Intermediate Macroeconomics
Lecture 8 - Search and Unemployment

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Sciences Po

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Roadmap

- labor market facts
- Diamond-Mortensen-Pissarides model of search and unemployment
  - change in unemployment insurance benefit
  - change in productivity
  - change in matching efficiency
Labor market facts
Labor market measurement

- working age population ($N$) = in the labor force + not in the labor force
- labor force ($Q$) = employed ($Q - U$) + unemployed ($U$)
- not in the labor force: not working and not looking for work
- unemployment rate $= \frac{U}{Q}$: fraction of those in the labor force who are not working, but are actively looking
- participation rate $= \frac{Q}{N}$: fraction of the working-age population that is working or seeking work
- employment rate $= \frac{Q-U}{N}$: fraction of the working-age population that is working
The participation rate in the US
The participation rate for men and women in the US
Key labor market statistics US

Source: Bureau of Labor statistics, monthly, seasonally adjusted data
The unemployment rate and the GDP in the US
Participation rates in European countries
Unemployment rates in European countries
Employment rates in European countries
Employment rates in 2006
Vacancies and unemployment

- aggregate number of vacancies posted by firms \((A)\)
- vacancy rate \(\frac{A}{A+Q-U}\): the ratio of the number of vacancies to vacancies plus the number of employed

can look at relationship between unemployment rate and vacancy rate
The vacancy rate and the unemployment rate in the US
The Beveridge curve in the US and very similar pictures across OECD countries
Key labor market observations

- the unemployment rate is counter-cyclical
- the vacancy rate is pro-cyclical
- the unemployment rate and the vacancy rate are negatively correlated
  - the Beveridge curve
- the Beveridge curve shifted out during the last recession
Diamond-Mortensen-Pissarides model: Search and Unemployment
Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel for 2010 to

Peter A. Diamond
Massachusetts Institute of Technology, Cambridge, MA, USA,

Dale T. Mortensen
Northwestern University, Evanston, IL, USA

Christopher A. Pissarides
London School of Economics and Political Science, UK

"for their analysis of markets with search frictions"
unemployed workers and job openings do not instantaneously find each other

→ there are frictions in the labor market
→ there is a search process

source of frictions:
  ▶ heterogeneity of workers and firms
  uncertainty about the skills, and quality of jobs
  ▶ imperfect information: invest resources in locating firm/worker
  it takes time for a worker to find an 'acceptable' job
  and similarly for an employer to find an 'acceptable' worker
  ▶ mobility costs

unemployment is a stock variable that adjusts slowly as a result of this job finding process
A (much) simplified DMP model

- one-period model
- \(N\) consumers who can all potentially enter the labor force
  \(\rightarrow\) \(N\) is the working age population
- number of (active) firms is endogenous
Households

- each of the $N$ individuals chooses whether to
  - search for work in the market
  - or to do home production (working outside the market)
- a consumer searches for work if
  the expected return to search $>\$\text{the value of home production}$
- expected return to search is the same for all consumers
  $\rightarrow$ if it is higher, more people search
- assumption: the value of home production is heterogenous across households
  this value captures: value of leisure, home production activity
- let $Q$ be the number of consumers who search for work
  $\rightarrow$ in the labor force
  $\rightarrow$ out of the labor force are $N - Q$
- denote by $P(Q)$ the level of expected payoff to search which induces exactly $Q$ workers to search
  $\rightarrow$ the supply curve of searching workers
The supply curve of searching worker
Firms

- each firm needs a worker to produce output
- a firm cannot simply hire a worker
- a firm must post a vacancy in order to have a chance of matching with a worker
- posting a vacancy incurs a (real) cost $k$
- let $A$ be the number of active firms
  $\rightarrow$ number of firms posting vacancies
Matching

- a match is between *one* firm and *one* worker
- timeline of decisions: 1. search 2. match 3. produce
- search is costly/time-consuming due to search frictions (e.g. heterogeneity in skills and skills requirements in the presence of incomplete information)
- the more workers search for work, the easier for a firm to find a worker
- the more vacancies posted, the easier for a worker to find a job
- relationship can be formalized by a **matching function**:

\[ M = e \cdot m(Q, A) \]

- \( M \) is the aggregate number of matches formed
- assumed to be a *neoclassical production function*: matches are produced using the labor force (here = number of people searching) \((Q)\) and active firms \((A)\)
- \( e \) is a parameter capturing the matching efficiency
Optimization by consumers

- a consumer who chooses to search for work will find a match with probability

\[ p_c = \frac{M}{Q} = \frac{e \cdot m(Q, A)}{Q} \]
Optimization by consumers

- A consumer who chooses to search for work will find a match with probability

\[ p_c = \frac{M}{Q} = \frac{e \cdot m(Q, A)}{Q} = e \cdot m \left(1, \frac{A}{Q}\right) \]
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- labor market tightness \( j \equiv \frac{A}{Q} \)
Optimization by consumers

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- labor market tightness \( j \equiv \frac{A}{Q} \)
- if searching and matched, consumer receives wage \( w \)
- if searching but not matched, consumer receives a payoff \( b \) unemployment benefit, utility value ?

\[ E[\text{search}] = p_c \cdot w + (1 - p_c) \cdot b = b + p_c \cdot (w - b) = b + e \cdot m(1, j) \cdot (w - b) \]
a consumer who chooses to search for work will find a match with probability

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unemployment benefit, utility value ?

expected payoff from searching is then

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E[\text{search}] = p_c \cdot w + (1 - p_c) \cdot b = b + p_c \cdot (w - b) = b + em(1, j) \cdot (w - b)
\]
Marginal consumer

- expected payoff from searching is

\[ E[\text{search}] = b + p_c \cdot (w - b) = b + em(1, j) \cdot (w - b) \]

- **note:** the higher \( Q \), the lower \( j \), and the lower \( p_c \)
  → the more people are searching the lower is the probability
  for each to find a job

- \( E[\text{search}] \) is an exogenous value from the perspective of a
  consumer

- there is a marginal consumer who is indifferent between home
  production and searching for work
  for this consumer: \( E[\text{search}] = \text{value of home production} \)

- for everyone with value of home production \( \leq E[\text{search}] \) it is
  optimal to search
    → the supply curve of searching workers \( (Q) \)

\[ P(Q) = b + em(1, j) \cdot (w - b) \]
Optimization by firms

- a firm posting a vacancy will find a match with probability

\[ p_f = \frac{M}{A} = \frac{e \cdot m(Q, A)}{A} = e \cdot m \left( \frac{Q}{A}, 1 \right) \]
Optimization by firms

- a firm posting a vacancy will find a match with probability
  \[ p_f = \frac{M}{A} = \frac{e \cdot m(Q, A)}{A} = e \cdot m \left( \frac{Q}{A}, 1 \right) = e \cdot m \left( \frac{1}{j}, 1 \right) \]

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- Labor market tightness \( j = \frac{A}{Q} \)
- To post the vacancy the firm bears cost \( k \)
- When a firm is matched with a worker, they produce output \( z \) and pay wages \( w \)
- When a firm is not matched, they do not produce
- The payoff to a firm posting a vacancy is therefore \( z - w - k \) when forming a match, and \(-k\) when they do not find a match
Optimization by firms

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- The payoff to a firm posting a vacancy is therefore \( z - w - k \) when forming a match, and \(-k\) when they do not find a match
- The expected payoff from posting a vacancy is then
  \[ E[\text{vacancy}] = p_f(z - w - k) + (1 - p_f)(-k) = -k + p_f(z - w) \]
  \[ = -k + em\left(\frac{1}{j}, 1\right)(z - w) \]
Free Entry of firm

\[ E[vacancy] = -k + em \left( \frac{1}{j}, 1 \right) (z - w) \]

- note: the higher \( A \), the higher \( j \), and the lower \( p_f \)
  \( \rightarrow \) the more vacancies are posted the lower the chance for each of being filled
- free entry of firms competes away all expected profits from posting vacancies
  \( \Rightarrow \) \( E[vacancy] = 0 \) \( \Rightarrow \)

\[ em \left( \frac{1}{j}, 1 \right) = \frac{k}{z - w} \]

- firms post vacancies up to the point where the probability of matching (LHS) is equal to the ratio of the cost of posting a vacancy to the profits from a successful match (RHS)
- this free-entry condition pins down labor market tightness \( j \) as a function of the wage rate \( w \)
Vacancies posted – Labor demand

\[
\frac{k}{(z-w)} \quad j_1
\]

\[
em(\frac{1}{j}, 1)
\]

\[j = \text{Labor Market Tightness}\]
Wage determination

- we have seen already labor supply and demand as a function of labor market tightness, at a given level of wages
- to close the model, we need to specify how wages are determined
- note: workers are not paid their marginal product, as there are frictions, which implies a kind of monopoly power from being in a match
- assumption: wages are determined through bilateral bargaining, between a firm and a worker when they form the match
  - bargaining takes place when firm and worker meet
  - the outside option of each party is not to form the match: firm would not produce; worker would receive UI benefit
  - firm has bargaining power since worker has only one offer
  - worker has bargaining power since firm has only one offer
Nash Bargaining

- Nash Bargaining: each party receives a share of the total surplus determined by their bargaining weight
- Surpluses from forming a match:
  - for the worker: $w - b$
  - for the firm: $z - w$
  - $\rightarrow$ total surplus: $z - b$
Nash Bargaining

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- then Nash bargaining determines a wage $w$ that splits the total surplus according to the bargaining weights
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- as long as $z - b > 0$, it is beneficial for the firm and the worker to form the match
- then Nash bargaining determines a wage $w$ that splits the total surplus according to the bargaining weights
- let the worker’s relative bargaining weight be $a$, and the firm’s is then $1 - a$
- outcome of Nash Bargaining:

\[
w - b = a(z - b)
\]
Summary of the equilibrium conditions

- from Nash Bargaining: \( w = b + a(z - b) \)
- the searching worker’s supply condition:
  \[
P(Q) = b + em(1, j) \cdot (w - b) = b + em(1, j) \cdot (a(z - b))
\]
- free entry condition of firms – job creation:
  \[
  em\left( \frac{1}{j}, 1 \right) = \frac{k}{z - w} = \frac{k}{(1 - a)(z - b)}
  \]
- these two equations characterize the equilibrium of the Mortenson-Pissarides model
Equilibrium
Equilibrium outcomes

- unemployment rate:
  \[ u = \frac{Q(1 - p_c)}{Q} = (1 - p_c) = 1 - em(1, j) \]

- vacancy rate:
  \[ v = \frac{A(1 - p_f)}{A} = (1 - p_f) = 1 - em\left(\frac{1}{j}, 1\right) \]

- aggregate output:
  \[ Y = em(Q, A)z = Qem(1, j)z \]

recall that \( j = \frac{A}{Q} \) is labor market tightness
Application 1: An increase in UI benefits, $b$

- reduces the total surplus of the match, $z - b$
- improves the worker’s outside option
  \[ \Rightarrow \text{increases the wage, } w = b + a(z - b), \text{ as Nash Bargaining now allocates more resources to the worker} \]
- \[ \Rightarrow \text{makes firms worse off, and therefore reduces job creation} \]
  \[ \Rightarrow \text{fewer vacancies posted, } A \downarrow, \text{ less tight labor market, } j \downarrow \]
- unemployment rate rise, $u = 1 - \em(1, j)$, vacancy rate falls, $v = 1 - \em\left(\frac{1}{j} , 1 \right)$
- overall effect on labor force is ambiguous, since:
  1. higher wages increase return to job search $\rightarrow Q \uparrow$
  2. lower labor market tightness (fewer vacancies relative to labor force) reduces chances to find a job $\rightarrow Q \downarrow$
- effect on aggregate output is ambiguous too, $Y = Qem(1, j)z$
Higher unemployment benefits
Application 2: An increase in productivity, $z$

- increases the total surplus of the match, $z - b$
- does *not* affect the outside options of firms or workers
  - according to Nash Bargaining, wages do increase,
    \[ w = b + a(z - b) \]
  - but also the surplus of the firm increases,
    \[ z - w = (1 - a)(z - b) \]
  - → both the surplus of the worker and of the firm increase by the same factor as $(z - b)$
- → the higher surplus boosts firm entry and job creation
  ⇒ more vacancies posted, $A \uparrow$, tighter labor market, $j \uparrow$
- unemployment rate falls, $u = 1 - em(1, j)$, vacancy rate rises, $v = 1 - em\left(\frac{1}{j}, 1\right)$
- labor force increases, since:
  1. higher wages increase return to job search → $Q \uparrow$
  2. tighter labor markets improve workers chances of finding a job → $Q \uparrow$
- aggregate output is rises too, $Y = Qem(1, j)z$
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  - $\rightarrow$ both the surplus of the worker and of the firm increase by the same factor as $(z - b)$

- $\rightarrow$ the higher surplus boosts firm entry and job creation
  $\Rightarrow$ more vacancies posted, $A \uparrow$, tighter labor market, $j \uparrow$

- unemployment rate falls, $u = 1 - em(1, j)$, vacancy rate rises, $v = 1 - em \left( \frac{1}{j}, 1 \right)$

- labor force increases, since:
  1. higher wages increase return to job search $\rightarrow Q \uparrow$
  2. tighter labor markets improve workers chances of finding a job $\rightarrow Q \uparrow$

- aggregate output is rises too, $Y = Qem(1, j)z$

- the behavior of $u$ and $v$ is consistent with the Beveridge curve
Higher productivity
Application 3: A decrease in matching efficiency, $e$

- no change in the total surplus of the match, $z - b$
- no change in outside options or wages, $w = b + a(z - b)$
- lower $e$ reduces chances of forming a match
- $\rightarrow$ the lower chances of finding a worker reduce job creation, i.e. fewer vacancies posted, $A \downarrow$, less tight labor market, $j \downarrow$
- $\rightarrow$ the lower chances of finding a job reduces the number of people searching for work $\Rightarrow$ reduces the labor force, $Q \downarrow$
- unemployment rate increases, $u = 1 - em(1, j)$
- aggregate output falls, $Y = Qem(1, j)z$
- vacancy rate in equilibrium constant two opposing effects: $e \downarrow \rightarrow v \uparrow$ and $j \downarrow \rightarrow v \downarrow$

$$v = 1 - em\left(\frac{1}{j}, 1\right) = 1 - \frac{k}{(1 - a)(z - b)}$$
Lower matching efficiency
Decrease in matching efficiency in the great recession?

- a decrease in matching efficiency implies a rightward shift of the Beveridge curve, a decrease in the labor force, higher unemployment, and lower aggregate output.
Decrease in matching efficiency in the great recession?

- A decrease in matching efficiency implies a rightward shift of the Beveridge curve, a decrease in the labor force, higher unemployment, and lower aggregate output.
- Just as experienced in the recent recession.
- What can be the cause of a decrease in matching efficiency?
  - Worse information about vacancies and searching workers.
    → Not a very plausible explanation for the labor market outcome of this recession.
  - Mismatch between skills firms needed and skills workers possess.
    → Possibly if there are sectoral shocks, and workers leaving declining industries do not have skills required by growing industries.
  - Mismatch between locations of vacancies posted and where workers search.
    → Quite relevant for financial crises: many workers are not selling their 'underwater' houses to move to different geographical area.