Occupational safety in a frictional labor market

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Motivation

- occupational safety is nowadays high on the political agenda
  - pandemic: avoiding disruptions vs. protecting worker health
  - key for longer working lives and healthy aging
  - work-related accidents and diseases lead to a loss of 3.3% of GDP in the EU (EU-OSHA, 2017)
  - policy initiatives around the world: EU, US, WHO, ILO, ...
- public intervention warranted since private provision is likely to be inefficient (Henderson, 1983; Pouliakas and Theodossiou, 2013)
  - inaccurate information about risks and long-term effects
  - psychological biases in risk-perceptions
  - externalities on co-workers, macroeconomy, public welfare systems
- not considered so far in this context: search frictions à la DMP

Why may search frictions matter?

- frictions increase the time that unemployed workers need to find a job
- the less frequent they get a job offer, the higher may be their willingness to accept jobs with low safety standards $\Rightarrow$ safety $\downarrow$
- frictions also increase the time that employers need to fill a vacancy
- the longer it takes to find a replacement worker, the higher is their incentive to protect health of incumbent workers $\Rightarrow$ safety $\uparrow$

$\Rightarrow$ impact of search frictions on occupational safety is not clear

This paper

study provision of occupational safety in the presence of search frictions

- extend basic DMP model (Pissarides, 2000, Ch. 1) for mortality shocks
- arrival rate is endogenously determined
- analyze effect of search frictions and externalities on mortality rate

solve and compare three model variants

1. social planner without search frictions $\Rightarrow$ efficient solution
2. social planner with search frictions $\Rightarrow$ constrained efficient solution
3. decentralized economy with search frictions $\Rightarrow$ equilibrium

- compare 1 and 2 $\Rightarrow$ differential effect of search frictions
- compare 2 and 3 $\Rightarrow$ effect of externalities (labor supply, matching)

Preview of results

Result #1

Search frictions unambiguously decrease safety provision.

Result #2

In an equilibrium with Nash bargaining, the labor supply externality is internalized.

Result #3

In an equilibrium with Nash bargaining, matching externalities are internalized if and only if the Hosios (1990) condition holds. Any deviation from the Hosios condition further decreases safety levels.

Result #4

The main result (#1) is supported by US data on fatal occupational injuries.

Social planning problems

- employed die at rate m, unemployed with $m_U \Rightarrow$ population dynamics:

$$\dot{N}(t) = B(t) - m(t)L(t) - m_U U(t)$$

- planner maximizes PDV of aggregate output (net of posting costs)

$$\int_0^\infty [y(m(t))L(t) + zU(t) - cV(t)]e^{-rt}\,dt$$

  - assume that $y'(m) > 0$ and $y''(m) < 0$, i.e. safety measures reduce output at an increasing rate, capturing direct and indirect costs

- Variant 1 (no frictions): planner chooses $m(t), L(t), U(t), V(t)$
- Variant 2 (frictions): planner chooses $m(t), V(t)$ subject to

$$\dot{L}(t) = -(m(t) + s)L(t) + p(\theta(t))U(t),$$
$$\dot{U}(t) = B(t) + sL(t) - (p(\theta(t)) + m_U)U(t)$$

Effect of search frictions

compare optimality conditions of the social planning problems in steady state

without frictions:

$$y'(m) = \frac{y(m)}{r+m}$$

with frictions:

$$y'(m) = \frac{y(m) + s\Delta}{r+m}$$

l.h.s.: marginal cost of safety = loss in current production

r.h.s.: marginal benefit of safety = PDV of expected future production

$\Delta < 0$ ... change in aggregate output when worker becomes unemployed

Result #1

Search frictions unambiguously lower the optimal safety level.

illustration

Decentralized economy

- mortality rate is bargained between workers and firms together with wage

$$\begin{aligned} \max_{(w,m)} \ & (W-U)^{\gamma}(J-V)^{1-\gamma} \\ s.t. \ \ & rW = w - s(W-U) - mW + \dot{W} \\ & rJ = y(m) - w - (s+m)(J-V) + \dot{J} \end{aligned}$$

- U and V are taken as given in the bargain, but in equilibrium satisfy

$$\begin{aligned} rU &= z + p(\theta)(W-U) - m_U U + \dot{U} \\ rV &= -c + q(\theta)(J-V) + \dot{V} \\ V &\equiv 0 \end{aligned}$$

Labor supply externality

- private agents do not consider that a deceased worker is lost for the economy as a whole
- compare optimality conditions of the constrained planner and the bargain

$$y'(m) = \frac{y(m) + s\Delta}{r + m} \qquad y'(m) = J + W = \frac{y(m) + sU}{r + m + s}$$

r.h.s.: social benefit of safety = PDV of **all expected future output**

r.h.s.: private benefit of safety = **expected future payoff of worker and incumbent firm**

Result #2

The equilibrium value of U is such that the labor supply externality is internalized.

intuition: W captures the expected value of production in future employment spells as in an equilibrium expected gains of future employers equal posting costs

Matching externalities

- private agents do not consider how their negotiation outcome affects job-finding and vacancy-filling rate
- by comparing planner and equilibrium conditions: show conditions

Result #3a

Matching externalities are internalized in equilibrium if and only if the Hosios (1990) condition holds.

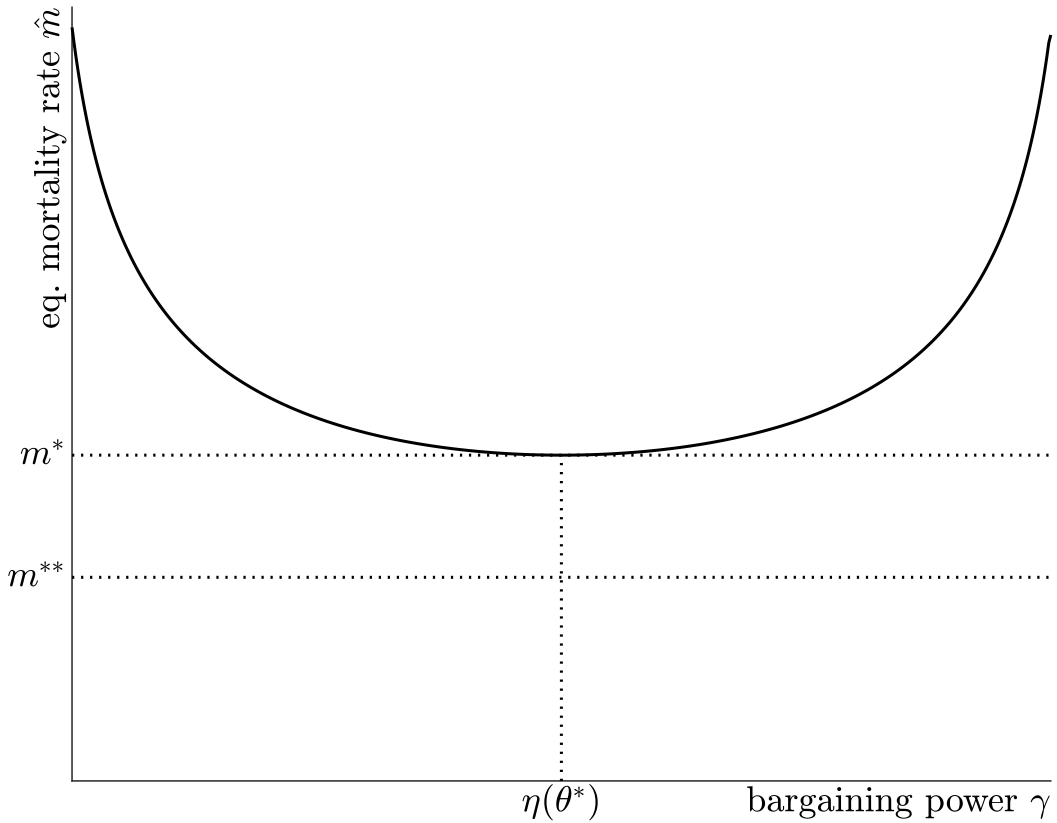
- in this case: equilibrium mortality rate $=$ mortality rate chosen by the constrained planner

Result #3b

Any deviation from the Hosios condition leads to an increase in mortality.

intuition: m *is inversely related to* U*, which is maximized when* $\gamma = \eta(\theta)$*.*

Comparison of mortality rates



1: m^{**} ... planner's optimal mortality rate without frictions
2: m^* ... planner's optimal mortality rate with frictions
3: $\hat{m}$ ... equilibrium mortality rate as a function of γ

Evidence

not yet in the paper

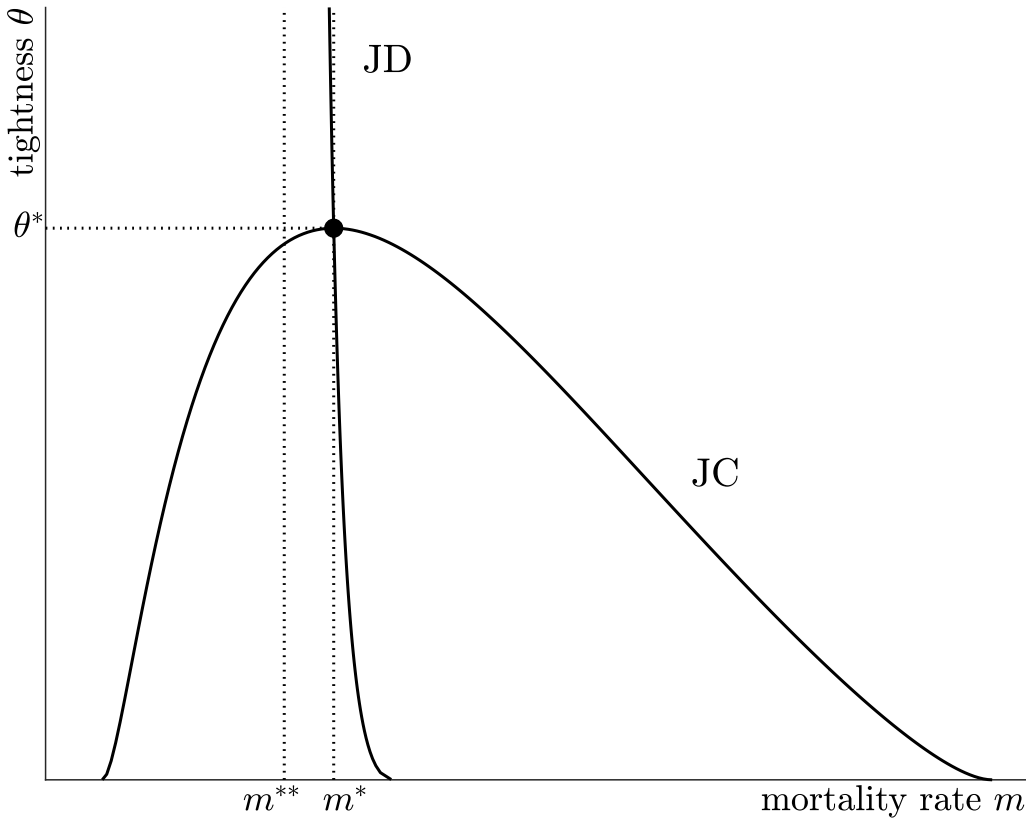
- the model predicts that more severe search frictions imply higher work-related mortality in steady state
- we combine data from the Census of Fatal Occupational Injuries (CFOI) and the Current Population Survey (CPS) from 2011–2018 for the 5,610 state-occupation-age cells provided by the CFOI sample statistics
- we use regional variation across US states to identify the effect of search frictions on mortality, controlling for a wide range of fixed effects and demographic characteristics regression model
- we find that mortality from fatal occupational injuries is positively related to the measures of search frictions (unemployment rate, mean duration of unemployment, share of long-term unemployed) regression results
- a 1pp higher unemployment rate increases the mortality rate by 2.3% ($\approx$ –1 year of life expectancy)

Conclusion

- analyze the effect of search frictions on occupational safety provision
- introduce mortality shocks with endogenous arrival rate into the standard DMP model
- search frictions unambiguously lower safety provision
  - the optimal safety level chosen by a planner decreases due to worker's lower lifetime production
  - not internalizing matching externalitis ($\Leftrightarrow$ departures from the Hosios condition) further decreases safety levels
  - the labor supply externality does not affect safety provision
- the theoretical prediction is consistent with data on fatal occupational injuries in the US

Backup slides

Planner's solutions



m^{**} ... planner's optimal mortality rate without frictions

m^* ... planner's optimal mortality rate with frictions

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Matching externalities

- decentralized equilibrium:

$$(1-\gamma)\frac{(r+m_U)y(m)-(r+m)z}{(r+m_U+p(\theta)\gamma)(r+m)+(r+m_U)s}=\frac{c}{q(\theta)},$$
$$y'(m)=\frac{(r+m_U+p(\theta)\gamma)y(m)+sz}{(r+m_U+p(\theta)\gamma)(r+m)+(r+m_U)s}.$$

- social planner solution with frictions:

$$(1-\gamma)\frac{(r+m_U)y(m)-(r+m)z}{(r+m_U+p(\theta)\eta(\theta))(r+m)+(r+m_U)s}=\frac{c}{q(\theta)},$$
$$y'(m)=\frac{(r+m_U+p(\theta)\eta(\theta))y(m)+sz}{(r+m_U+p(\theta)\eta(\theta))(r+m)+(r+m_U)s}.$$

where $\eta(\theta):=-\frac{q'(\theta)\theta}{q(\theta)}=\frac{\partial \ln M(U,V)}{\partial \ln U}$

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Sample statistics

variable	population-level	cell-level			
		mean	st.dev.	min	max
deaths from occupational injuries	32,979	4.47	15.3	0	323
employment (in 100,000)	11,868	1.925	3.173	0	44.186
full time equivalents (in 100,000)	11,042	1.836	3.088	0	46.829
mean hours worked last week	37.214	37.863	3.807	20.178	56.409
share male workers	0.530	0.551	0.259	0	1
share black workers	0.116	0.105	0.124	1	0.914
share Asian workers	0.061	0.052	0.091	0	0.915
share hispanic workers	0.161	0.113	0.141	0	1
share self-employed workers	0.102	0.091	0.105	0	0.775
share high-school graduates	0.911	0.934	0.094	0.232	1
share college graduates	0.460	0.488	0.279	0	1
mean tenure (in years)	7.822	7.230	4.886	0.020	31.121
unemployment rate	0.062	0.053	0.041	0	0.676
mean weeks in unemployment	29.597	27.204	14.704	1	119
share of long-term unemployed	0.232	0.205	0.169	0	1

Occupational deaths computed from the *Census of Fatal Occupational Injuries (CFOI)* public use files, all other variables from the *Current Population Survey (CPS)* provided by IPUMS, pooled years 2011–2018.

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Empirical strategy

- estimation on 5,610 state-occupation-age group cells ($51 \times 22 \times 5$)
- count data regression model:

$$\mathbb{E}[D_{ais}|Z_{ais}] = \mu_{ais} N_{ais}$$
$$\mu_{ais} = \exp(\alpha_{ai} + \beta_s + \zeta u_{ais} + \delta X_{ais})$$

  - D_{ais} ... number of fatal occupation injuries (CFOI)
  - N_{ais} ... number of full-time equivalent workers (CPS)
  - α_{ai} ... age $\times$ occupation fixed effects
  - β_s ... state fixed effects
  - u_{ais} ... unemployment rate
  - X_{ais} ... rich set of demographic characteristics
- Poisson and Negative binomial (NB2) regressions, using cluster-robust standard errors for inference

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Negative binomial regressions

	(1)	(2)	(3)	(4)	(5)	(6)
unemployment rate	2.291***	2.427***				
	(0.689)	(0.728)				
log(mean weeks in unemp.)			0.077**	0.077**		
			(0.034)	(0.032)		
share of long-term unemp.					0.251**	0.269**
					(0.117)	(0.114)
age group × occ. FE	✓	✓	✓	✓	✓	✓
state FE	✓	✓	✓	✓	✓	✓
demographic characteristics		✓		✓		✓
Observations	5,609	5,529	5,515	5,454	5,515	5,454
Akaike Inf. Crit.	15,113	14,951	15,067	14,913	15,067	14,913

Negative Binomial (NB2) regressions on state-occupation-age group cells with the number of occupational fatalities as dependent variable and full-time equivalents as exposure variable. Demographic characteristics include share of male workers, share of black workers, share of Asian workers, share of workers with hispanic origin, share of workers with high-school education, share of workers with college education, share of self-employed, and mean tenure. Some variables are not available for all cells. Standard errors are clustered at the state level. Coefficient significance levels: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

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