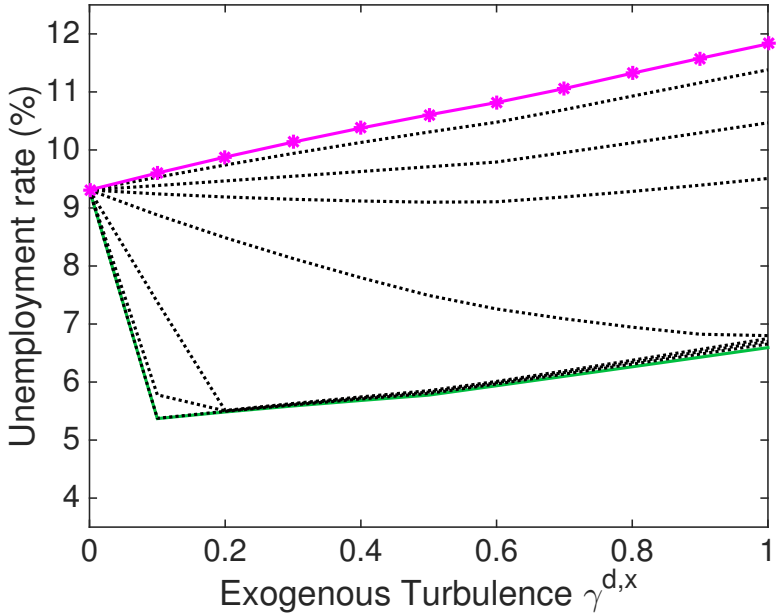
- **dHHR's exposure**: same as high-skilled employed $\gamma^e = \gamma^d$
- **LS's exposure**: non, $\gamma^e = 0$

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 $\gamma^e = \gamma^d$

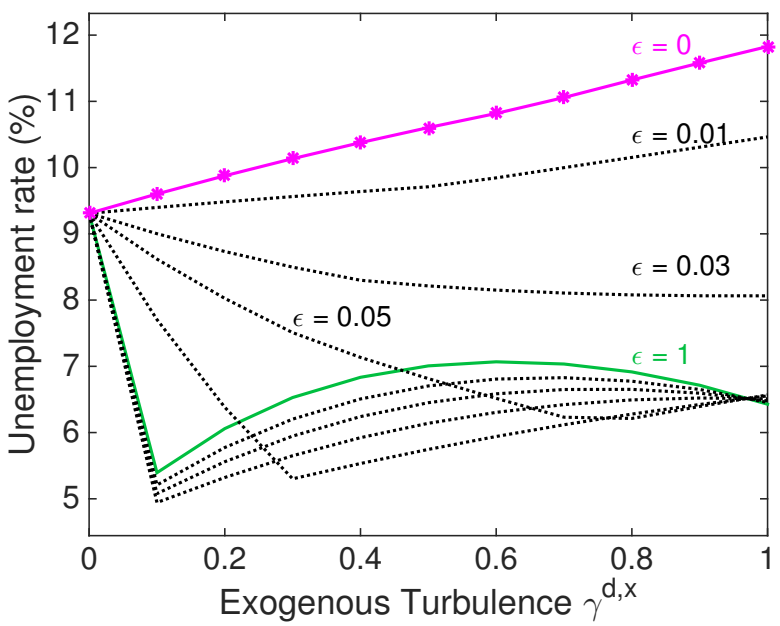


(b) No exposure $\gamma^e = 0$

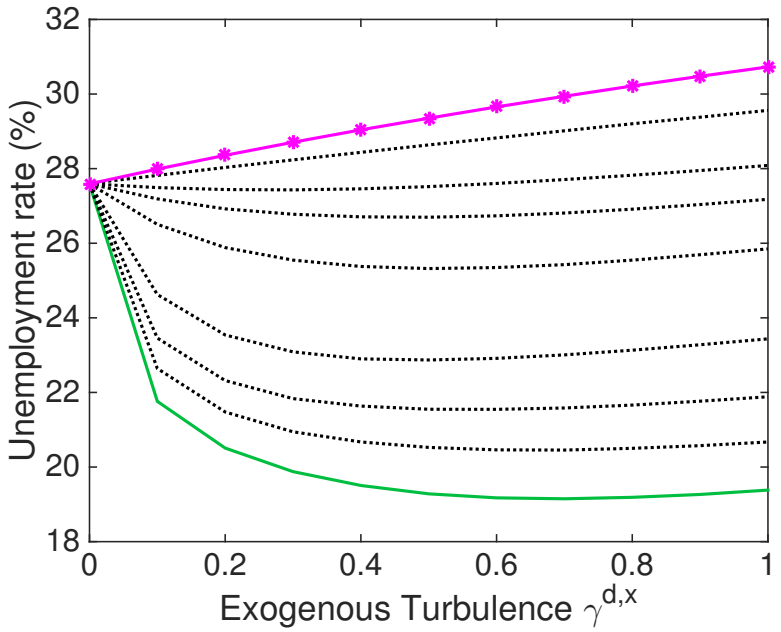
D.2) Productivity distributions

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

Verdict: Accrual of u driven by <u>increasing incentives to quit</u> does not fully eliminate the dHHR puzzle $\times$



(a) Normal with wide support

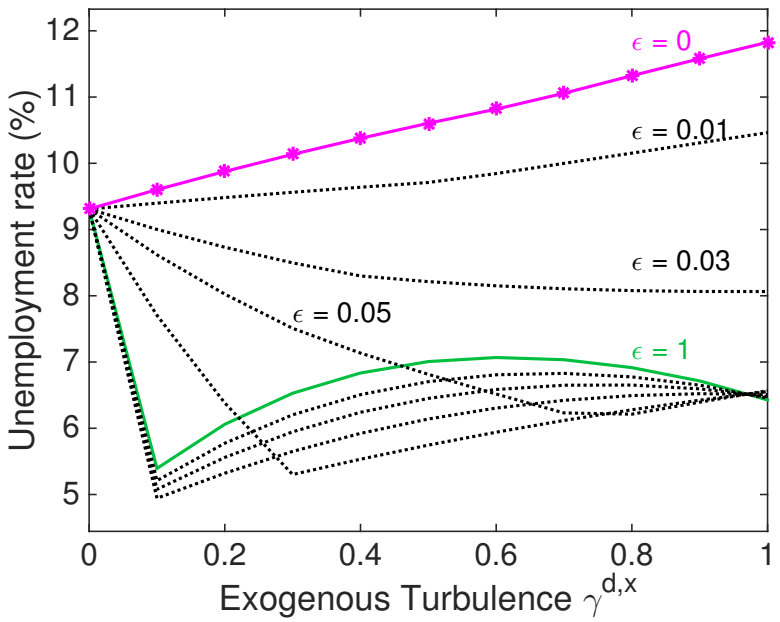


(b) Uniform with narrow support

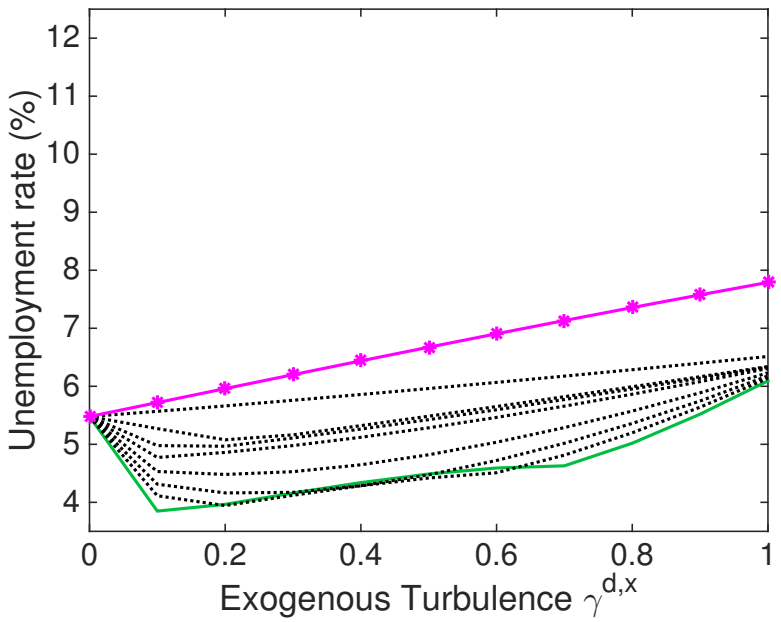
D.3) Type of matching

- **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 <u>endogenous vacancy creation</u> does not eliminate the dHHR puzzle $\times$



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

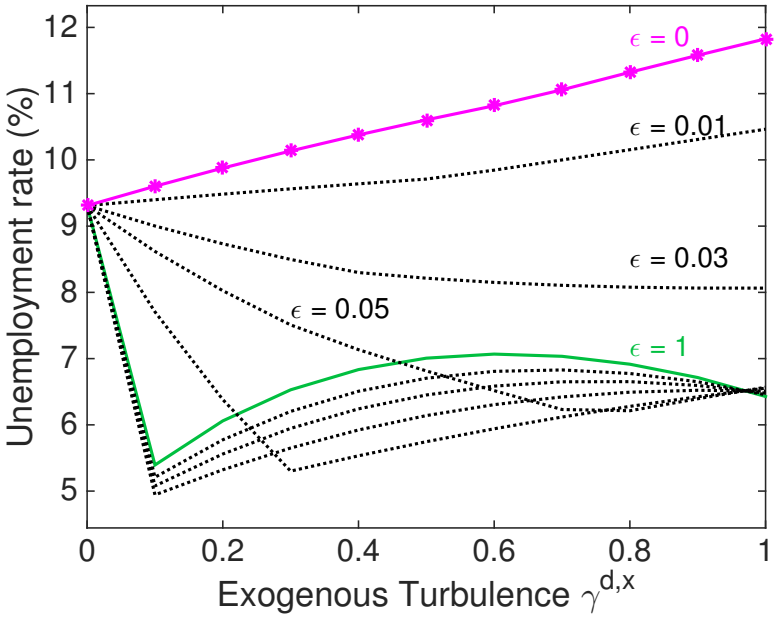


(b) Endogenous tightness ($\theta = v/u$)

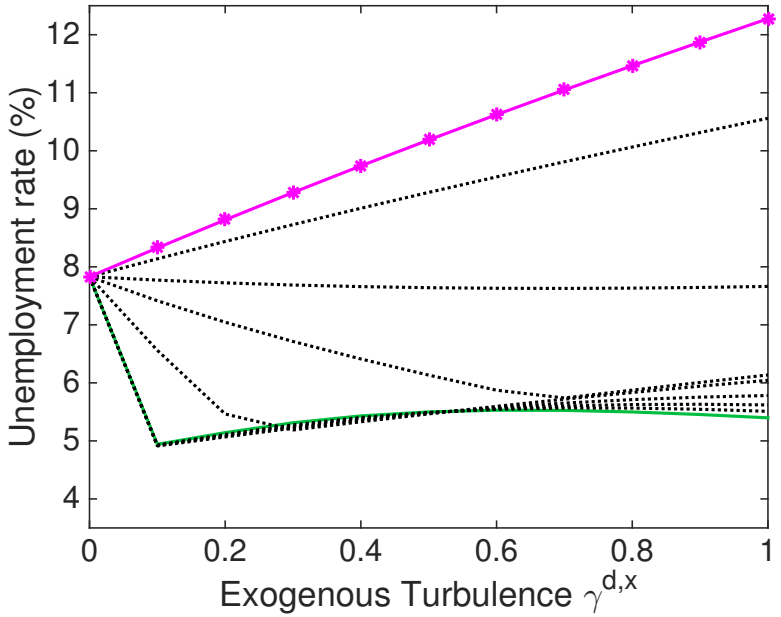
D.4) Timing of skill consummation

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

Verdict: Accrual of u driven by <u>enhancing workers' bargaining power</u> does not eliminate the dHHR puzzle $\times$



(a) Delayed consummation

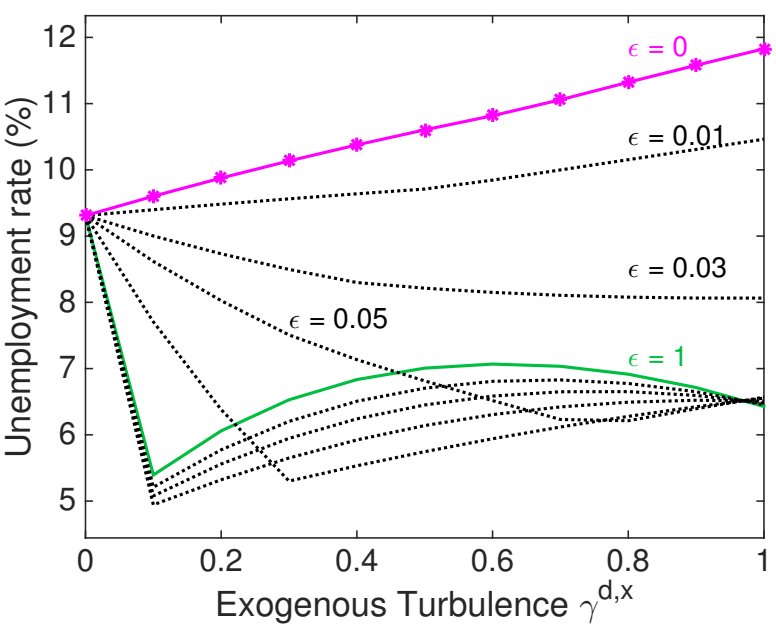


(b) Immediate consummation

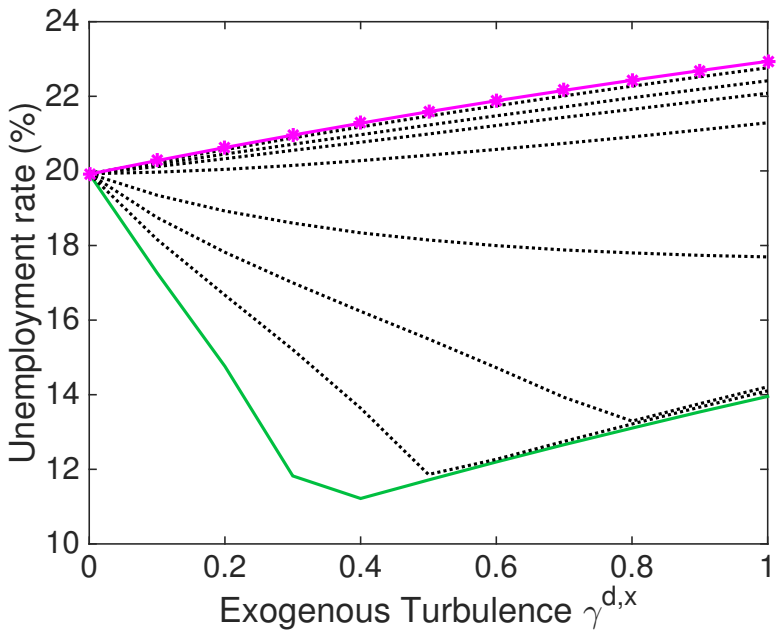
Solution: dHHR + wide support + ($\gamma^e = 0$)

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 + ($\gamma^e = 0$)