Motivation

Unemployment rate


3%
5%
7%
9%
11%
Motivation

Unemployment rate vs. Years

- Technology?
- Aggregate demand?
Motivation

Unemployment rate


3% 5% 7% 9% 11%

Technology?  Mismatch?
Aggregate demand?  Low job search?
Low participation?
Motivation

Unemployment rate


Technology?
Aggregate demand?
Mismatch?
Low job search?
Low participation?
Monetary policy?
Unemployment insurance?
Payroll tax?
Nothing?
Transfers?
The available models

1. matching model of the labor market
   ▶ realistic mechanism + tractable
   ▶ but no aggregate demand

2. ?

3. New Keynesian DSGE model
   ▶ many shocks + quantitatively realistic
   ▶ but greater complexity
The general disequilibrium model?

■ vast literature after Barro & Grossman [1971]
■ recent revival after Great Recession
  ▶ Mankiw & Weinzierl [2011]
  ▶ Caballero & Farhi [2014]
■ captures important intuitions
■ but difficult to analyze
This model

equilibrium version of the Barro-Grossman model, with **matching frictions** on product + labor markets:

- graphical representation of GE and welfare
- frictional + classical + Keynesian unemployment
- broad range of comparative statics
- empirical measures of slack
Basic model (no labor market)
Setup

- static model
- measure 1 of identical households
- production takes place within households
- households cannot consume own production
- households trade production on frictional market
Matching function and tightness

$k$ units of produced good

$\nu$ visits
Matching function and tightness

capacity $k$

CRS matching function $h(k, v)$

sales

purchases

visits $v$
Matching function and tightness

sales = \( k \cdot h(1, x) = k \cdot f(x) \)

output: \( y = h(k, v) \)

purchases = \( v \cdot h \left( \frac{1}{x}, 1 \right) = v \cdot q(x) \)

tightness: \( x = v / k \)

capacity \( k \)

visits \( v \)
Low product market tightness
High product market tightness
Matching cost: $\rho$ goods per visit

- output $= \left[ 1 + \tau(x) \right] \cdot \text{consumption}$

- proof:

\[
y = \underbrace{\text{output}}_{\text{output}} + \underbrace{\text{consumption}}_{\text{consumption}} + \underbrace{\rho \cdot v}_{\text{trading}} = c + \rho \cdot \frac{y}{q(x)}
\]

$\Rightarrow y \cdot \left[ 1 - \frac{\rho}{q(x)} \right] = c$

$\Rightarrow y = \left[ 1 + \frac{\rho}{q(x) - \rho} \right] \cdot c \equiv \left[ 1 + \tau(x) \right] \cdot c$
Tightness and aggregate supply

product market tightness: $x$

quantity of produced good

product price

product price
Tightness and aggregate supply

product market tightness $x$

capacity: $k$

quantity of produced good
Tightness and aggregate supply

output: \( y = f(x) k \)
Tightness and aggregate supply

\[ c = \frac{f(x) \cdot k}{1 + \tau(x)} = (f(x) - \rho \cdot x) \cdot k \]
Tightness and aggregate supply

Consumption

Trading cost

Idle time

Aggregate supply $c$

Output $y$

Capacity $k$

Product market tightness $x$

Quantity of produced good

aggregate supply $c$

output $y$

capacity $k$
Nonproduced good

- valued by consumers
- in fixed supply
- traded on a perfectly competitive market
- examples: real money, land, gold, fixed capital
- as in Barro & Grossman [1971], Hart [1982], and Blanchard & Kiyotaki [1987]
Households

- take price $p$ and tightness $x$ as given
- choose $c, m$ to maximize utility

\[
\left( \frac{\chi}{1 + \chi} \cdot \frac{c^{\frac{\varepsilon-1}{\varepsilon}}}{c^{\frac{1}{\varepsilon}}} + \frac{1}{1 + \chi} \cdot \frac{m^{\frac{\varepsilon-1}{\varepsilon}}}{m^{\frac{1}{\varepsilon}}} \right)^{\frac{\varepsilon}{\varepsilon-1}}
\]

- produced good
- nonproduced good

subject to budget constraint

\[
m + p \cdot (1 + \tau(x)) \cdot c = \mu + f(x) \cdot p \cdot k
\]

numeraire
produced good
endowment
labor income
Optimal consumption decision

- first-order condition

\[ (1 + \tau(x)) \cdot p \cdot \frac{1}{1 + \chi} \cdot m^{-\frac{1}{\varepsilon}} = \frac{\chi}{1 + \chi} \cdot c^{-\frac{1}{\varepsilon}} \]

- aggregate demand (as \( m = \mu \)):

\[ c^d(x, p) = \frac{\chi^\varepsilon \cdot \mu}{(1 + \tau(x))^\varepsilon \cdot p^\varepsilon} \]
Tightness and aggregate demand

\[ c^d(x, p) = \frac{\chi^\varepsilon \cdot \mu}{(1 + \tau(x))^\varepsilon \cdot p^\varepsilon} \]
Definition of equilibrium

- equilibrium is \((x, p)\) such that supply = demand:

\[ c^s(x) = c^d(x, p) \]

- 1 equation, 2 variables: indeterminacy
- need a price mechanism to select equilibrium
  - fixed price
  - efficient price
Comparative statics

with fixed price and efficient price
Increase in AD with fixed price
Increase in AD with fixed price

![Graph showing the relationship between product market tightness and quantity, with an upward shift in AD with a fixed price.](image)
Increase in AS with fixed price
Comparative statics with fixed price

<table>
<thead>
<tr>
<th>Increase in:</th>
<th>Effect on:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>output</td>
</tr>
<tr>
<td>aggregate demand</td>
<td>$y$</td>
</tr>
<tr>
<td>aggregate supply</td>
<td>$+$</td>
</tr>
</tbody>
</table>
Definition of efficient price

The diagram illustrates the relationship between product market tightness $x$ and consumption $c$. The efficient price is determined at the slack equilibrium, which is the point where the aggregate supply (AS) and aggregate demand (AD) curves intersect. At this point, the price is such that consumption is maximized without causing price increases or shortages. The price is considered too high if it is outside the slack equilibrium, as indicated by the orange box in the diagram.
Definition of efficient price

A tight equilibrium occurs when the price is too low, as indicated by the intersection of the demand (AD) and supply (AS) curves. The price at this equilibrium is denoted by $c^*$, and the product market tightness $x^*$ is also shown on the diagram.
Definition of efficient price

price is efficient

efficient equilibrium

product market tightness $x$

consumption $c$

$\text{efficient equilibrium}$

$\text{price is efficient}$
Comparative statics with efficient price

<table>
<thead>
<tr>
<th>increase in:</th>
<th>effect on:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>output</td>
</tr>
<tr>
<td>aggregate demand</td>
<td>$y$</td>
</tr>
<tr>
<td>aggregate supply</td>
<td>$+$</td>
</tr>
</tbody>
</table>
Complete model
Labor market and unemployment

- Labor supply $n$
- Employment $l$
- Labor force $h$

Producers
Recruiters
Unemployment

Labor market tightness $\theta$

Number of workers
Firms

- employ producers and recruiters and sell production
- take real wage $w$ and tightnesses $x$ and $\theta$ as given
- choose number of producers $n$ to maximize profits

\[
\begin{align*}
\underbrace{f(x)}_{\text{selling probability}} \cdot \underbrace{a \cdot n^\alpha}_{\text{production}} - \underbrace{[1 + \hat{\tau}(\theta)] \cdot w \cdot n}_{\text{wage of producers + recruiters}}
\end{align*}
\]
Optimal employment decision

- first-order condition:
  \[
  f(x) \cdot \alpha \cdot a \cdot n^{\alpha-1} = [1 + \hat{\tau}(\theta)] \cdot w \\
  \text{selling probability} \quad \text{MPL} \quad \text{matching wedge} \quad \text{real wage}
  \]

- labor demand: demand for producers
  \[
  n^d(\theta, x, w) = \left[ \frac{f(x) \cdot a \cdot \alpha}{(1 + \hat{\tau}(\theta)) \cdot w} \right]^{\frac{1}{1-\alpha}}
  \]
Partial equilibrium on labor market

- Labor supply
- Employment $l$
- Labor force $h$
- Labor market tightness $\theta$
- Partial equilibrium
- Labor demand

Diagram shows the relationship between labor supply, employment, and labor force, with labor market tightness as a parameter.
General equilibrium \((x, \theta, p, w)\)

- supply = demand on product and labor markets

\[
\begin{align*}
  c^s(x, \theta) &= c^d(x, p) \\
  n^s(\theta) &= n^d(\theta, x, w)
\end{align*}
\]

- 2 equations, 4 variables: indeterminacy
- need price and wage mechanisms
Keynesian, classical, and frictional unemployment

- equilibrium employment:

\[ l = \left( \frac{f(x) \cdot a \cdot \alpha}{w} \right)^{\frac{1}{1-\alpha}} \cdot \left( \frac{1}{1 + \hat{\tau}(\theta)} \right)^{\frac{\alpha}{1-\alpha}} \]

- frictional unemployment from \( \hat{\tau}(\theta) > 0 \)

- classical unemployment from \( w > a \cdot \alpha \)

- **Keynesian unemployment from** \( f(x) < 1 \)
Comparative statics with fixed prices

<table>
<thead>
<tr>
<th>increase in:</th>
<th>effect on:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>output</td>
</tr>
<tr>
<td>aggregate demand</td>
<td>+</td>
</tr>
<tr>
<td>technology</td>
<td>+</td>
</tr>
<tr>
<td>labor supply</td>
<td>+</td>
</tr>
<tr>
<td>mismatch</td>
<td>-</td>
</tr>
</tbody>
</table>
Comparative statics with efficient prices

<table>
<thead>
<tr>
<th>increase in:</th>
<th>effect on:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>product output</td>
</tr>
<tr>
<td>aggregate demand</td>
<td>0</td>
</tr>
<tr>
<td>technology</td>
<td>+</td>
</tr>
<tr>
<td>labor supply</td>
<td>+</td>
</tr>
<tr>
<td>mismatch</td>
<td>—</td>
</tr>
</tbody>
</table>
Rigid or flexible prices?
Construct proxy for product market tightness from capacity utilization measure in Survey of Plant Capacity:
Fluctuations in product market tightness: rigid price
Fluctuations in labor market tightness: rigid real wage

![Graph showing fluctuations in labor market tightness: rigid real wage from 1974 to 2013.](image)
Labor demand
or labor supply shocks?
Source of labor supply and demand shocks

- labor demand: AD, technology
- labor supply: mismatch, job search, participation
Effect of labor supply and demand shocks

- labor supply shocks: negative correlation between employment and labor market tightness
- labor demand shocks: positive correlation between employment and labor market tightness
Evidence of labor demand shocks

Labor market tightness (left scale)

Employment (right scale)
Cross-correlogram: labor market tightness and employment
Labor demand shocks:
AD or technology shocks?
Effect of AD and technology shocks

- AD shocks: positive correlation between output and product market tightness
- technology shocks: negative correlation between output and product market tightness
Evidence of AD shocks
Cross-correlogram: product market tightness and output
Conclusion

- tractable model of unemployment fluctuations
- empirical series to measure tightness
  - product market tightness
  - labor market tightness
- origins of unemployment fluctuations
  1. importance of price and wage rigidity (not flexibility)
  2. importance of labor demand shocks (not labor supply)
  3. importance of AD shocks (not technology)