technische universität
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Lecture 4a:
Standard model of job search

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Empirical Economics

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Today's agenda

I. Facts and concepts of unemployment

- Measurement of & reasons for unemployment
- Stocks of & flows into/out of unemployment
- The Beveridge curve

II. Modeling job search behavior

- Evidence on individuals' job search activity
- Theory: Job search decisions in partial equilibrium

Unemployment as an economic & social problem

Pecuniary and non-pecuniary consequences of unemployment manifold

At the macro level, unemployment found to

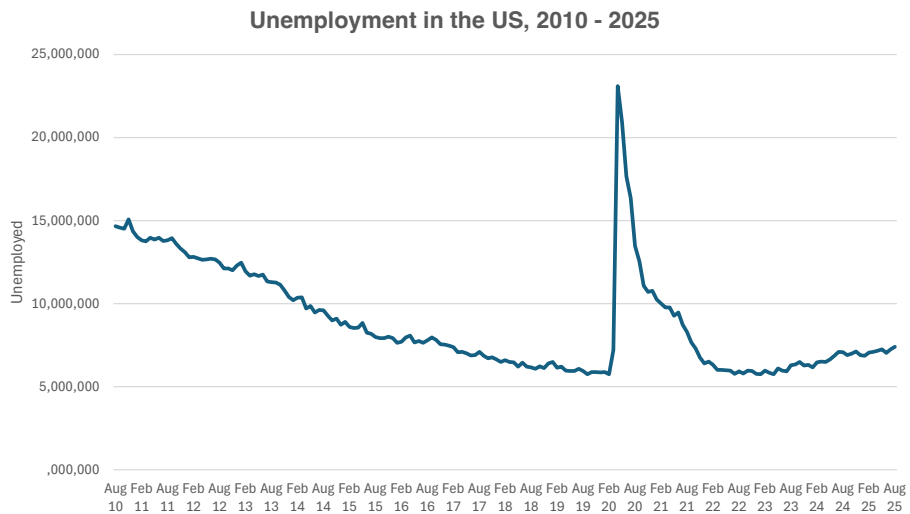
- Reduce overall income and consumption
- Reinforce inequality within an economy
- Trigger fiscal costs (transfer payments, loss of income taxes)

At the micro level, unemployment found to

- Cause earnings losses even after re-employment (stigma effects)
- Cause mental and physical stress/sickness
- Affect wellbeing beyond the effect that is due to reduced income

Unemployment During Times Of Covid-19

Due to economic stagnation, unemployment has increased in Germany and also relative to the US



Source: Bureau of Labor Statistics

Source: Bundesagentur für Arbeit

Measuring the stock of unemployed

Economic definition:

Individuals not employed but willing to work at the given wage level

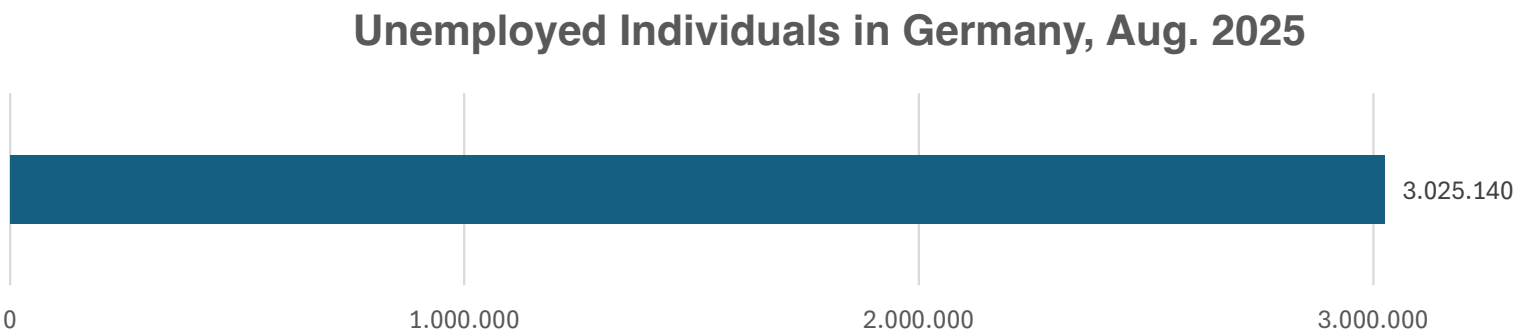
(Some) statistical definitions:

I **International Labour Organization (ILO):**
"The unemployed comprise all persons above a specified age who – during the reference period – were (i) without paid work, (ii) currently available for work, and (iii) seeking work."

II **German Federal Employment Agency (BA):**
"Unemployed persons who would accept reasonable employment and are available for placement, excluding persons (i) older than 65, (ii) looking for employment of less than three months duration, (iii) looking for employment of less than 18 hours a week, (iv) not registered with the BA."

Measuring the stock of unemployed

Unemployed individuals according to the German BA



Source: Bundesagentur für Arbeit

Excludes unemployed individuals who are...

- ... in active labour market programs (training, integration course, etc.)
- ... sick at the time of registration with the BA
- ... older than 58 and subject to Bürgergeld (counted in “Stille Reserve”).

$\rightarrow$ Roughly 1 million individuals

Calculating unemployment rates

Unemployment rates according to the Federal Employment Agency:

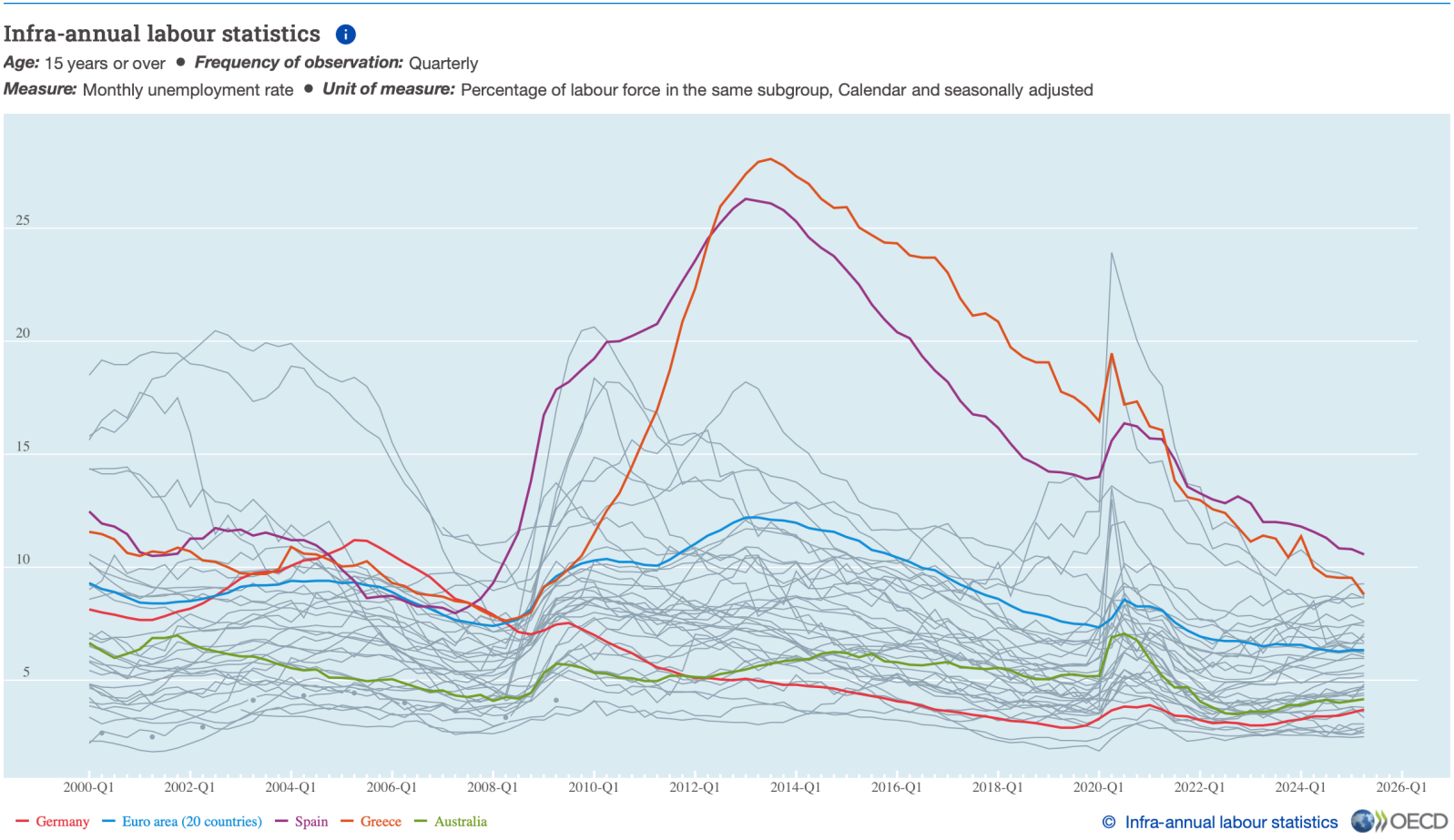
- $\mu = \frac{\text{unemployed individuals}}{\text{unemployed individuals + dependent workers}}$
- Dependent workers: regular and marginal employed, civil servants

Unemployment rates according to the OECD:

- $\mu = \frac{\text{unemployed individuals}}{\text{working population}}$
- Working population: unemployed & employed individuals
- Employed individuals: dependent workers, self-employed, family helpers

Unemployment rates across countries over time

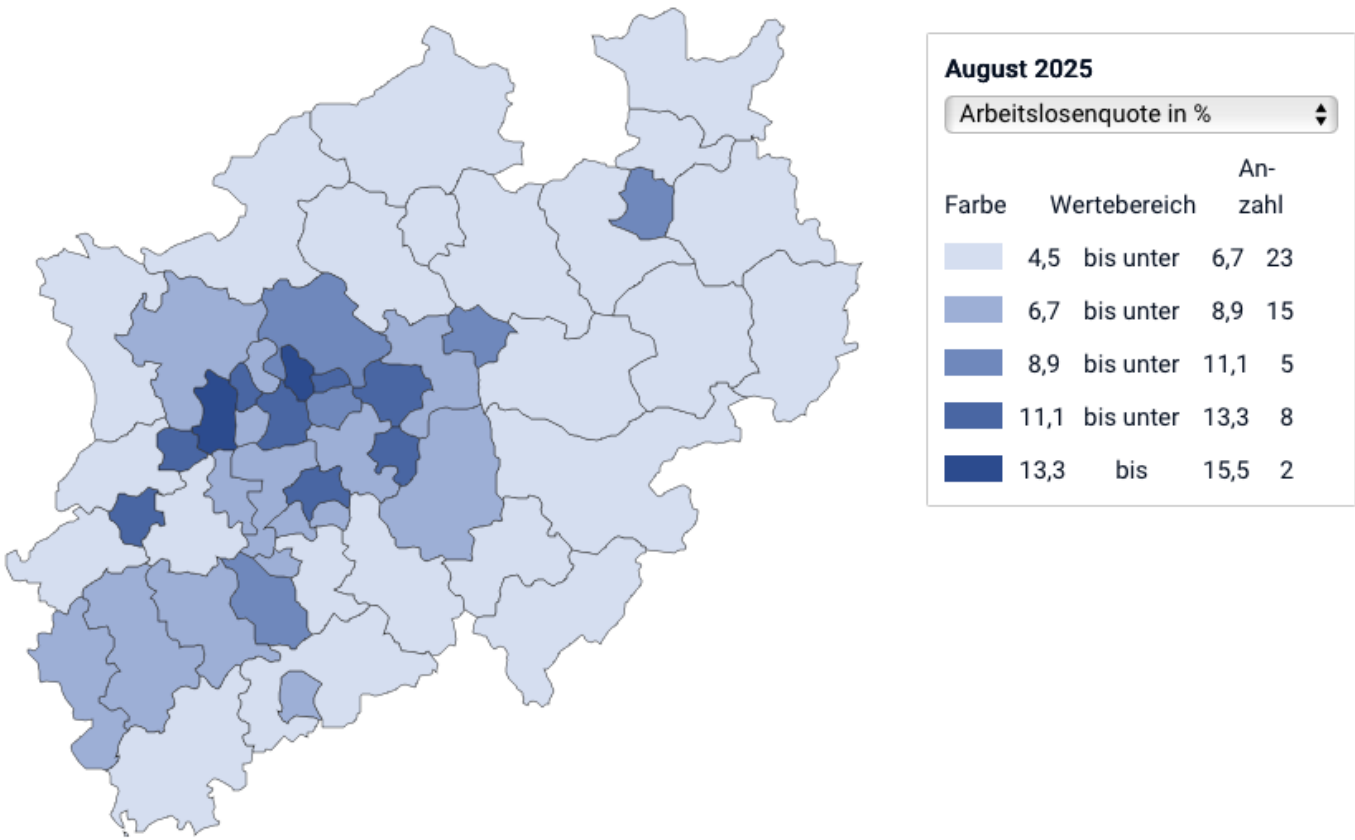
Unemployment rates vary substantially within and across countries



Source: `https://data.oecd.org/unemp/harmonised-unemployment-rate-hur.htm`

Local variation in NRW

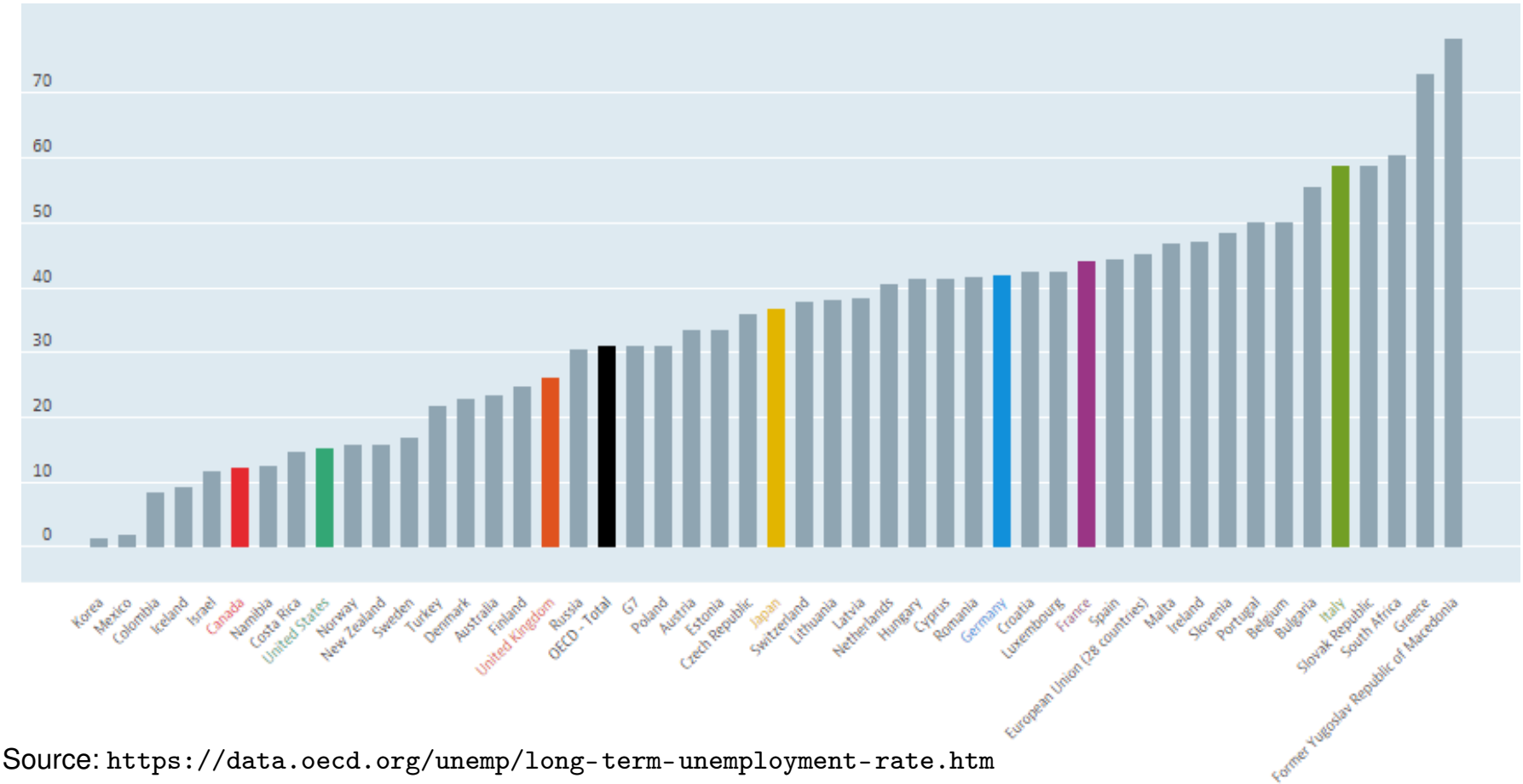
Of course, unemployment rates vary at more local levels, too



Source: `https://statistik.arbeitsagentur.de/Navigation/Statistik/Statistik-nach-Regionen/Politische-Gebietsstruktur/Nordrhein-Westfalen-Nav.html`

Share of long-term unemployed

Long-term unemployed: unemployed for 12 months or more



Source: `https://data.oecd.org/unemp/long-term-unemployment-rate.htm`

Note: Statistics reflect economic crises in Greece/Macedonia

Different reasons of unemployment

Different "types" of unemployment exist

- Seasonal/Frictional/Cyclical/Structural Unemployment

A. Seasonal unemployment

- Result of seasonal fluctuation in production (e.g., agriculture, construction) or demand (e.g., tourism) $\rightarrow$ Mostly does not show up in official unemployment figures

B. Frictional unemployment

- Result of incomplete information in the labour market
  $\rightarrow$ Delaying the match between jobs and workers
  $\rightarrow$ E.g., due to search frictions, random variation in hirings/layoffs

Different reasons of unemployment

C. Cyclical unemployment

- Result of cyclical variation in macroeconomic production (and wage rigidity)
- To be cured by fiscal policies (e.g. increase in public spending, tax cuts)?
  $\rightarrow$ Problems: time lags, crowding-out of private investment
- To be cured by expansive monetary policies (lower interest rates)?
  $\rightarrow$ Problem: policy with substantial time lag, risk of inflation

Different reasons of unemployment

D. Structural Unemployment

- Result of structural changes in the production process (e.g., due to technological advances) that make some workers (and their skills) obsolete
- Structural unemployment as a consequence of mismatch
  $\rightarrow$ With regard to, e.g., qualification, wages, locations
- Moreover, structural unemployment due to institutional conditions
  $\rightarrow$ Dismissal protection legislation, wage setting agreements, bureaucracy

Measuring (mis-)match: Stock vs. Flows

Note: Unemployment rates tell little about labour market dynamics

Example: An annual unemployment rate of 10% may be due to:

- 10% of the workforce being laid off at the beginning of the year and remaining unemployed for exactly one year
- 40% of the workforce being laid off over the course of one year and remaining unemployed for three months on average

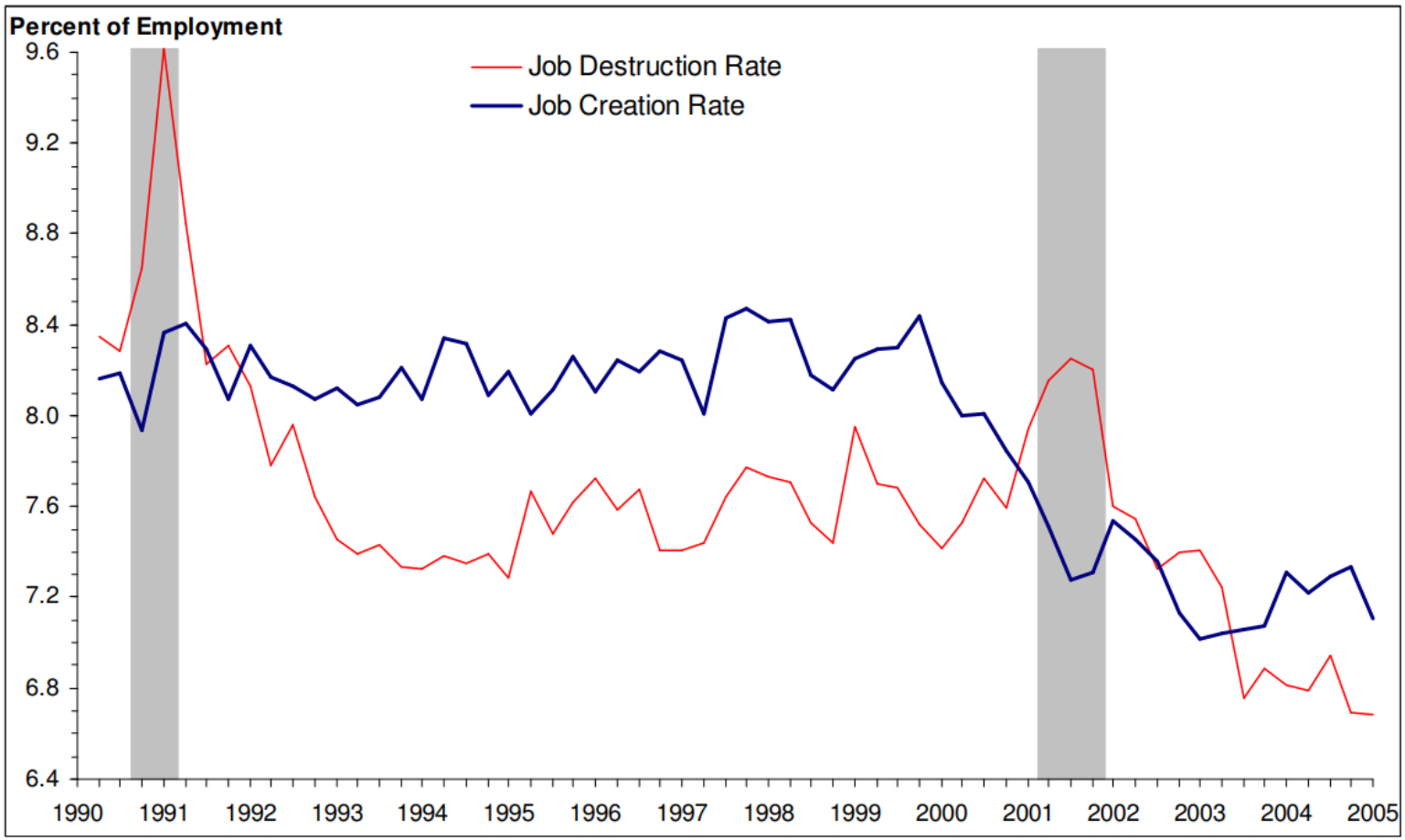
Focus on flow data to better understand labour market dynamics:

$$\text{Net employment change} = \underbrace{\text{Creations - Destructions}}_{\text{Job flows}} = \underbrace{\text{Hirings - Separations}}_{\text{Worker flows}}$$

Usually: Hirings > (Job) Creations, Separations > Destructions

Measuring (mis-)match: Stock vs. Flows

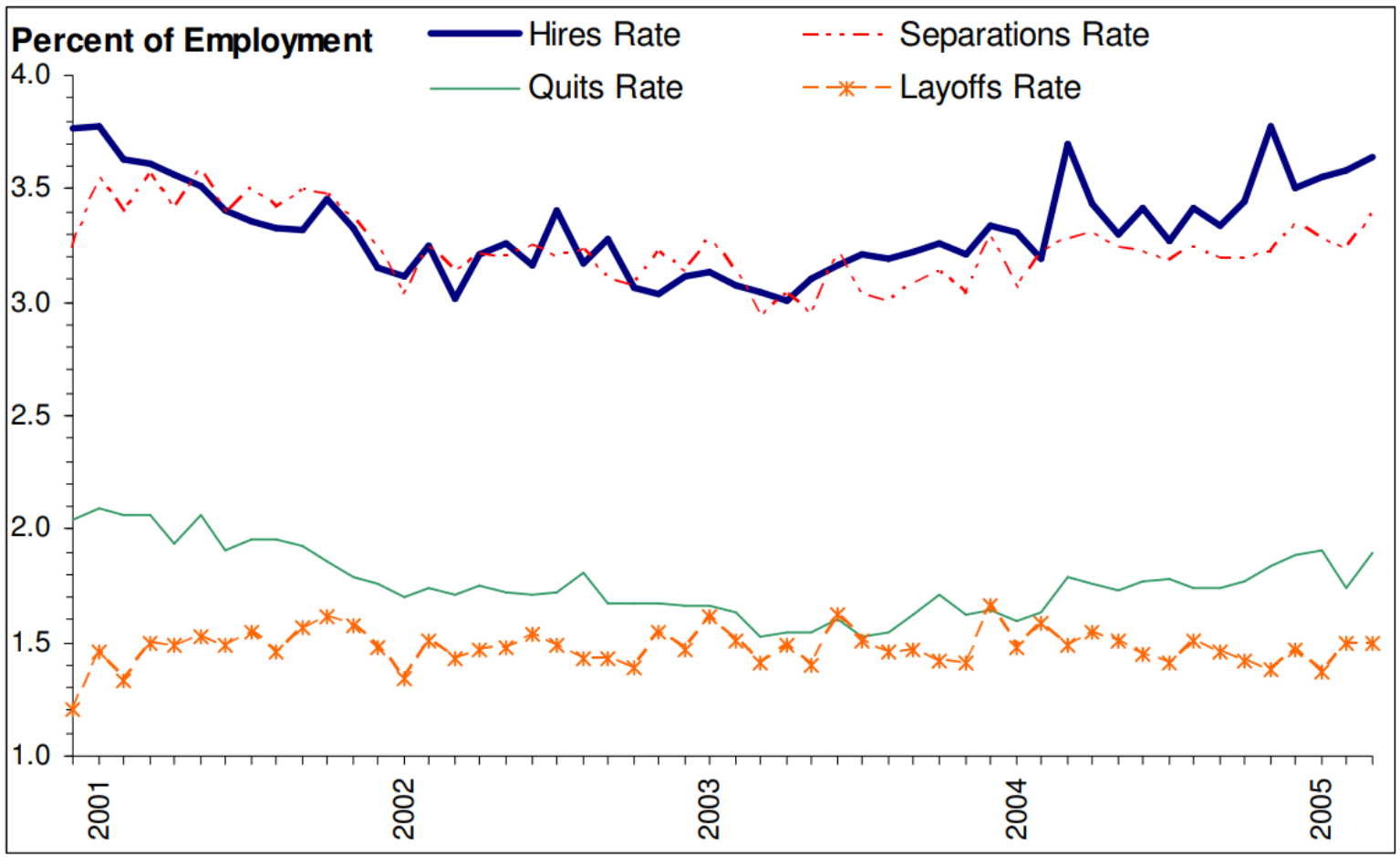
Job creation and destruction rates for the US **(quarterly)**



Source: `https://www.nber.org/papers/w12167.pdf`

Measuring (mis-)match: Stock vs. Flows

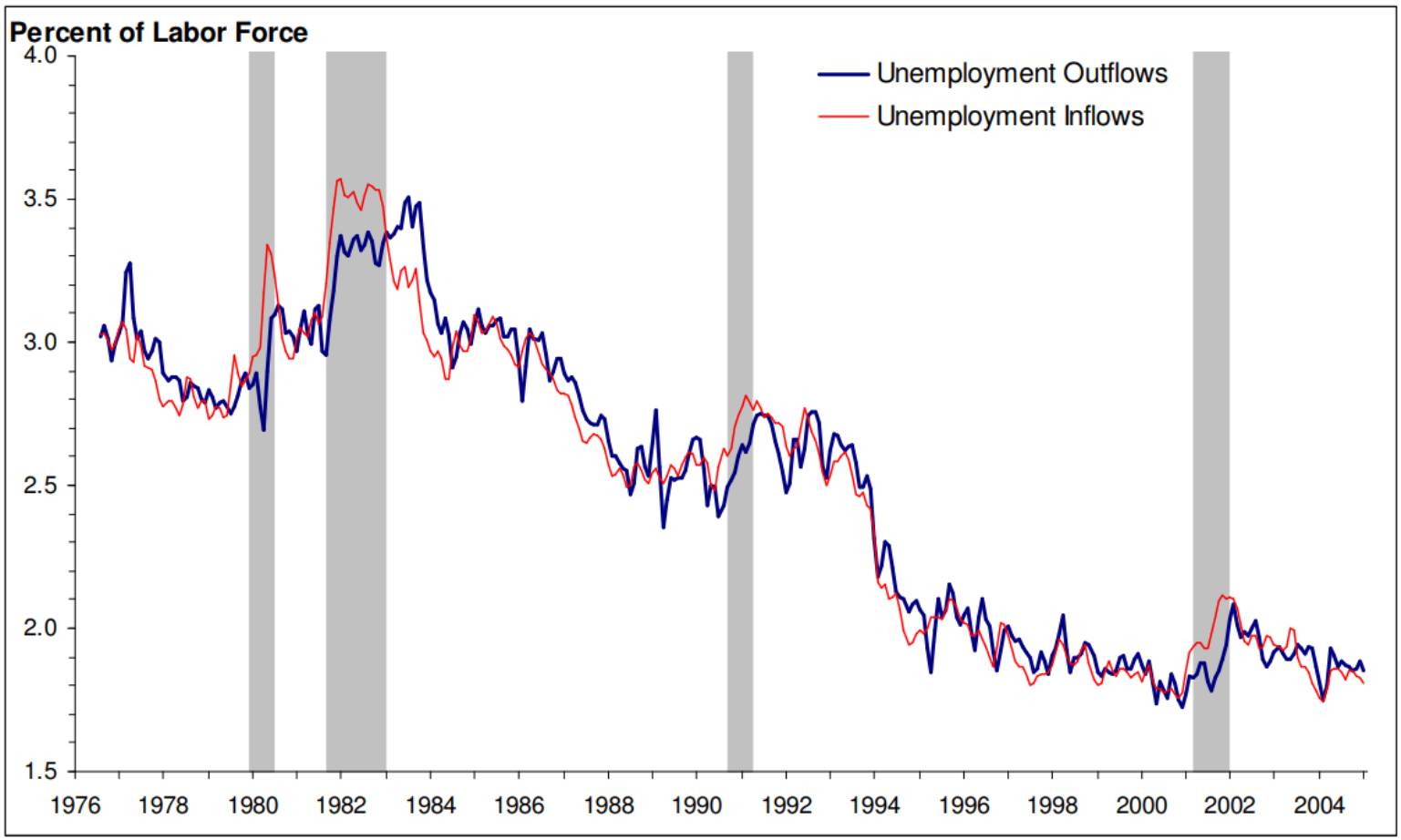
Data on worker flows for the US **(monthly)**



Source: `https://www.nber.org/papers/w12167.pdf`

Measuring (mis-)match: Stock vs. Flows

Inflows to and outflows from unemployment over time



Source: `https://www.nber.org/papers/w12167.pdf`

The Beveridge curve

Mass of job and worker flows illustrate scope of labour market fluctuation

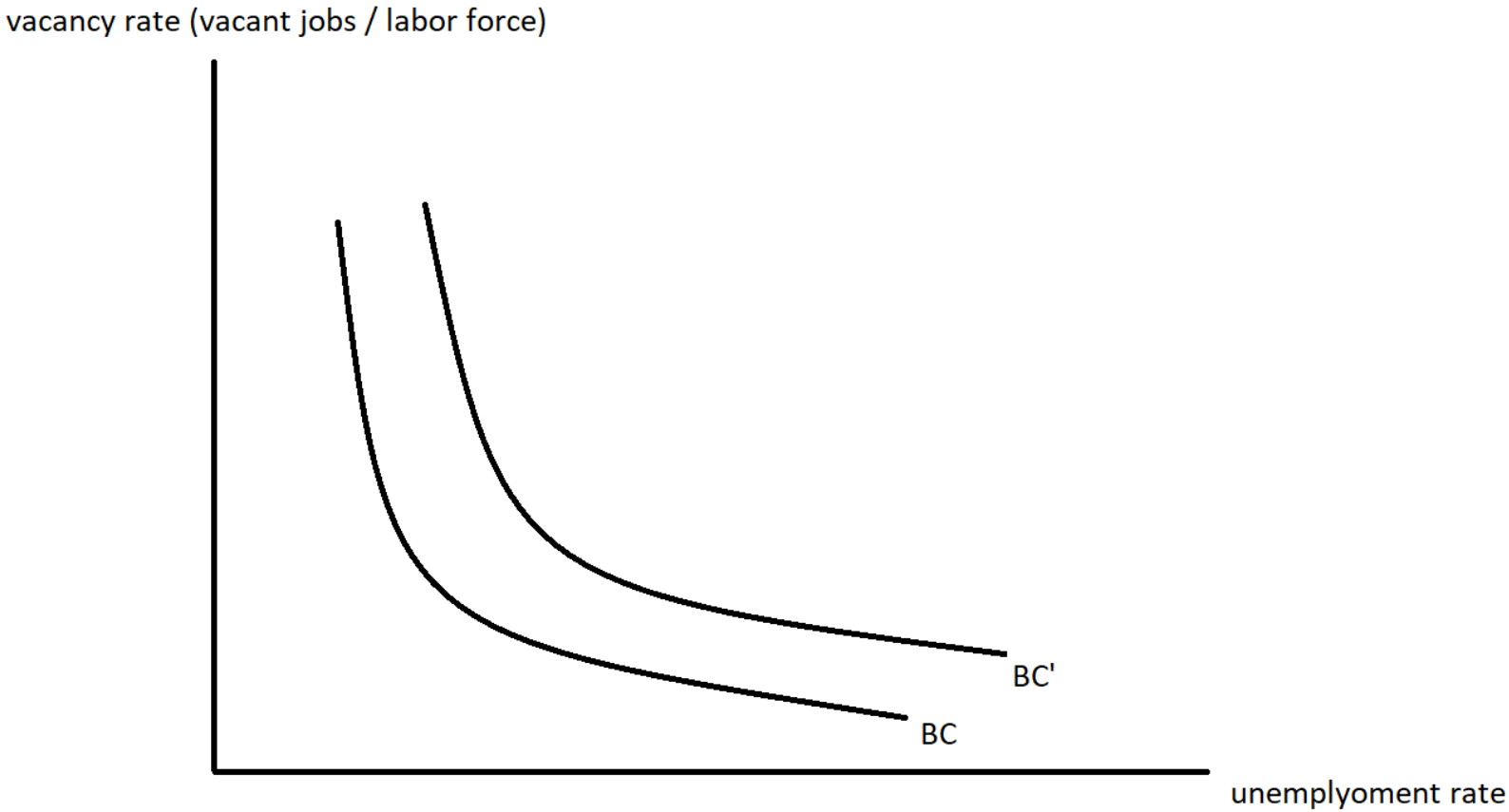
At every instant, some workers loose their jobs while some unemployed find employment; simultaneous existence of vacancies and unemployment

For example due to imperfect information, skill mismatch or mobility constraints

William Beveridge (1944):

Use relation b/w level of vacancies & unemployment to assess reallocation

The Beveridge curve



The Beveridge curve

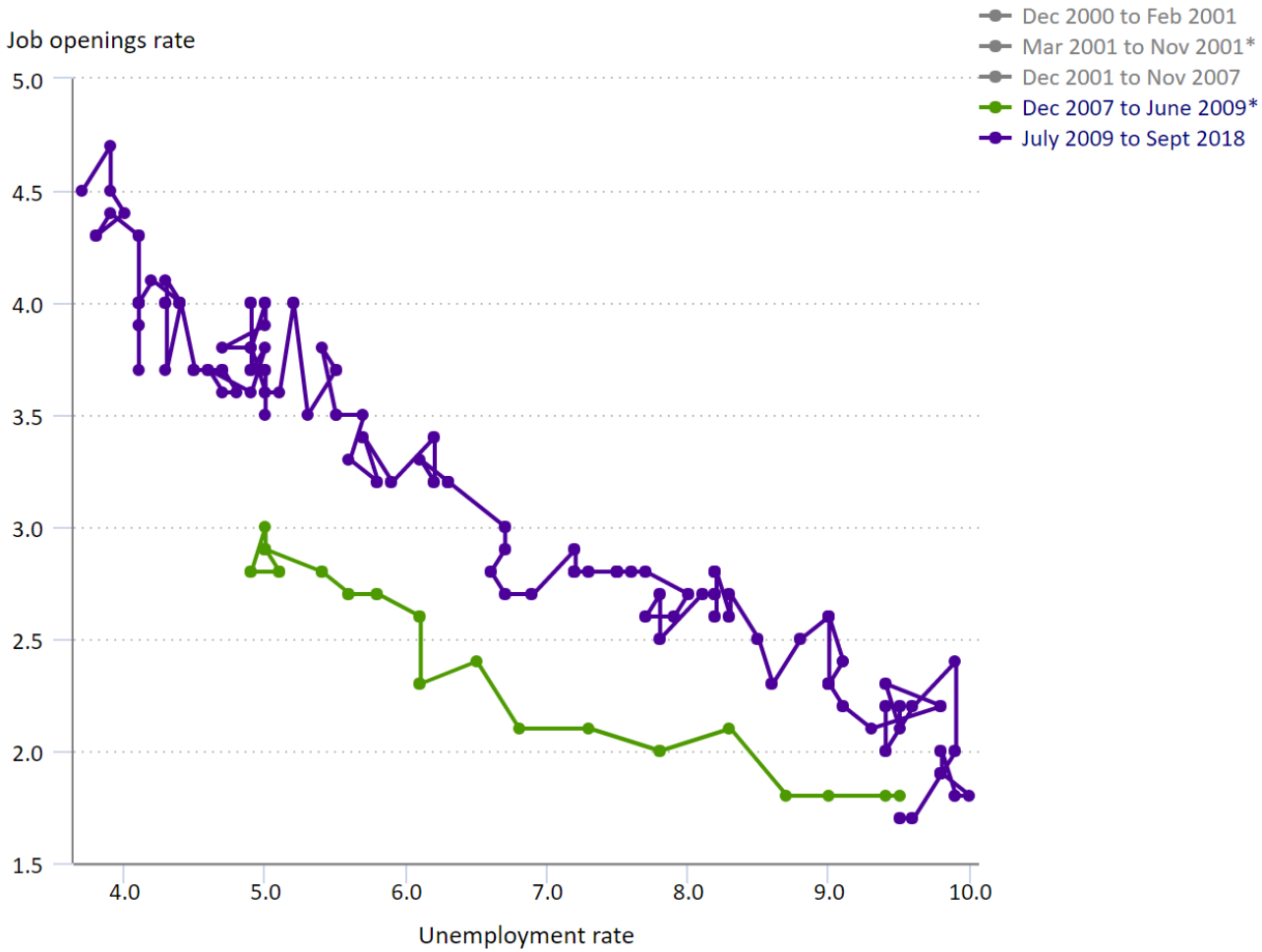
Basic idea:

- Economic slowdown to lower vacancies & increase unemployment rate
- During economic recovery, vacancies increase & unemployment rate falls

Efficiency of labour market adjustments shown by position of curve

- The closer the curve to the origin, the more efficient the labour market
- For the same number of vacancies, the unemployment rate is lower in curve BC than BC' (i.e. there is more efficient matching in BC)

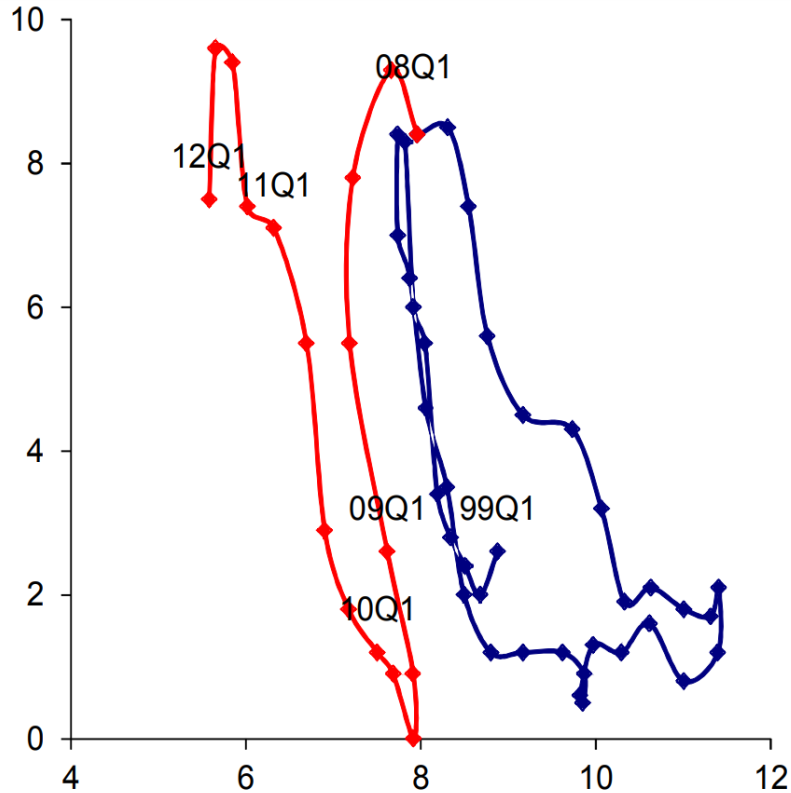
The Beveridge curve for the US



Source: `https://www.bls.gov/charts/job-openings-and-labor-turnover/job-openings-unemployment-beveridge-curve.htm`

The Beveridge curve for Germany

A different pattern emerges for Germany



Source: `https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1586.pdf`

The "German labour market miracle" due to (policy) reforms:
Hartz IV, short-time work agreements, more flexible wage setting

Modeling job search behavior

Neoclassical labour supply theory neglects time and costs of job search

- Leisure time as sole alternative to paid work in labour supply model
- An individual who spends their entire time on leisure $\rightarrow$ non-participant
- No role for unemployed person who spends its time looking for work
- Description of labour market assuming perfect information on available employment opportunities and (universal) wages

Modeling job search behavior

However, description of labour market too simplistic

- We observe involuntary unemployment and open vacancies
- Unemployed workers spend considerable time on searching for jobs (and firms on filling vacancies)
- Information about employment opportunities and wages is imperfect

Job search theory: job search and acceptance behavior under imperfect information

Descriptive evidence on job search behavior

How do job seekers spend their time?

Table 1: Average minutes per day by activity and employment status

	Employed	Unemployed
Sleep	496	555
Personal care and eating	110	97
Home production, shopping	158	254
Leisure, travel, sports	320	442
Work	325	10
Job Search	1	32

Sources: Krueger and Mueller (2012, table 3, p.773) and Cahuc et al. (2014) American Time Use Survey 2003–07

- Only 20% of unemployed actively search for job
- Conditional on searching, unemployed look for job 160 minutes on average

Descriptive evidence on job search behavior

How do job seekers search for jobs? Evidence from survey data

Table 2: Search methods of unemployed workers (aged 24-28)

	Share of workers using offline methods	Share of workers using online methods
Contacted employer directly	0.36	0.29
Contacted public employment agency	0.19	0.19
Contacted private employment agency	0.07	0.08
Contacted friends/relatives	0.44	0.11
Contacted school/uni employment center	0.05	0.06
Sent out CV/application	0.24	0.48
Checked unions	0.03	0.03
Placed or answered job ads	0.16	0.17
Other active methods	0.04	0.03

Sources: Kuhn and Mansour (2011, table 2, p. 22)

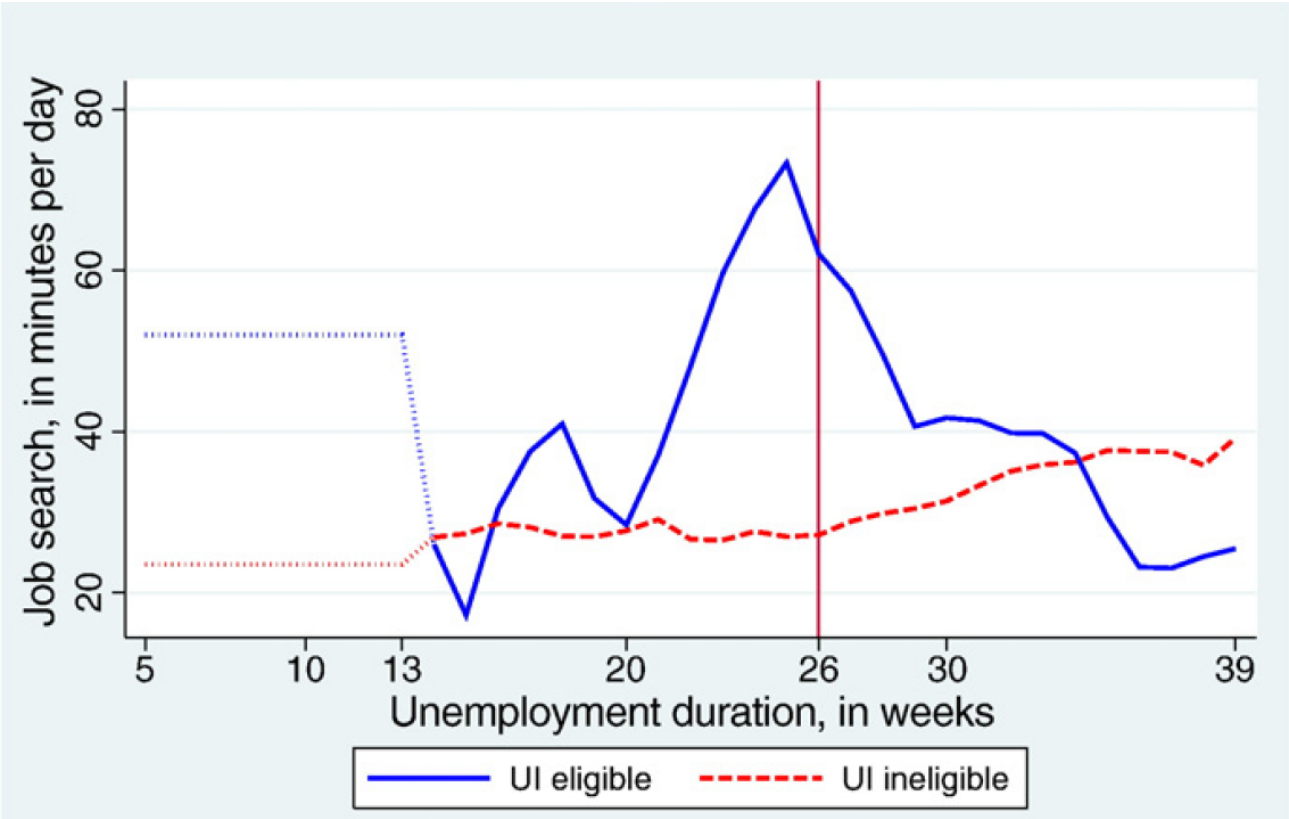
- Online job search much more “formal”
- Internet plays key role in job search

Descriptive evidence on job search behavior

Unemployed individuals react to economic incentives

- Workers expecting to be called back (e.g. seasonal or short-time work) from previous employer search less
- Higher levels of unemployment benefits reduce job search effort
- Search effort related to length of benefit duration

Descriptive evidence on job search behavior



Source: Krueger/Mueller (2010): Job search and unemployment insurance: new evidence from time use data, JPubE.
Note: To the left of 13 weeks are just averages over the whole of that period (and UI eligible indiviuals have more labour market attachment & search more unconditionally).

Job search theory – the standard model

Job search theory in continuous time:

Describes individuals' behavior looking for work absent perfect information

Optimal strategy:

- Individual *i* chooses a reservation wage (ϕ) that represents the lowest renumeration the unemployed will accept to take an offered job
- Level of ϕ_i dependent on benefit level (b) and job offer arrival rate (λ)

Assumptions in baseline model (to be relaxed later):

- Benefits for everyone and paid out indefinitely (stationary environment)
- No choice of search effort (fixed effort)

Job search theory – the standard model

Job seekers in a world with imperfect information

- Job seeker ex ante unaware about wage offered by specific job
- Job seeker knows wage offer distribution only; $F(\cdot)$
- In base model, wage offer distribution the same over all periods
- Via job search, *i* can improve their earnings prospects by drawing more offers
- Each offer comes with some constant real wage w
- Constant and exogenous interest rate r

Job search theory – the value of employment

Value of employment: $V^e = \frac{1}{1+r\,dt}[w\,dt + (1 - q\,dt)\,V^e + q\,dt\,V^u]$

- Assuming job seekers to be risk-neutral and discarding dis-utility from work
- Discounted value of employment equals to

  [a] Discounted flow of income $w\,dt$ over the time increment dt and

  [b] Discounted expected future income:
  - With probability $(1 - q\,dt)$: expected utility of continued working
  - With probability $q\,dt$: discounted value of being unemployed (V^u)

Job search theory – the value of employment

Value of Employment: $V^e = \frac{1}{1+r\,dt}[w\,dt + (1 - q\,dt)V^e + q\,dt\,V^u]$

Multiplying both sides with $1 + r\,dt$ & re-arranging terms

$$rV^e = w + q(V^u - V^e)$$

$\rightarrow$ At every point in time, discounted utility of working equals to the wage rate

and potential losses due to a change in the worker's employment status

We can now express the discounted utility of working for wage (w) as:

$$V^e(w) - V^u = \frac{w - rV^u}{r + q}$$

$\rightarrow$ Difference in V^e and V^u increases in w and declines in V^u, r, q

Job search theory – the optimal search strategy

The optimal search strategy (assuming max! one offer at given time *dt*):

I. If job seeker receives no offer in *dt*, continue search

II. If job offered, accept it if $V^e(w) > V^u$ (continue search otherwise)

As $V^e(w)$ increases in *w*, optimal strategy as a *stopping rule*

$\rightarrow$ Accept job offer only if *w* larger than threshold value $\phi = rV^u$

$\rightarrow \phi$: reservation wage; yielding same utility as remaining unemployed

Job search theory – the value of unemployment

Existence of stopping rule allows description of job search process in detail

To this end: specify V^u, the discounted value of unemployment

- In every period, the job seeker receives benefits (b)
- Job search triggers (non-)monetary costs (ψ)
- Job offers arrive at rate λ; reflecting, e.g., differences in job search effort, personal traits, the state of the labour market
- At every moment, the status of a job seeker may change with rate λ
- The discounted value of an offer amounts to: $V^\lambda = \int_0^\phi V^u dF(w) + \int_\phi^\infty V^e(w) dF(w)$.

The discounted expected value of unemployment thus satisfies:

$$V^u = \frac{1}{1 + r\,dt}[b\,dt - \psi\,dt + \lambda\,dt V^\lambda + (1 - \lambda\,dt)\,V^u]$$

Job search theory – the reservation wage

Take expression for value of unemployment:

$$V^u = \frac{1}{1+r\,dt}[b\,dt - \psi\,dt + \lambda\,dt V^\lambda + (1-\lambda\,dt)V^u]$$

Multiplying both sides with $1 + r\,dt$ & re-arranging terms:

$$rV^u = b - \psi + \lambda \int_\phi^\infty (V^e(w) - V^u) dF(w)$$

Using definitions of $(V^e(w) - V^u)$ & ϕ, optimal reservation wage:

$$\phi = b - \psi + \frac{\lambda}{r+q} \int_\phi^\infty (w - \phi) dF(w)$$

$\rightarrow$ Optimal ϕ maximizes the intertemporal utility of the job seeker

$\rightarrow$ ϕ equal to net income from job search plus discounted value of what job search can yield on top of the reservation wage

Job search theory – the hazard rate

Given description of optimal reservation wage (ϕ)

$\rightarrow$ Characterization of additional job search variables possible

The hazard rate (exit rate from unemployment):

$$h = \lambda[1 - F(\phi)]$$

$\rightarrow$ Job seeker receives offer at rate λ

$\rightarrow$ Offered wage is at least as high as ϕ with probability $1 - F(\phi)$

Job search theory – duration of unemployment

Can show:

$\rightarrow$ Poisson process with constant hazard rate h has density function $g(x) = he^{-hx}$.
$\rightarrow$ Expectation $E(x) = \int_0^\infty xhe^{-hx}dx = \frac{1}{h}$ (proof: integration by parts)

Therefore, the duration of unemployment:

$$T^u = \frac{1}{\lambda[1 - F(\phi)]}$$

$\rightarrow$ If monthly hazard is 0.2, average UE duration is 1/0.2 = 5 months
$\rightarrow$ T^u as a increasing function of the reservation wage

Job search theory – comparative statics

Comparative statics of baseline model using the expression of ϕ

$$R(\phi, b, \psi, r, \lambda, q) = 0 \quad \text{with} \tag{1}$$

$$R(\phi, b, \psi, r, \lambda, q) = \phi - b + \psi - \frac{\lambda}{r+q}\int_{\phi}^{\infty}(w-\phi)dF(w) \tag{2}$$

The partial derivatives of R are as follows:

$$R_{\phi} > 0, \;\; R_b < 0, \;\; R_{\psi} > 0, \;\; R_{\lambda} < 0, \;\; R_r > 0, \;\; R_q > 0$$

where e.g. by Leibniz Rule

$$R_{\phi} = 1 - \frac{\lambda}{r+q}\int_{\phi}^{\infty} -1 f(w)dw = 1 + \frac{\lambda}{r+q}[1 - F(\phi)]$$

Job search theory – comparative statics

Implicit function theorem on equation (2):

$$\frac{\partial \phi}{\partial i} = -\frac{R_i}{R_\phi} \quad \text{for} \quad i = b, \psi, \lambda, r, q \tag{3}$$

It follows that

$$\frac{d\phi}{db} > 0, \quad \frac{d\phi}{d\psi} < 0, \quad \frac{d\phi}{d\lambda} > 0, \quad \frac{d\phi}{dr} < 0, \quad \frac{d\phi}{dq} < 0$$

Using that $T^u = \frac{1}{\lambda[1-F(\phi)]}$, it further holds that

$$\frac{dT^u}{db} > 0, \quad \frac{dT^u}{dr} < 0, \quad \frac{dT^u}{dq} < 0$$

Key take-away comparative statics

- Increase in unemployment benefits
  $\rightarrow$ to raise reservation wage
  $\rightarrow$ to prolong unemployment duration
- Higher r (less value of the future) to lower reservation wage and UE duration
- Increase in q to lower reservation wage and UE duration
  $\rightarrow$ If jobs are shorter duration, job seekers less demanding
- Effect of increase in λ on unemployment duration ambiguous
  $\rightarrow$ Reservation wage increases in λ, lowering $[1 - F(\phi)]$
  $\rightarrow$ Effect on $\frac{1}{\lambda[1-F(\phi)]}$ ambiguous

Job search theory - Extensions

Basic job search model yields **numerous useful predictions**
$\rightarrow$ but subject to some restrictive assumptions

Important extensions:

- Possible on-the-job-search
- Job offer arrival rate subject to endogenous search effort
- Non-stationary UI benefits (e.g., ALG I $\rightarrow$ ALG II in GER)

Further readings

Further readings:

- Borjas - Labor Economics, Chapter 12.
- Cahuc et al. - Labor Economics, Chapters 5 & 9.
- Krueger/Müller (2010): Job Search and Unemployment Insurance: New Evidence from Time Use Data, JPubE.