Do Matching Frictions Explain Unemployment? Not in Bad Times

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workers queue for jobs in bad times
workers queue for jobs in bad times
workers queue for jobs in bad times
in existing matching models, however, queues are absent

- a queue is a situation where workers desperately want a job but cannot find one
- in existing models, unemployment vanishes when workers desperately want a job: queues cannot exist
  - formally: unemployment vanishes when workers’ job-search effort becomes infinite
- problem with existing models: firms hire everybody when recruiting is costless
the matching model in this paper

- firms may not hire everybody when recruiting is costless

- based on two assumptions:
  - diminishing marginal returns to labor
  - wage rigidity

- in bad times, jobs are rationed: unemployment would not disappear if recruiting costs vanished

- hence, queues could appear in bad times
a generic matching model
matching structure

\[\nu\] unemployed workers

\[\nu\] vacancies
matching structure

$u$ unemployed workers

$h$ newly employed workers

CRS matching function: $h = h(u, v)$

$h$ newly filled jobs

$\nu$ vacancies
matching structure

\( u \) unemployed workers

job-finding probability:

\[ f(\theta) = \frac{h}{u} = h(1, \theta) \]

CRS matching function: \( h = h(u, v) \)

vacancy-filling probability:

\[ q(\theta) = \frac{h}{v} = h(1/\theta, 1) \]

\( v \) vacancies

tightness: \( \theta = \frac{v}{u} \)
worker flows: job creation and destruction

1 - $u_t$ employed workers

$u_t$ unemployed workers
worker flows: job creation and destruction

\[ f(\theta_t) \times u_t \]
worker flows: job creation and destruction

\[ n_t \, \text{employed workers} \xrightarrow{-s \times n_t} \, u_{t+1} \, \text{unemployed workers} \]
the Beveridge curve

- the Beveridge curve relates employment $n$ to tightness $\theta$ when labor market flows are balanced

- balanced flows: $E \rightarrow U = U \rightarrow E$
  
  $s \cdot n = f(\theta) \cdot u = f(\theta) \cdot [1 - n + s \cdot n]$

- equation of the Beveridge curve:
  
  $$n = \frac{f(\theta)}{s + (1 - s) \cdot f(\theta)}$$
a generic wage schedule

- there are mutual gains from matching
- many wage schedules are consistent with equilibrium
- generic wage schedule: \( w_t = w(n_t, \theta_t, x_t) \)
  - \( n_t \): level of employment in the firm
  - \( \theta_t \): aggregate level of tightness
  - \( x_t \): state of the economy
- \( w \) nests various types of bargaining and wage rigidity
the representative firm

- employs $n_t$ workers paid $w_t$
- produces $y_t = g(n_t, a_t)$
  - $g$: production function
  - $a_t$: productivity (random variable)
- hires $n_t - (1 - s) \cdot n_{t-1}$ new workers
  - cost per vacancy: $c \cdot a_t$
  - probability to fill a vacancy: $q(\theta_t)$
the firm’s problem

given productivity \( \{a_t\} \), tightness \( \{\theta_t\} \), and the wage schedule \( w \), the firm chooses employment \( \{n_t\} \) to maximize expected profits

\[
\mathbb{E}_0 \sum_{t=0}^{+\infty} \delta^t \left[ g(n_t, a_t) - w(n_t, \theta_t, x_t) \cdot n_t \right]
\]

\[
= \frac{c \cdot a_t}{q(\theta_t)} \cdot (n_t - (1 - s) \cdot n_{t-1}) 
\]

production

wage bill

recruiting expenses
profit-maximization condition

\[
\frac{\partial g(n,a)}{\partial n} - w - n \cdot \frac{\partial w(n,\theta,x)}{\partial n} - \left[1 - \delta \cdot (1 - s)\right] \cdot \frac{c \cdot a}{q(\theta)} = 0
\]

- the condition says that marginal profit = 0
- the marginal profit is the sum of
  - gross marginal profit: independent of \( c \)
  - marginal recruiting expenses: dependent on \( c \)
- (this is the steady-state expression of the condition)
absence and presence of
job rationing in several models
definition of job rationing

- jobs are rationed if the employment rate remains strictly below 1 when recruiting is costless.
- equivalently, jobs are rationed if the employment rate remains strictly below 1 when the recruiting cost $c$ approaches 0.
- when jobs are rationed, queues could exist:
  - the employment rate is the same when job-search effort $\rightarrow \infty$ and when $c \rightarrow 0$. 
four matching models

<table>
<thead>
<tr>
<th>model</th>
<th>production function</th>
<th>wage setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pissarides [2000]</td>
<td>constant returns to labor</td>
<td>Nash bargaining</td>
</tr>
<tr>
<td>Cahuc &amp; Wasmer [2001]</td>
<td>diminishing marginal returns to labor</td>
<td>Stole-Zwiebel bargaining</td>
</tr>
<tr>
<td>Hall [2005]</td>
<td>constant returns to labor</td>
<td>rigid wage</td>
</tr>
<tr>
<td>this paper</td>
<td>diminishing marginal returns to labor</td>
<td>rigid wage</td>
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</table>
the model of Pissarides [2000]

- linear production function: \( g(n, a) = a \cdot n \)
- wage from Nash bargaining:

\[
w = a \cdot c \cdot \frac{\beta}{1 - \beta} \left[ \frac{1 - \delta \cdot (1 - s)}{q(\theta)} + \delta \cdot (1 - s) \cdot \theta \right]
\]

- \( \beta \in (0, 1) \): workers’ bargaining power
- (this is the steady-state expression of the wage)
Pissarides [2000]: equilibrium

- steady-state equilibrium: pair \((n, \theta)\) that satisfies
  - the Beveridge curve
  - the firm’s profit-maximization condition

- the equilibrium condition:

\[
1 - \beta = c \cdot \left[ \frac{1 - \delta \cdot (1 - s)}{q(\theta(n))} + \delta \cdot (1 - s) \cdot \beta \cdot \theta(n) \right]
\]

- where \(\theta(n)\) is implicitly defined by Beveridge curve
Pissarides [2000]: equilibrium

Employment

Gross marginal profit
Marginal recruiting expenses
Pissarides [2000]: equilibrium as $c \to 0$
Pissarides [2000]: no job rationing

employment = 1 when \( c \) goes to 0
the model of Cahuc & Wasmer [2001]

- concave production function: \( g(n, a) = a \cdot n^\alpha \)
  - \( \alpha < 1 \): diminishing marginal returns to labor
- wage from Stole-Zwiebel bargaining:
  \[
  w = a \cdot \left[ \frac{\beta \cdot \alpha}{1 - \beta \cdot (1 - \alpha)} \cdot n^{\alpha-1} + c \cdot (1 - s) \cdot \delta \cdot \beta \cdot \theta \right]
  \]
  - \( \beta \in (0, 1) \): workers’ bargaining power
  - (this is the steady-state expression of the wage)
Cahuc & Wasmer [2001]: equilibrium

- steady-state equilibrium: pair \((n, \theta)\) that satisfies
  - the Beveridge curve
  - the firm’s profit-maximization condition

- the equilibrium condition:

\[
\frac{\alpha \cdot (1 - \beta)}{1 - \beta \cdot (1 - \alpha)} \cdot n^{\alpha - 1} = c \cdot \left[ \frac{1 - \delta(1 - s)}{q(\theta(n))} + \delta(1 - s) \cdot \beta \cdot \theta(n) \right]
\]

- gross marginal profit
- marginal recruiting expenses
- where \(\theta(n)\) is implicitly defined by Beveridge curve
Cahuc & Wasmer [2001]: equilibrium

Employment Model with diminishing returns

Gross marginal profit
Marginal recruiting expenses
Cahuc & Wasmer [2001]: no job rationing

Employment = 1 when $c$ goes to 0
the model of Hall [2005]

- linear production function: $g(n, a) = a \cdot n$
- rigid wage: $w = \omega \cdot a^\gamma$
  - $\omega > 0$: level of the real wage
  - $\gamma < 1$: partially rigid real wage
  - if $\gamma = 0$: fixed wage
  - specification from Blanchard & Gali [2010]
Hall [2005]: equilibrium

- steady-state equilibrium: pair \((n, \theta)\) that satisfies
  - the Beveridge curve
  - the firm’s profit-maximization condition

- the equilibrium condition:

\[
1 - \omega \cdot a^{\gamma-1} = c \cdot \frac{1 - \delta \cdot (1 - s)}{q(\theta(n))}
\]

- where \(\theta(n)\) is implicitly defined by Beveridge curve
Hall [2005]: equilibrium

![Graph showing employment model with wage rigidity.]

- **Gross marginal profit**
- **Marginal recruiting expenses**

The graph illustrates the relationship between employment and two economic parameters: gross marginal profit and marginal recruiting expenses. The x-axis represents employment levels, while the y-axis shows the respective values of the parameters. The graph highlights the equilibrium point where the gross marginal profit and marginal recruiting expenses intersect, indicating a balance in the employment model with wage rigidity.
Hall [2005]: no job rationing

employment = 1 when \( c \) goes to 0
this paper’s model

- concave production function: $g(n,a) = a \cdot n^\alpha$
  - $\alpha < 1$: diminishing marginal returns to labor

- rigid wage: $w = \omega \cdot a^\gamma$
  - $\omega > 0$: level of the real wage
  - $\gamma < 1$: partially rigid real wage
    - if $\gamma = 0$: fixed wage
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this paper’s model: equilibrium

- steady-state equilibrium: pair \((n, \theta)\) that satisfies
  - the Beveridge curve
  - the firm’s profit-maximization condition

- the equilibrium condition:
  \[
  \alpha \cdot n^{\alpha-1} - \omega \cdot a^{\gamma-1} = \underbrace{c \cdot \frac{1 - \delta \cdot (1 - s)}{q(\theta(n))}}_{\text{marginal recruiting expenses}}
  \]

- where \(\theta(n)\) is implicitly defined by Beveridge curve
this paper’s model: equilibrium

Gross marginal profit
Marginal recruiting expenses
this paper’s model: equilibrium as $c \to 0$
this paper’s model: job rationing

Gross marginal profit
Marginal recruiting expenses

employment < 1 when c goes to 0
this paper's model: job rationing

Employment

Gross marginal profit
Marginal recruiting expenses

situation with long queues
regular equilibrium
frictional and rationing unemployment

Employment Model with job rationing

Gross marginal profit
Marginal recruiting expenses

rationing unemployment
frictional and rationing unemployment

![Graph showing frictional and rationing unemployment](image)
<table>
<thead>
<tr>
<th>model</th>
<th>assumptions</th>
<th>job rationing?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pissarides [2000]</td>
<td>bargaining</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td>linear production</td>
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<td>Cahuc &amp; Wasmer [2001]</td>
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<td></td>
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<tr>
<td>this paper</td>
<td>rigid wage</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>concave production</td>
<td></td>
</tr>
</tbody>
</table>
frictional unemployment over the business cycle: comparative statics
frictional unemployment is high in booms
frictional unemployment is low in slumps

Gross marginal profit
Marginal recruiting expenses
Frictional unemp.
Rationing unemp.

low productivity
summary

- with low productivity, gross marginal profits are low
  - because of wage rigidity
  - in other words: the labor demand is depressed

- hence, total unemployment and rationing unemployment are high

- but frictional unemployment is low
  - because it is easy for firms to recruit workers
frictional unemployment over the business cycle: simulations
### Calibration (weekly frequency)

<table>
<thead>
<tr>
<th>Interpretation</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\eta$ elasticity of matching</td>
<td>0.5</td>
<td>Petrongolo &amp; Pissarides [2001]</td>
</tr>
<tr>
<td>$\gamma$ real wage flexibility</td>
<td>0.7</td>
<td>Haefke et al. [2008]</td>
</tr>
<tr>
<td>$c$ recruiting cost</td>
<td>0.22</td>
<td>Barron et al. [1997]</td>
</tr>
<tr>
<td>$s$ separation rate</td>
<td>0.95%</td>
<td>JOLTS, 2000–2009</td>
</tr>
<tr>
<td>$\mu$ effectiveness of matching</td>
<td>0.23</td>
<td>JOLTS, 2000–2009</td>
</tr>
<tr>
<td>$\alpha$ marginal returns to labor</td>
<td>0.67</td>
<td>matches labor share = 0.66</td>
</tr>
<tr>
<td>$\omega$ steady-state real wage</td>
<td>0.67</td>
<td>matches unemployment = 5.8%</td>
</tr>
<tr>
<td>$\rho$ autocorrelation of productivity</td>
<td>0.992</td>
<td>MSPC, 1964–2009</td>
</tr>
<tr>
<td>$\omega$ standard deviation of shocks</td>
<td>0.0027</td>
<td>MSPC, 1964–2009</td>
</tr>
</tbody>
</table>
impulse responses to a negative shock

- Technology
- Output
- Wage
- Number of hires
- Vacancy–unemployment ratio
- Unemployment
- Rationing unemployment
- Frictional unemployment

Weeks after shock

0% 50 100 150 200 250

-10% 0% 10% 20%
## Simulated and Empirical Moments

<table>
<thead>
<tr>
<th></th>
<th>Model</th>
<th>US Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elasticity of $u$ wrt $a$</td>
<td>5.9</td>
<td>4.2</td>
</tr>
<tr>
<td>Elasticity of $v$ wrt $a$</td>
<td>6.8</td>
<td>4.3</td>
</tr>
<tr>
<td>Elasticity of $w$ wrt $a$</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Autocorrelation($u$)</td>
<td>0.90</td>
<td>0.91</td>
</tr>
<tr>
<td>Autocorrelation($v$)</td>
<td>0.76</td>
<td>0.93</td>
</tr>
<tr>
<td>Correlation($u, v$)</td>
<td>$-0.89$</td>
<td>$-0.89$</td>
</tr>
</tbody>
</table>
simulated and empirical moments

- the volatility of unemployment and vacancies in the model is as large as in US data
  - no Shimer [2005] puzzle
  - even though wages in the model are as flexible as in newly created jobs in the US ($\gamma = 0.7$)
- the correlation between unemployment and vacancies in the model is the same as in the data
  - the model generates a realistic Beveridge curve
historical decomposition of unemployment

Unemployment rate

2%
4%
6%
8%

Rationing
historical decomposition of unemployment

Unemployment rate

2%
4%
6%
8%

Frictional

Rationing
historical decomposition of unemployment

Unemployment rate


2%
4%
6%
8%

Frictional
Rationing
Total unemployment
The model is simulated using measured productivity from US data and a shooting algorithm.
historical decomposition of unemployment

Unemployment rate


2% 4% 6% 8%

Frictional = 1.3%
Rationing = 7%


frictional
rationing
historical decomposition of unemployment

Unemployment rate


2%

4%

6%

8%

Frictional

Rationing

frictional = 4.8%
historical decomposition of unemployment

Unemployment rate


- Frictional = 1.8%
- Rationing = 6.3%

Frictional

Rationing
unemployment in the model and the data
conclusion
summary

- this paper develops a matching model of the labor market with job rationing
  
  • unemployment does not disappear when recruiting costs vanish

- in booms most of unemployment is frictional
  
  • there are enough jobs
  
  • but the matching process and recruiting costs create unemployment
summary

- In slumps, frictional unemployment is lower and unemployment mostly comes from job rationing.
  - There are not enough jobs.
  - The matching process and recruiting costs create little additional unemployment.

- Simulations:
  - As unemployment \(\uparrow\) from 4.8% to 8.3%.
  - Rationing unemployment \(\uparrow\) from 0% to 7%.
  - Frictional unemployment \(\downarrow\) from 4.8% to 1.3%.
implications for modeling unemployment

- the result that frictional unemployment is low in slumps does not mean that the matching framework is inappropriate to describe slumps
- but it means that in slumps, the matching process and recruiting costs create little unemployment
- instead, most unemployment arises from a shortage of jobs (a weak labor demand)
implications for policy

- in slumps, unemployment comes from job rationing
- hence, to reduce unemployment in slumps, it is necessary to stimulate labor demand
- on the other hand, policies reducing frictional unemployment have limited scope in slumps
  - example #1: creating a placement agency to improve matching
  - example #2: reducing unemployment insurance to stimulate job search
application #1: unemployment insurance

- The model can be combined with a Baily-Chetty model of optimal unemployment insurance (UI).
- This model explains the rat-race effect: higher UI alleviates the rat race for jobs and raises tightness.
- Policy implication: optimal UI is more generous in slumps than in booms.
- See Landais, Michaillat, & Saez [2010].
application #2: countercyclical multipliers

- the labor market model can be embedded into a New Keynesian model
- this model explains the countercyclical nature of the government multiplier
- the result relies not on the zero lower bound but on the nonlinearity of the labor market
- see Michaillat [2014]
application #3: unemployment fluctuations

- the labor market model can be combined to a product market model with a similar structure
- this general-equilibrium model describes how unemployment fluctuations arise from
  - aggregate demand shocks
  - technology shocks
  - labor supply shocks

- see Michaillat & Saez [2015]