We just presented an accounting exercise. No theory. Now develop model to explain variations in unemployment.

Unlike Keynesian models, unemployment here will be in a market clearing setting.

Basic premise: Search and matching are costly. Both for workers looking for job, firms looking to hire.

Markets with Search Frictions

- **2010 Nobel citation:** Why are so many people unemployed at the same time that there are a large number of job openings? How can economic policy affect unemployment? This year’s Laureates have developed a theory which can be used to answer these questions.

- High costs are often associated with buyers’ difficulties in finding sellers, and vice versa. Even after they have located one another, the goods in question might not correspond to the buyers’ requirements. A buyer might regard a seller’s price as too high, or a seller might consider a buyer’s bid to be too low. Then no transaction will take place and both parties will continue to search elsewhere. In other words, the process of finding the right outcome is not without frictions.

- Diamond, Mortensen, and Pissarides have developed a model of joint search of firms posting vacancies looking for workers and workers looking for jobs. Leads to a the Beveridge curve: a stable relationship between job vacancies and unemployment.

- We will focus on the workers’ side, taking the distribution of wage offers as given.
An infinitely-lived worker would like to maximize

\[ \sum_{t=0}^{\infty} \beta^t U(C_t) = U(C_0) + \beta U(C_1) + \beta^2 U(C_2) + \cdots \]

She has two uses for her time: Work or search for a job. For simplicity, she does not enjoy leisure.

If she is unemployed, she must search to find a job.

- Probability \( p \) of finding a job in any period.
- The job pays some wage \( w_1 < w_2 < \cdots < w_N \).
- The probability it pays \( w_i \) is \( \pi_i \).
- She may reject the job if the wage is too low.
There is no borrowing or lending:

- When unemployed, she consumes an unemployment benefit $b$.
- When employed she consumes her wage $w$.

An employed worker loses her job with probability $s$.

The key to solving this problem is expressing it recursively.

- $V_e(w)$ is the expected lifetime utility of an employed worker.
- $V_u$ is the expected lifetime utility of an unemployed worker.
An Employed Worker

- An employed worker earns and consumes $w$.
- Next period, she is unemployed with probability $s$, otherwise she is still employed.
- This can be expressed recursively as

$$V_e(w) = U(w) + \beta [sV_u + (1 - s) V_e(w)]$$

- Solving this for $V_e(w)$ gives

$$V_e(w) = \frac{U(w) + \beta s V_u}{1 - \beta (1 - s)}$$

So $V_e(w)$ is increasing, assuming $U$ is.
An unemployed worker earns and consumes $b$.
Next period she finds a job with probability $p$.
- The job pays a wage $w_i$ with probability $\pi_i$.
- She may accept the wage (continuation value $V_e(w)$), or she may reject the wage (continuation value $V_u$).
She fails to find a job with probability $1 - p$.
This can be expressed recursively as

$$V_u = U(b) + \beta \left[ p \left( \sum_{i=1}^{N} \pi_i \max\{ V_e(w_i), V_u \} \right) + (1 - p) V_u \right]$$
The worker accepts any wage above her reservation wage \( w^* \):

\[
V_e(w^*) = V_u
\]

Let \( n^* \) satisfy \( w_1 < \cdots < w_{n^* - 1} < w^* \leq w_{n^*} < \cdots < w_N \).

Key question is what determines the reservation wage.

We can rewrite the unemployed worker value as

\[
V_u = U(b) + \beta \left( p \left( \sum_{i=n^*}^{N} \pi_i (V_e(w_i) - V_u) \right) + V_u \right)
\]

Solving this for \((1 - \beta) V_u\) gives

\[
(1 - \beta) V_u = U(b) + \beta p \sum_{i=n^*}^{N} \pi_i (V_e(w_i) - V_u)
\]
The recursive equation for employed workers implies

\[ V_e(w_i) = \frac{U(w_i) + \beta s V_u}{1 - \beta(1 - s)} \Rightarrow V_e(w_i) - V_u = \frac{U(w_i) - (1 - \beta) V_u}{1 - \beta(1 - s)} \]

A worker accepts a job if \( U(w_i) \geq (1 - \beta) V_u \).

The reservation wage satisfies

\[ V_e(w^*) = V_u \text{ or equivalently } U(w^*) = (1 - \beta) V_u \]

Combine the earlier equations to get the reservation wage:

\[ (1 - \beta) V_u = U(b) + \beta p \sum_{i=n^*}^{N} \pi_i (V_e(w_i) - V_u) \]

\[ V_e(w_i) - V_u = \frac{U(w_i) - (1 - \beta) V_u}{1 - \beta(1 - s)} \]
Determination of Reservation Wage

\[ U(w^*) - U(b) = \frac{\beta p}{1 - \beta (1 - s)} \sum_{i=n^*}^{N} \pi_i (U(w_i) - U(w^*)) \]
Figure 16.8 The Reservation Wage
What raises the reservation wage?

- Higher unemployment benefits $b$.
- The best jobs pay very high wages.
- Workers are more patient $\beta$.
- Jobs are easier to find $p$.
- Separations are less frequent $s$. 
Figure 16.9 An Increase in the Unemployment Insurance Benefit
Lucas (1987):

*Questioning a McCall worker is like having a conversation with an out-of-work friend: “Maybe you are setting your sights too high”, or “Why did you quit your old job before you had a new one lined up?” This is real social science: an attempt to model, to understand, human behavior by visualizing the situation people find themselves in, the options they face and the pros and cons as they themselves see them.*
Determination of the unemployment rate:

- Unemployed workers find jobs with probability
  \[ p \sum_{i=n^*}^{N} \pi_i = pH(w^*) \] in book notation.
- Employed workers lose jobs with probability \( s \).
- A fraction \( u \) of the workers are unemployed.
- Job creation and destruction must balance.

\[ upH(w^*) = s(1 - u) \]
Figure 16.13 The Determination of the Reservation Wage and the Unemployment Rate in the Search Model
What raises the unemployment rate?

- Anything raising reservation wage: higher unemployment benefits $b$, best jobs pay very high wages, workers are more patient $\beta$.
- Jobs are *harder* to find $p$ (despite lower reservation wage).
- Separations are *more* frequent (despite lower reservation wage).
Figure 16.14 An Increase in the Unemployment Insurance Benefit

(a) $V_u^2$ and $V_u^1$ as functions of $w^*$

(b) $UpH(w_1^*)$ and $UpH(w_2^*)$ as functions of $U$
Figure 16.15 An Increase in the Job Offer Rate $\rho$
If the **job finding rate** falls:

- Workers become less choosy: the reservation wage falls.
- Direct effect: fewer unemployed workers find jobs.
- Direct effect dominates, so unemployment rate rises and unemployment spells get longer.
- This seems to characterize the recent recessions.

If **unemployment benefits** increase:

- Workers become more choosy: the reservation wage increases.
- No direct effect on separations or job finding rates.
- Unemployment rate rises and spells get longer.
- This seems to characterize differences between US and Europe.
Comparing the US and Europe

The following are facts about unemployment outcomes in the two continents:

1. In the 1950s and 1960s, unemployment rates were persistently lower in Europe than in the U.S. The difference was accounted for by a higher inflow rate into unemployment in the U.S.

2. After the 1970s, unemployment became persistently higher in Europe.

3. Inflow rates into unemployment were roughly constant across periods within both Europe and U.S.

4. In Europe, average durations of unemployment were low in the 1950s and 1960s, but became high after the 1970s. Average duration in the U.S. stayed low.

5. In Europe, since the 1970s, hazard rates of leaving unemployment fall with increases in the duration of unemployment.
Comparing the US and Europe

There were two key differences in labor market policies:

1. In both periods, government supplied unemployment insurance were generous with long durations in Europe, but they were stingy with short durations in the U.S.
   - **US**: unemployment insurance ends after 26 weeks. Extended to 39 weeks by federal government during recessions. Replacement rate capped at 40% (in Wisconsin)
   - **France**: The duration of benefit payments depends on job and age. The minimum period is 122 days. Maximum period is 730 days for private-sector employees under 50, and 1,095 days for employees over 50. Minimum replacement rate: 57.4%

2. Government mandated employment protection (rules and regulations for firing and layoffs, firing taxes) was stronger in Europe throughout both periods.
Labor market turbulence increased after the 1970s:

1. Displaced workers studies document substantial human capital destruction after involuntary job loss (Jacobson et al. (1993), Farber (1997, 2005)).

2. There is evidence of increased volatility of earnings (Gottschalk and Moffitt (1994), Katz and Autor (1999)).

3. There has been an increase in occupational and industry mobility (Kambourov and Manovskii (2005)).
Using these Facts in Our Model

We can use a search model of the labor market to analyze the differences between the US and Europe. The relevant facts (for recent years) are:

1. The job finding rate $p$ is higher in the US
2. The separation rate $s$ from jobs is higher in the US
3. Unemployment benefits $b$ are higher in Europe
4. There is more wage dispersion (more spread in the distribution of wages) in the US.
Impacts of these Facts on Reservation Wages

What will be the impact of these four facts (separately) on his reservation wage (relative to an American in the same situation)?

1. A lower job finding rate in Europe will reduce,
2. A lower separation rate in Europe will raise,
3. Higher unemployment benefits in Europe will raise,
4. A lower wage dispersion in Europe will lower

the reservation wage of European workers (relative to their US counterparts).
What will be the impact of these four facts (separately) on the steady state unemployment rate in Europe (relative to the US)?

1. A lower job finding rate in Europe will raise,
2. A lower separation rate in Europe will reduce,
3. Higher unemployment benefits in Europe will raise,
4. A lower wage dispersion in Europe will reduce
the European unemployment rate (relative to the US).
So far we have considered only the worker’s problem, taking the wage distribution as given.

But firms also need to search to hire workers.

This gives rise to a matching problem, which was studied by Pissarides (1985) and Mortensen and Pissarides (1994).

This now serves as the benchmark model for studying unemployment.
Model

- Time is continuous.

Demographics:
  - There are $\bar{L}$ identical workers.
  - They live forever (or they could die stochastically).

Preferences:
  - Utility = consumption (one good).
  - Discount rate $r$. 
Output is produced from labor only.
Production can take place only in a worker-job match.
Each match consists of exactly one job / one worker.
When matched, a match produces a flow output of $A$. 
Enter the "period" with
- $U$ unemployed workers
- $F = \bar{L} - U$ job matches.
- $E = F$ employed workers

$bE$ matches break up (exogenously)

Firms post $V$ vacancies, paying a cost.
Unemployed workers and vacancies meet at random. Workers who don’t meet a firm stay unemployed, consume 0.

In a match:

- Firm and worker **bargain** over the wage (no contracts!).
- If no agreement is reached, the job becomes vacant and the worker becomes unemployed.
- If agreement is reached, the pair produces until exogenous breakup occurs.
Workers

- Workers live forever and maximize the expected present value of earnings.
- The discount rate is $r$ (exogenous).
- The only decisions: in wage negotiation.
Firms can create jobs (vacancies) at a flow cost of $C$ per unit of time.

A filled job produces $A$ and pays $w$ (endogenous) to the worker.

The firm keeps the profit: $A - w - C$. 
Matching

- A matching function describes how workers are matched to vacancies.
- The number of matches per period is

\[ M(U,V) = mU^\beta V^\gamma \]  

(1)

- We take \( M(U,V) \) as given.
- Matching functions can be derived from micro-foundations.
- More vacancies or more unemployed workers result in more matches.