EC106: Introduction to Economics
– Macroeconomics –

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Lecture - 6 -

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This Week: Outline

1. Introduction and Terminology

2. One-Sided Search Model of Unemployment

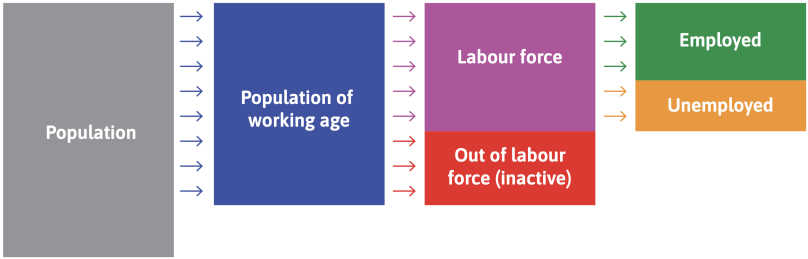
3. A Two-Sided Model of Search and Unemployment

4. Working with the Two-Sided Search Model

Unemployment

According to the standardized definition of *the International Labour Organization* (**ILO**), **the unemployed are the people who**:

- were without work during a reference period (usually four weeks),
- which means they were not in paid employment or self-employment were available for work
- were seeking work, which means they had taken specific steps in that period to seek paid employment or self-employment



Terminology

- N is the working-age population,
- $\mathcal{Q}$ is the labour force (employed + unemployed)
- U is the number of unemployed,

$$Unemployment\ Rate = \frac{U}{\mathcal{Q}} \tag{1}$$

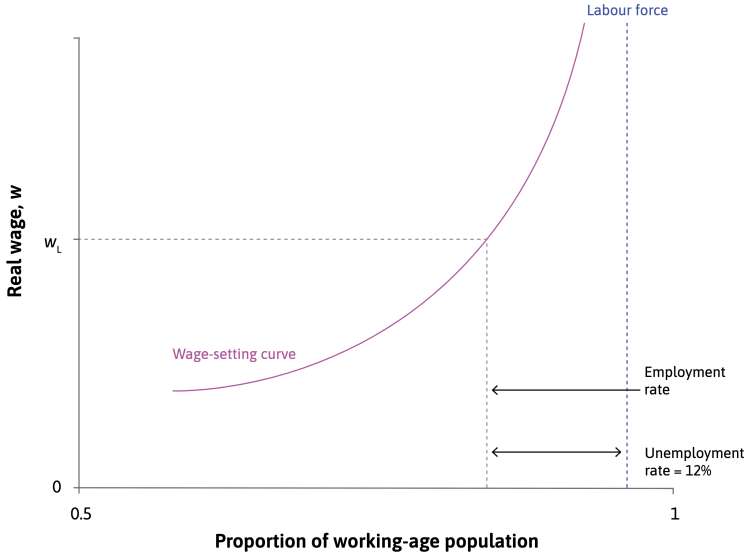
$$Participation\ Rate = \frac{\mathcal{Q}}{N} \tag{2}$$

- the employment/population ratio

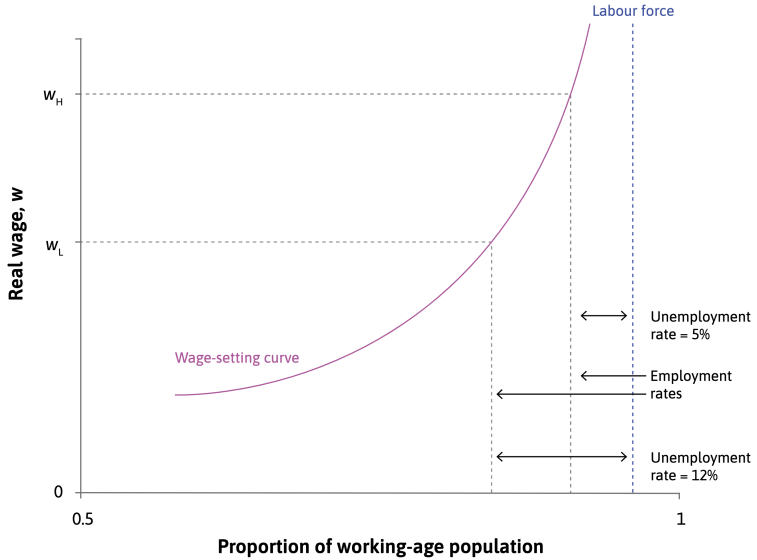
$$\frac{Employment}{Population} = \frac{Q - U}{N} \tag{3}$$

Unemployment

Unemployment

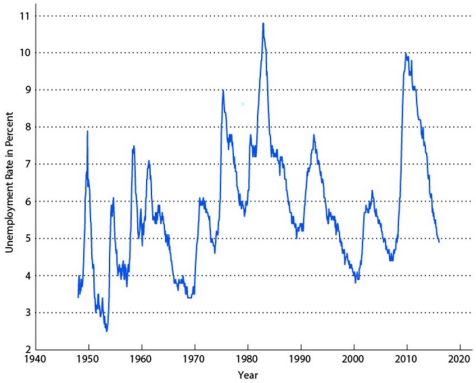


Unemployment

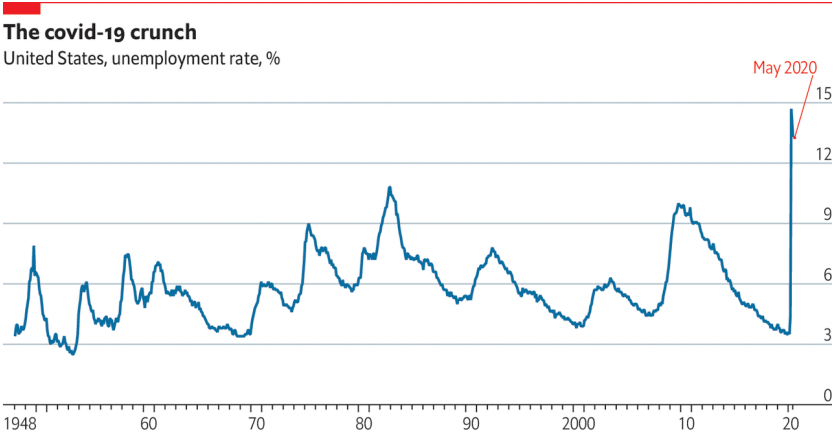


Countercyclicality of Unemployment

- The figure shows a plot of the unemployment rate for the United States for the years 1948-2016.
- The unemployment rate is a **counter-cyclical** variable: high during recessions and low during booms.
- In particular, note in the figure that the unemployment rate spiked during the recessions of 1973–1975, 1981–1982, 1991–1992, and 2008–2009, and decreased during the periods between recessions.



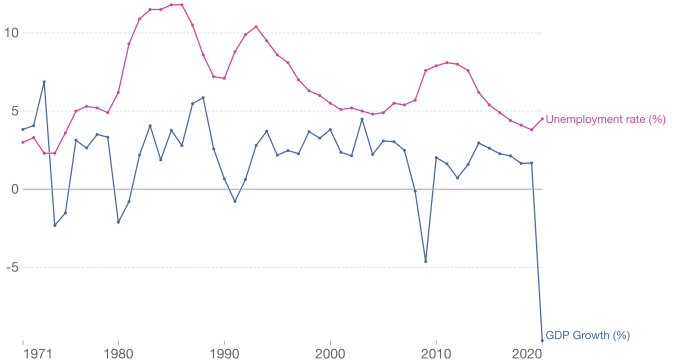
U Unemployment and Covid



UK Unemployment and GDP

GDP growth and unemployment rate, United Kingdom, 1971 to 2020

Unit 13 'Economic fluctuations and unemployment' Section 13.1 'Growth and fluctuations' in The CORE Team, The Economy. Available at: https://tinyco.re/39384422
[Figure 13.3]



Source: ONS (2020), Maddison Project Database (2018)
Note: CC-BY-ND-NC

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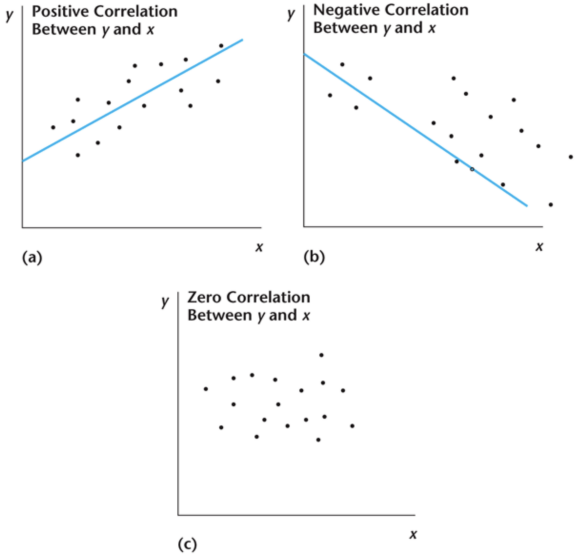
Global Unemployment

Some terminology 2

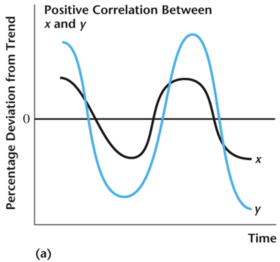
Countercyclical: And when economic activity is low, firms reduce their workforce and unemployment rises. In that sense, unemployment is countercyclical, meaning it rises when economic growth is low and vice versa.

Procyclical: In business cycle theory and finance, any economic quantity that is positively correlated with the overall state of the economy is said to be procyclical.

Correlations



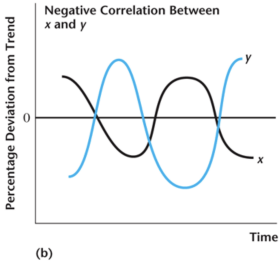
Pro- vs Counter-Cyclical



- PRO-CYCLICAL

  positive co-movement

  positive correlation

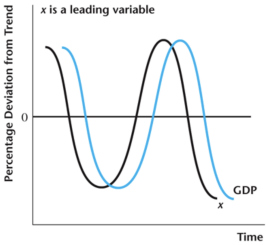


- COUNTER-CYCLICAL

  negative co-movement

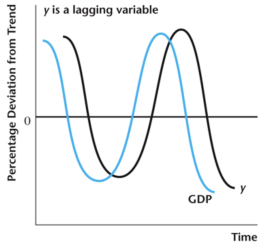
  negative correlation

Leading and Lagging Variables



- LEADING

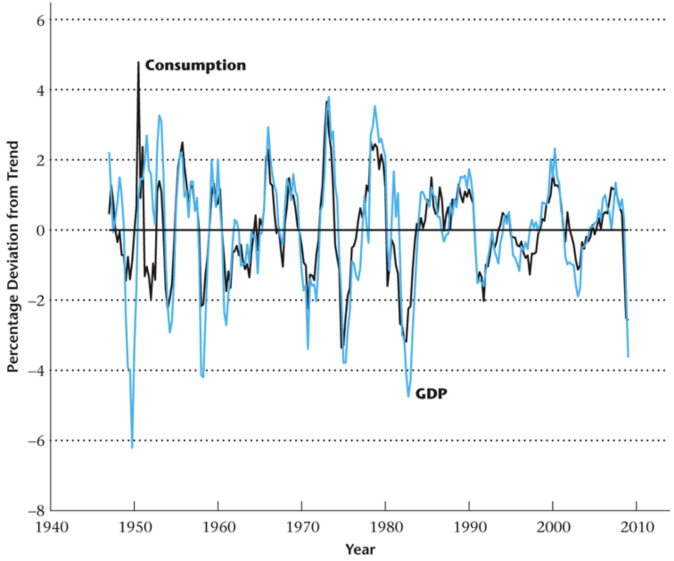
  the peak and trough of the series is **before** the GDP's peak and trough



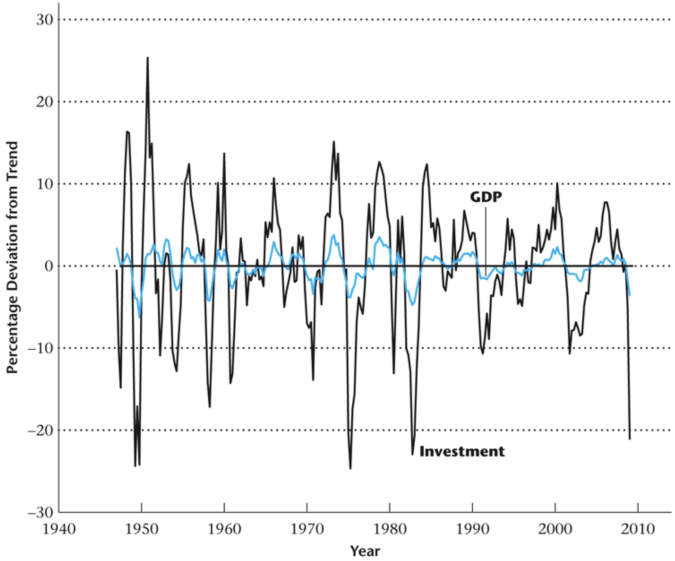
- LAGGING

  the peak and trough of the series is **after** the GDP's peak and trough

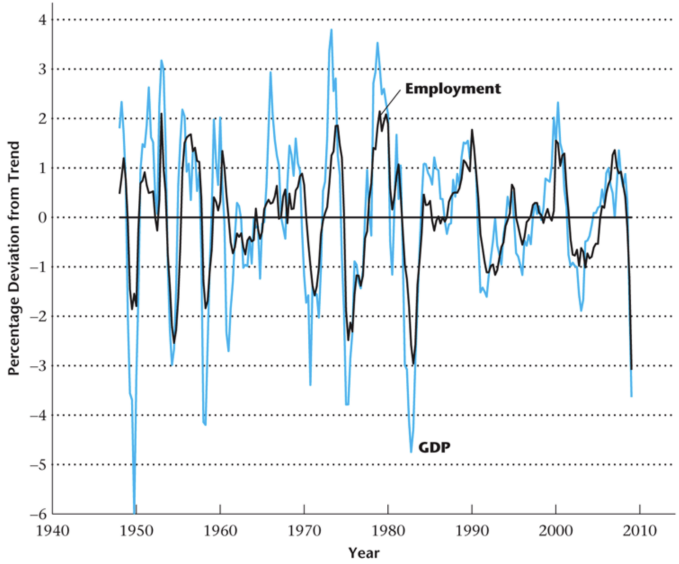
Consumption is Pro-cyclical, Coincident, Less Variable



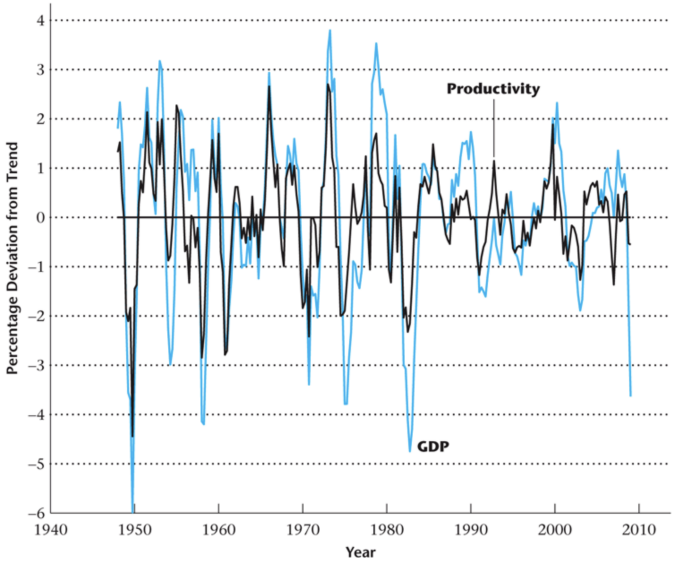
Investment is Pro-cyclical, Coincident, More Variable



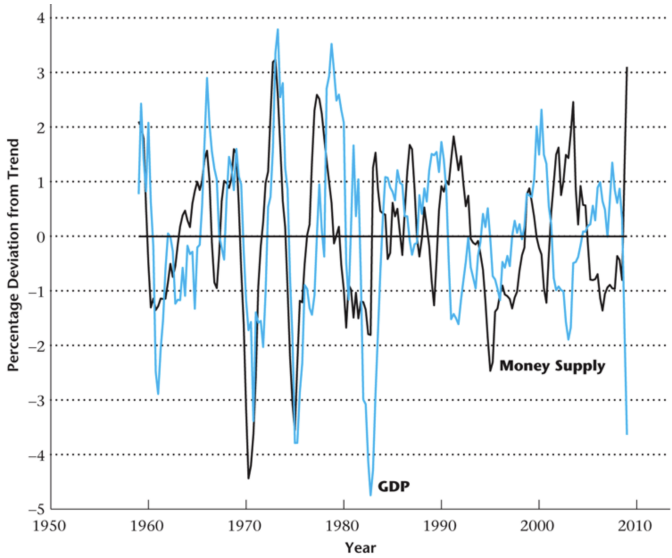
Employment is Pro-cyclical, Lagging, Less Variable



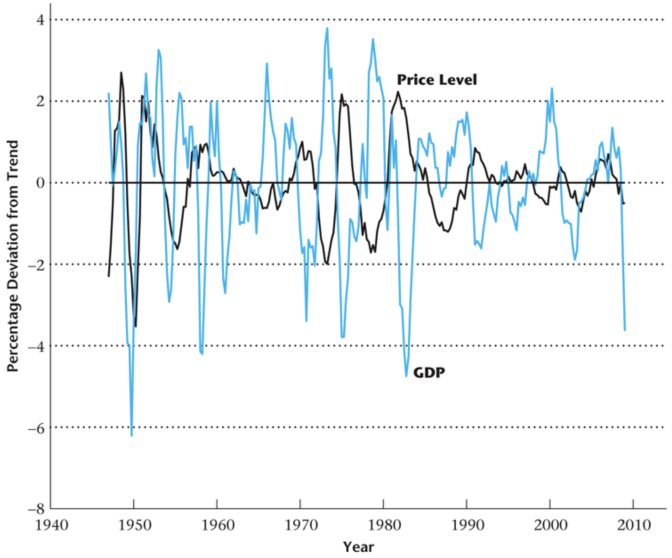
Labour Productivity is Pro-cyclical, Coincident, Less Variable



Money Supply is Pro-Cyclical, Leading, Less Variable



Price Level is Counter-Cyclical, Coincident, Less Variable



Summary of Business Cycle Facts

Table 3.1 Correlation Coefficients and Variability of Percentage Deviations from Trend

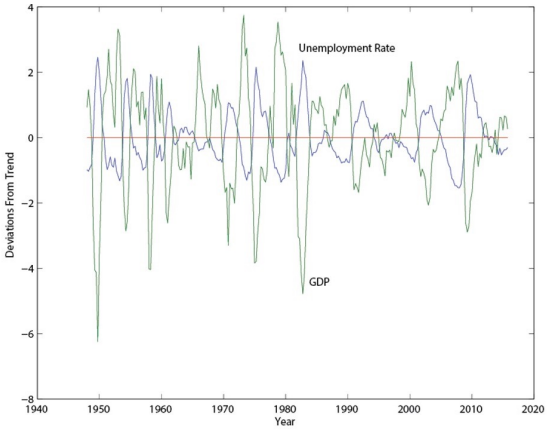
	Correlation Coefficient	Standard Deviation (% of S.D. of GDP)
Consumption	0.76	75.9
Investment	0.84	478.9
Price Level	−0.23	57.4
Money Supply	0.26	80.4
Employment	0.80	61.5
Average Labor Productivity	0.81	62.4

Table 3.2 Summary of Business Cycle Facts

	Cyclicality	Lead/Lag	Variation Relative to GDP
Consumption	Procyclical	Coincident	Smaller
Investment	Procyclical	Coincident	Larger
Price Level	Countercyclical	Coincident	Smaller
Money Supply	Procyclical	Leading	Smaller
Employment	Procyclical	Lagging	Smaller
Real Wage	Procyclical	?	?
Average Labor Productivity	Procyclical	Coincident	Smaller

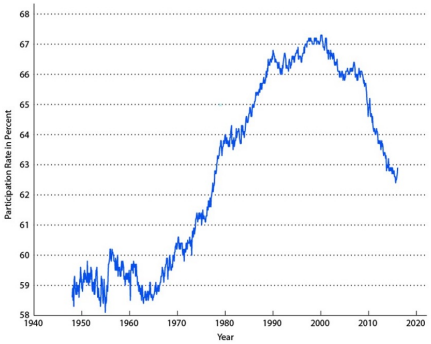
Countercyclicality of Unemployment

- The cyclical behaviour of the unemployment rate can be seen even more clearly in the figure on the right, which displays the percentage deviations from the trend in real GDP and the deviations from the trend in the unemployment rate.
- The unemployment rate tends to be above (below) trend when real GDP is below (above) trend; that is, the unemployment rate is strongly countercyclical.
- There also appear to be longer-run movements in the unemployment rate in figure.
- For example, from the late 1960s until the mid-1980s there was a trend increase in the unemployment rate, and there was a trend decrease from the mid-1980s until the recession of 2008– 2009.

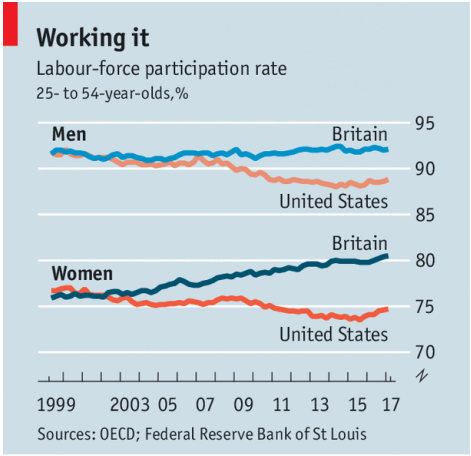


Labour Force Participation $\frac{Q}{N}$

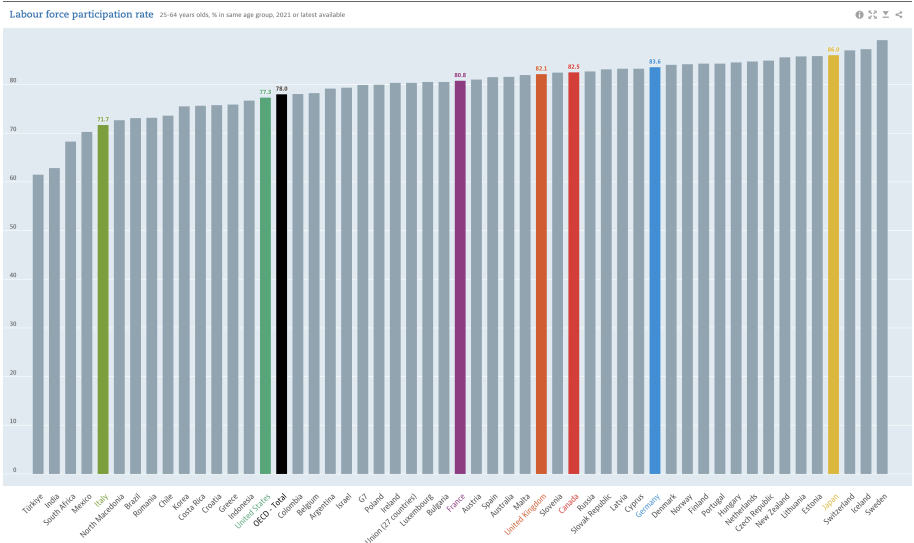
- In the figure, note that the participation rate increased from about 59% in the late 1940s to more than 67% in 2000.
- The large decline beginning in 2000, to about 63% in 2016, is quite striking.



Labour Force Participation $\frac{Q}{N}$

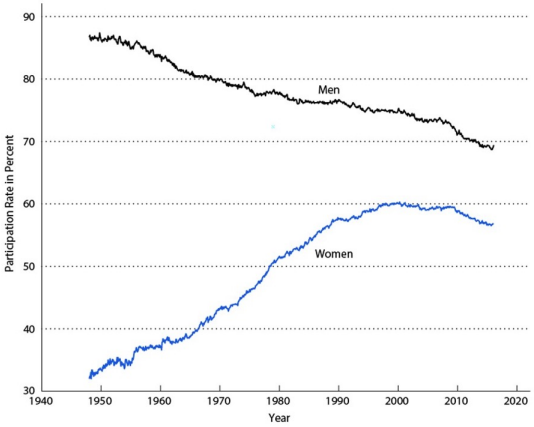


Economist.com


Labour force participation rate
25-64 years olds, % in same age group, 2021 or latest available
71.7
77.5
78.0
80.8
82.1
82.5
83.6
86.0
0
10
20
30
40
50
60
70
80
Türkiye
India
South Africa
Mexico
Italy
North Macedonia
Brazil
Romania
Chile
Korea
Costa Rica
Croatia
Greece
Indonesia
United States
OECD - Total
Colombia
Belgium
Argentina
Israel
G7
Poland
Ireland
European Union (27 countries)
Luxembourg
Bulgaria
France
Austria
Spain
Australia
Malta
United Kingdom
Slovenia
Canada
Russia
Slovak Republic
Latvia
Cyprus
Germany
Denmark
Norway
Finland
Portugal
Hungary
Netherlands
Czech Republic
New Zealand
Lithuania
Estonia
Japan
Switzerland
Iceland
Sweden

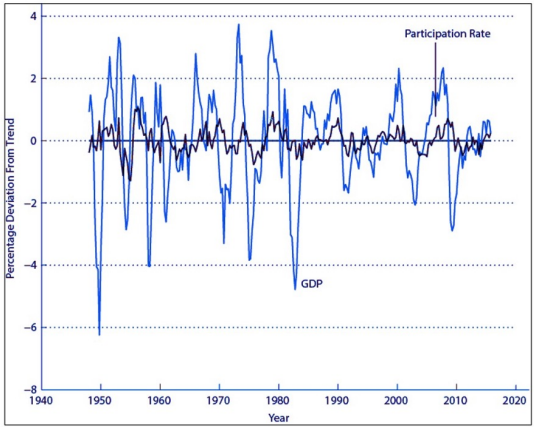
Labour Force Participation Rates of Men and Women (the US)

- Figure shows how the behavior of men and women has contributed to aggregate labor force participation.
- As the labor force participation rate of men has declined steadily since 1948, the increase in aggregate labor force participation that occurred before 2000 was due entirely to the behavior of women.
- Since 2000, the participation rate of women has declined, but not by as much as that for men.



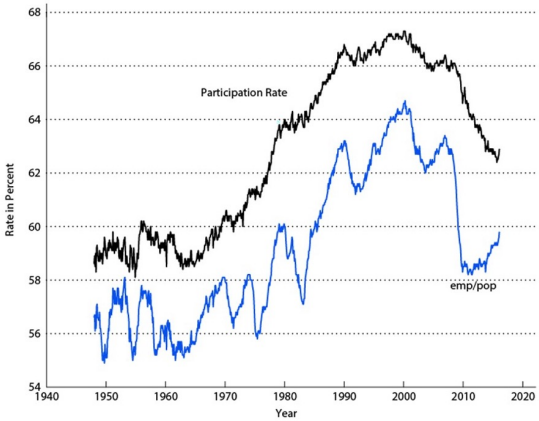
Percentage Deviations from Trend in the Labor Force Participation Rate and Real GDP

- Figure illustrates the cyclical behavior of the aggregate participation rate by showing the percentage deviations from trend in the participation rate and in real GDP.
- In the figure, the participation rate is clearly procyclical, but it is much less volatile than is real GDP.



Labor Force Participation Rate and Employment/Population Ratio

- The labor force participation rate is much less cyclically variable than is the employment/population ratio.
- During a recession, workers who lose their jobs tend to search for other jobs and remain in the labor force as unemployed, rather than leave the labor force.
- The 2008–2009 recession is an exception to the rule, in that there were large declines in both the participation rate and the employment/population ratio.



The Vacancy Rate and the Beveridge Curve

At any point in time, firms recruit new workers by advertising job vacancies they wish to fill. If we let A denote the number of vacancies in the economy as a whole, the vacancy rate is defined by

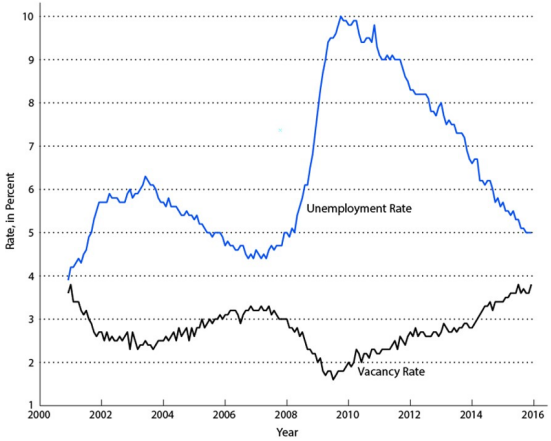
$$Vacancy\ Rate = \frac{A}{A + \mathcal{Q} - U} \tag{4}$$

which is the ratio of the number of vacancies to vacancies plus the number employed.

Since December 2000 , the vacancy rate has been measured as part of the Job Openings and Labor Turnover Survey (JOLTS) conducted by the Bureau of Labor Statistics.You can check it in FRED.

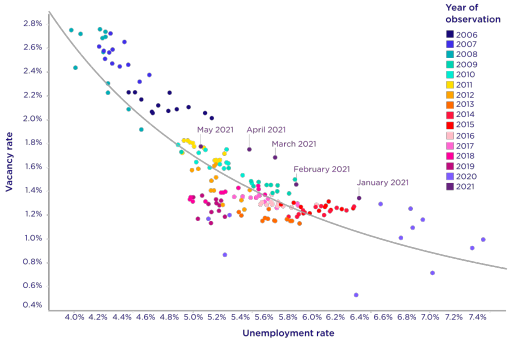
The Vacancy Rate and the Unemployment Rate

- The figure plots the vacancy rate and the unemployment rate for the period 2000–2015
- The figure shows clearly that the unemployment rate and the vacancy rate are negatively correlated
- The vacancy rate is a procyclical variable.
- In particular, the vacancy rate decreased after the onset of the 2001 recession, and the 2008–2009 recession.



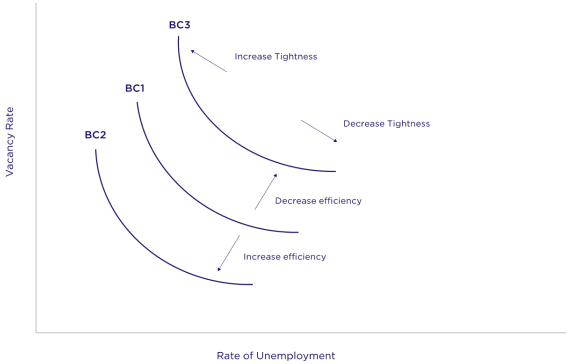
The Beveridge Curve

- The Beveridge Curve is named after Lord William Beveridge, who in 1944 looked at data on unemployment and the number of job vacancies and how they move over time.
- the Beveridge Curve is so useful to distinguish between cyclical and structural changes in the labour market matching process.
- Figure highlights the impact of the pandemic on the Australian labour market and highlight the speed of the shock as well as the subsequent recovery.
- The observations over mid-2020 are consistent with a recessionary environment with a relatively high unemployment rate and few vacancies.
- Recent observations (2021) suggest a solid recovery in the labour market with a lower rate of unemployment and an increase in job vacancies.



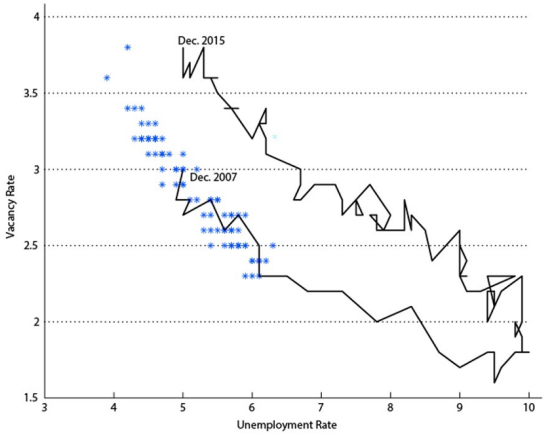
The Beveridge Curve

- The Beveridge Curve compares the unemployment rate to the vacancy rate and shows how this changes over time.
- The Beveridge Curve is used to assess the current state of the labour market due to the economic cycle and is also a measure of the efficiency of labour market matching.
- Figure shows how movements along the curve will generally reflect cyclical changes in labour market conditions.
- For example, when the economy strengthens the unemployment rate will fall while job vacancies will rise. When the economy weakens, the opposite is true.
- Firms lay off workers, so unemployment rises and the number of vacancies falls.



The Beveridge Curve

- The Beveridge curve is a downward-sloping curve reflecting the observed relationship between the unemployment rate and the vacancy rate.
- Figure shows the observed Beveridge curve relationship for the period 2000–2015.
- In the figure the observations are to show the shift in the curve that occurred at the end of the 2008–2009 recession.
- The dots in the figure denote the observations for December 2000 through December 2007, and the solid line connects observations from December 2007 through December 2015.
- Until about December 2009, the observations appear to fall on a stable downward-sloping curve, but the last set of observations appears to lie on a curve that has shifted to the right.



One-Sided Search Model of Unemployment

One-Sided Search Model of Unemployment

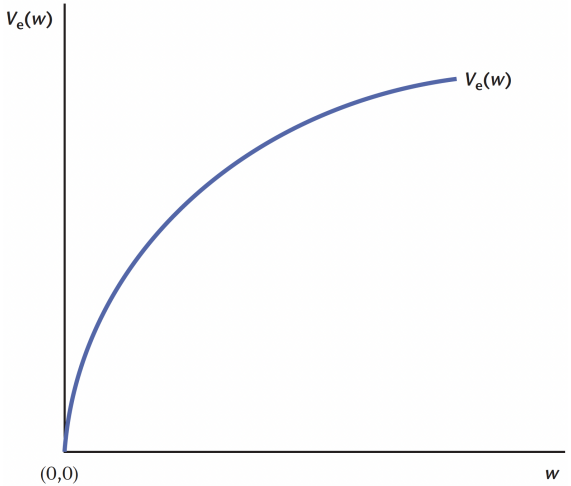
- This model focuses on the behavior of an unemployed worker, who searches for work,receives job offers that pay particular wages, and must decide when to accept a job and stop searching.
- An important goal in this basic model is to capture the nature of unemployment as a different economic activity from leisure, in that it involves active search.
- **This model will allow us to think about the factors that motivate the search behavior of unemployed workers,** and it will permit us to analyze some of the determinants of the unemployment rate.

One-Sided Search Model of Unemployment

- The workers in our model will all be in the labor force; that is, they will be either employed or unemployed.
- with U denoting the fraction of workers who are unemployed, and $1 - U$ the fraction who are employed
- The jobs of the employed differ according to the wages that they are paid, where w will denote the real wage associated with a particular job.
- Let $V_{\mathrm{e}}(w)$ denote the value of being employed. This is the welfare of a worker who is employed and earning a real wage, w, and it takes into account the worker's preferences and all possible future events, including the chances of the worker being separated from his or her job, and what will happen to the worker in such an event.
- We will let s denote **the separation rate**; that is, s is the fraction of workers who will become randomly separated from their jobs every period.
- This is a simple way to capture job separations that occur in practice because of firings and quits arising from poor matches between workers and firms.

One-Sided Search Model of Unemployment: The welfare of an employed worker

- The function $V_{\mathrm{e}}(w)$ is depicted
- $V_{\mathrm{e}}(w)$ increases with w, as the worker is better off with higher paying jobs, and $V_{\mathrm{e}}(w)$ is concave because the worker experiences diminishing marginal utility from higher-paying jobs.
- That is, the increase in welfare for the worker from an extra unit of real wage income becomes smaller as real wage income increases, reflected in the declining slope of $V_e(w)$.
- The function $V_{\mathrm{e}}(w)$ shifts down if the separation rate s increases. An increase in the separation rate, there is a greater chance of an employed worker losing his or her job and becoming unemployed.
- Employment becomes less attractive, and the welfare from being employed at any wage must fall.



One-Sided Search Model of Unemployment: The welfare of an unemployed worker

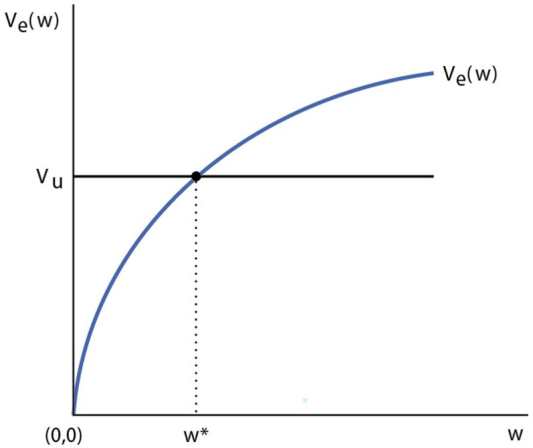
- The welfare of an unemployed worker, which is denoted by V_{u}.
- The key determinant of V_{u} is the size of the unemployment insurance (UI) **benefit** that an unemployed worker receives.
- Assume that the UI benefit is a constant real amount, b, that does not depend on the wage the unemployed worker earned when he or she was employed.
- Another important determinant of V_{u} is the frequency with which the unemployed worker receives job offers, and we will denote this frequency by p.
- Each period a fraction, p, of all the unemployed workers will receive job offers. Two important facts are the following:
  - V_{u} increases when b increases. An increase in the UI benefit increases an unemployed worker's welfare.
  - V_{u} increases when p increases. With a higher p the chances are better for the unemployed worker of receiving a job offer he or she will take, and this will increase welfare.

An unemployed worker with an offer at hand compares:

- The value of becoming employed, $V^e(w)$
- Increasing and concave function of the offered wage w
- Decreasing in the separation rate s (more likely to lose the job)
- The value of staying unemployed, V^u
- Does not depend on the offered wage w
- Increasing in unemployment benefits b
- Increasing in the probability of receiving another offer next period p

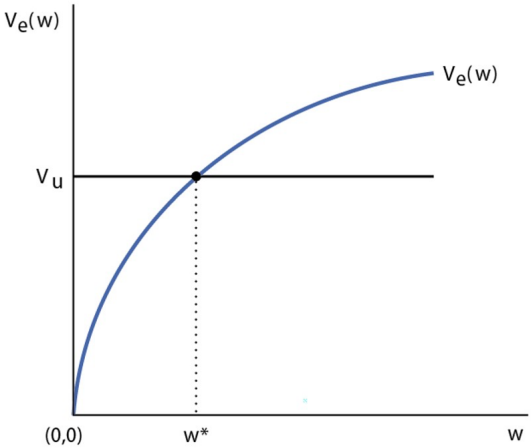
The Determination of the Unemployment Rate

- Now we can ask that how the unemployed worker will make choices.
- Unemployed worker receives a job offer at a particular wage, w.
- The key decision is whether to take the offer or continue searching for work.
- If a low-wage job is turned down, there is some possibility of receiving a higher-wage offer in the future, but the worker must bear a period of unemployment and uncertainty before such an offer is received.



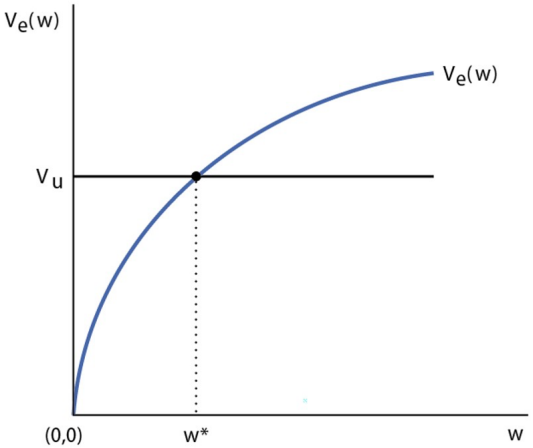
The Reservation Wage

- A trade-off between the short-run losses from unemployment and the uncertain long-run benefits from a good job.
- Clearly, some wage offer will be sufficiently high that the unemployed worker will accept it, and he or she would also accept any wage offer that was higher than this amount.
- We call this **the reservation wage** and denote it by w^*.



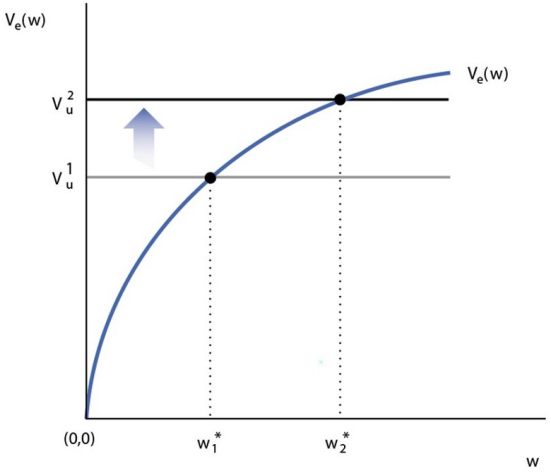
The Determination of the Unemployment Rate

- When a wage offer, w, is received, this implies a level of welfare for the job, $V_{\mathrm{e}}(w)$.
- The unemployed worker will accept the job if the welfare from taking it is higher than the welfare of being unemployed, and will decline it otherwise.
- That is, the worker will accept the job if $V_{\mathrm{e}}(w) \geq V_{\mathrm{u}}$ and will turn it down if $V_{\mathrm{e}}(w) < Vu$.
- In Figure we have $V_{\mathrm{e}}(w) \geq V_{\mathrm{u}}$ if $w \geq w^*$ and $V_{\mathrm{e}}(w) < V_{\mathrm{u}}$ if $w < w^*$, and so w^* is the reservation wage that determines acceptance or rejection of job offers.



The Determination of the Unemployment Rate

- The reservation wage will change if there are shifts in either $V_{\mathrm{e}}(w)$ or V_{u}.
- For example, suppose that the unemployment benefit increases.
- This causes an increase in V_u from V_{u}^1 to V_{u}^2 in Figure.
- As a result, the reservation wage increases from w_1^* to w_2^*
- Thus, an increase in the unemployment benefit, there is a smaller cost to turning down a job to hold out for a higher wage offer, and an unemployed worker will then become more picky concerning the jobs that he or she will take.



Flow of Workers

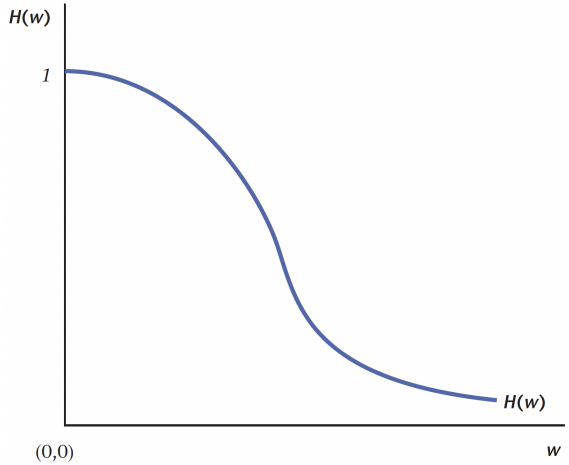
- In the model, there will be flows between the pool of employed workers and the pool of unemployed workers each period.
- Some employed workers will be separated from their jobs and become unemployed, while some unemployed workers will receive job offers that are sufficiently attractive to accept.
- If U is the unemployment rate-that is, the fraction of the labor force that is unemployed-then given that the separation rate is s, **the flow of workers from employment to unemployment** will be $s(1-U)$.
- Now, let $H(w)$ denote the fraction of unemployed workers receiving a wage offer whose offer is greater than w, where $H(w)$ is depicted in Figure below.
- Note that $H(w)$ is decreasing in w.
- Now, if unemployed workers choose a reservation wage, w^*, then, given that a fraction, p, of the unemployed receive a job offer and that a fraction, $H\left(w^*\right)$, of those receiving an offer are offered a wage greater than w^*, the portion of the unemployed who will be employed next period will be the fraction who receive a wage offer at or above their reservation wage.
- Therefore, **the flow of workers from unemployment to employment** will be $UpH\left(w_1^*\right)$

The Determination of the Unemployment Rate

- In a long-run equilibrium, the flow of workers from employment to unemployment must be equal to the flow of workers from unemployment to employment, and so we must have

$$s(1-U) = UpH\left(w^*\right).$$

- This equation determines the unemployment rate, U, given s, p, and the reservation wage, w^*.

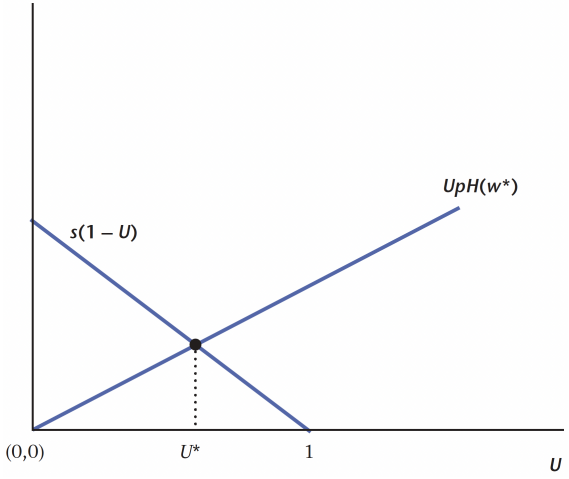


The Determination of the Unemployment Rate

- The Determination of the Unemployment Rate, U^*, in the One-Sided Search Model. In the figure, $s(1-U)$ is the flow of workers from employment to unemployment, and $UpH\left(w^*\right)$ is the flow of workers from unemployment to employment.

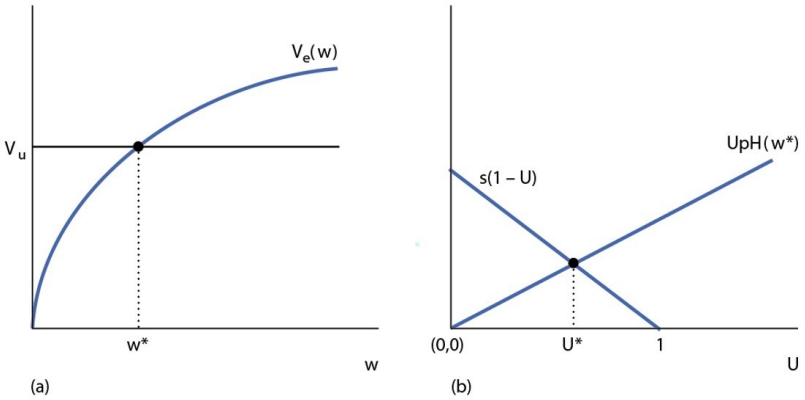
$$s(1-U) = UpH\left(w^*\right).$$

- In Figure we depict the left-hand and right-hand sides of Equation above, with the intersection of these two curves determining the long-run unemployment rate, U^*, which is determined by the intersection of the two lines.



The Determination of the Unemployment Rate

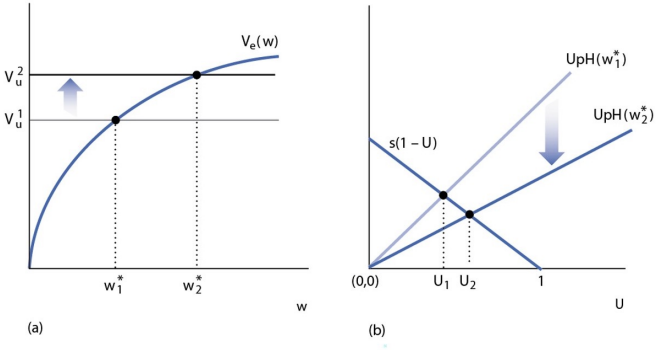
- Figures show how the reservation wage and the unemployment rate are determined in equilibrium.
- In Figure on the left, the reservation wage w^* is determined by the intersection of the V_{u} and $V_{\mathrm{e}}(w)$ curves, while Figure on the right determines the unemployment rate given the reservation wage, w^*.



An Increase in Unemployment Insurance Benefits, b

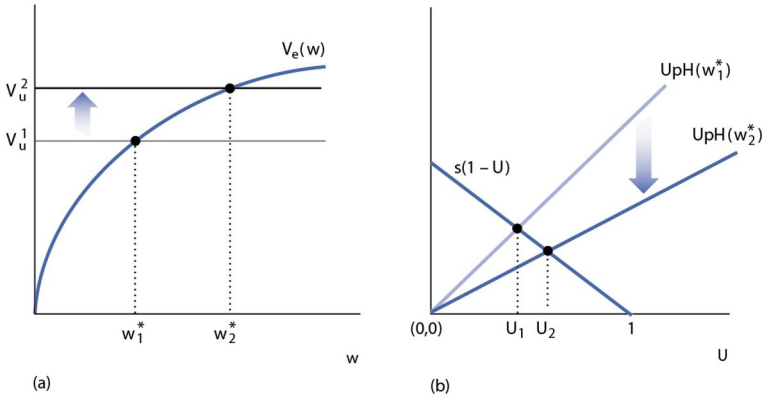
What are the possible effects of a change in UI benefits?

- The figure on the left, an increase in benefits, b, increases the welfare of the unemployed, V_{u}, from V_{u}^1 to V_{u}^2.
- The effect of this is to increase the reservation wage from w_1^* to w_2^*.
- This then implies that the fraction of unemployed workers receiving an acceptable wage offer is smaller.
- That is, since $H(w)$ is decreasing in w, we have $H\left(w_2^*\right) < H\left(w_1^*\right)$.



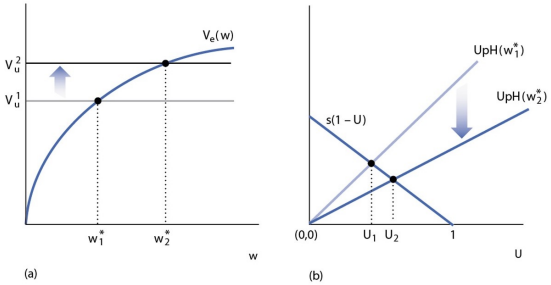
An Increase in Unemployment Insurance Benefits, b

- The figure on the right, this implies that the line $UpH\left(w_1^*\right)$ shifts down to $UpH\left(w_2^*\right)$
- As a result, the unemployment rate increases from U_1 to U_2 in the long run.



An Increase in Unemployment Insurance Benefits, b

- The intuition behind this result is that more generous UI benefits imply that unemployed workers can afford to be more picky about the jobs they accept.
- On average, then, spells of unemployment will tend to be longer, and the long-run unemployment rate must increase.
- Relatively higher unemployment insurance benefits in part explain higher average unemployment rates in Europe and Canada than in the United States.



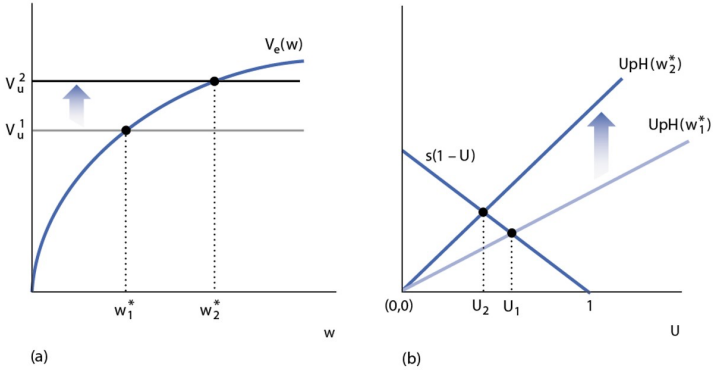
An Increase in the Job Offer Rate, p

What are the possible effects of an increase in the job offer rate, p, on the reservation wage and the long-run unemployment rate?

- Suppose the job offer rate, p, increases.
- Such a change would result from an increase in the efficiency with which firms and unemployed workers are matched.
- This could occur for two reasons. First, there might be technological change, such as better information technology, which could increase the likelihood of matches between unemployed workers and firms with vacancies.
- For example, the Internet greatly increases an unemployed worker's ability to find work at low cost such as Linkedin etc.
- Second, p could increase because of government intervention.
- In many countries, the government plays an active role in finding work for unemployed workers, through government-run employment centers and the like.

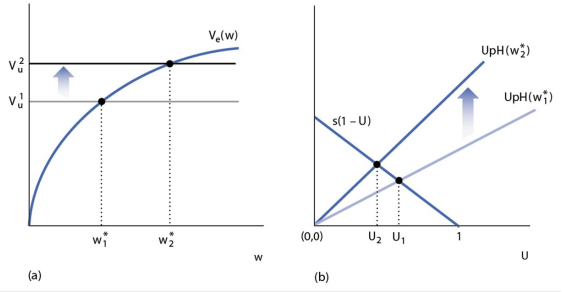
An Increase in the Job Offer Rate, p

- Figures show the long-run equilibrium effects of an increase in p.
- When p increases, this raises the welfare of the unemployed from V_{u}^1 to V_u^2 in the figure of right.
- As a result, the reservation wage increases from w_1^* to w_2^*, since unemployed workers can now afford to be more picky, as they will not have to wait as long for another wage offer if the current offer is turned down.



An Increase in the Job Offer Rate, p

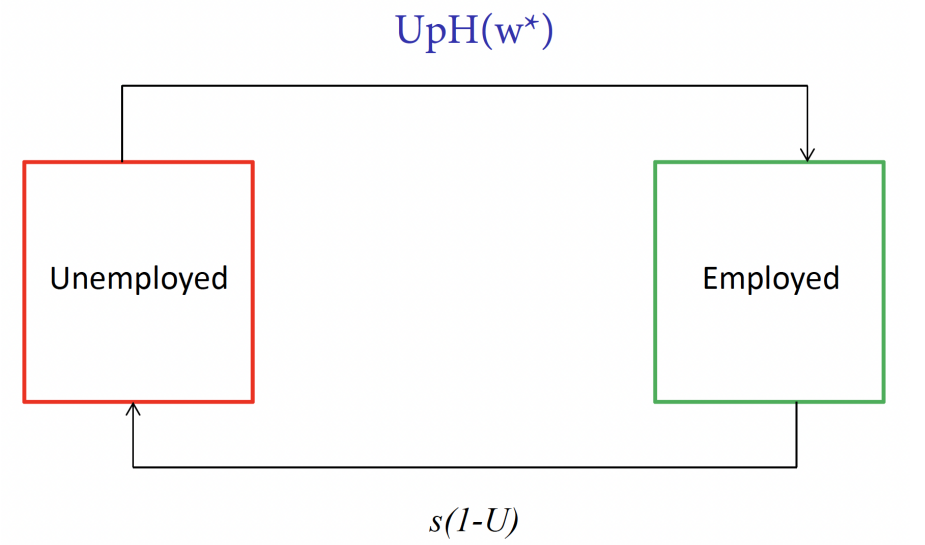
- There are two effects on the flow of workers from unemployment to employment.
- **The direct effect** is that an increase in p from p_1 to p_2 increases the flow of workers from unemployment to employment, since job offers are now received at a higher rate.
- This shifts the line $\mathrm{UpH}\,H\left(w^*\right)$ up.
- **The indirect effect** is that the reservation wage rises, reducing $H\left(w^*\right)$, the fraction of workers receiving a job offer who accept the offer.
- It is not clear whether $\mathrm{UpH}\left(w^*\right)$ will rise or fall, but in the figures it is shown that it increasing from $Up_1H\left(w_1^*\right)$ to $Up_2H\left(w_2^*\right)$, which implies that the unemployment rate falls in long-run equilibrium from U_1 to U_2.
- **However**, if the indirect effect is greater than the direct effect, the unemployment rate will rise.



An Increase in the Job Offer Rate, p

- The implications of this for government policy are important.
- If the government uses resources to find work for unemployed workers, then this may be counterproductive if its goal is to decrease the unemployment rate.
- It may be the case that unemployed workers simply become more picky about acceptable jobs, causing the unemployment rate to rise.
- Also, workers may or may not be better off as a result. The welfare of the unemployed is affected positively, because unemployed workers have better choices, and the employed will in general be working at higher-paying jobs, but there is a cost of the government's unemployment program that will ultimately have to be financed through taxation, and this will reduce the welfare of those taxed.
- **The net effect of an increase in the job offer rate on economic welfare is therefore uncertain.**

The Bathtub Model of Unemployment



The Bathtub Model of Unemployment

- Let u_t denote the number of unemployed workers in period t. This is predetermined and cannot change within period t.
- Denote the job separation rate by s and the job finding rate by f. Think of these as time invariant parameters.
- Unemployment evolves over time according to the following law of motion:

$$u_{t+1} - u_t = -f u_t + s\left(1 - u_t\right).$$

- Equation says that the change in unemployment between t and $t+1$, i.e. $u_{t+1} - u_t$, depends negatively on matches, $f u_t$, and positively on separations, where $s\left(1 - u_t\right)$ denotes the number of separated workers in period t.

The Bathtub Model of Unemployment

- If matches exceed separations, the unemployment rate declines. If separations exceed job finding, the unemployment rate increases.
- Similarly to the growth models considered in growth lecture, there exists a steady state in which the unemployment rate is constant, which means $u_{t+1} = u_t = u^*$.
- Imposing this condition yields

$$0 = -fu^* + s\left(1 - u^*\right) \Leftrightarrow u^* = \frac{s}{s+f}$$

- Equation shows that the steady state unemployment rate is higher when the separation rate is higher or the finding rate is lower.
- Similar to models of long run growth, if $u_t < u^*$ then the economy will transition to a higher unemployment rate and vice-versa.

The Bathtub Model of Unemployment

- Let's consider some numbers based on real-world data.
- The job finding rate for the first few months of 2016 hovered around 25 percent.
- The layoffs and discharges rate was around 1.2 percent and the quit rate was around 2 percent.
- Since many people who quit are transferring to another job rather than entering unemployment, it would not be correct to count them as separations in this model.
- Suppose one quarter of quits transition to unemployment. Then, the separation rate is $0.25(2) + 1.2 = 1.7$ percent.

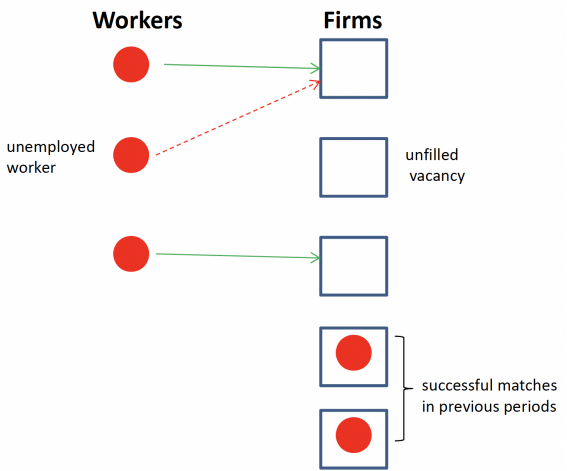
The Bathtub Model of Unemployment

- If the separation and job finding rate remain the same going forward in time, the long run unemployment rate would be:

$$u^* = \frac{0.017}{0.017 + 0.25} = 0.064$$

- Hence, the long run unemployment rate is around 6.4 percent.
- At the beginning of 2016 the unemployment rate was 4.7 percent.
- If our numbers for the separation and job finding rates are correct and constant, we would have expected the unemployment rate to rise from that time. This is in fact not what has happened, where the unemployment rate has continued to decline into 2018.

One-Sided Search Model of Unemployment



A Two-Sided Model of Search and Unemployment

A Two-Sided Model of Search and Unemployment

The model is based on Mortensen and Christopher (1994) [1]

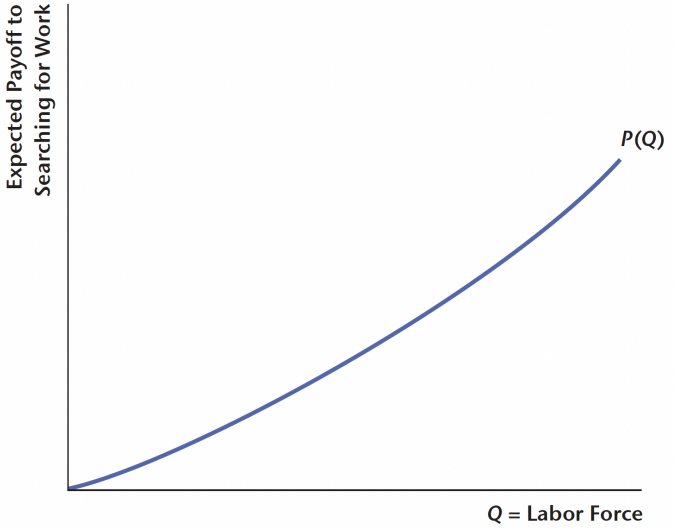
- Two-sided model: considers the supply side (one-sided model), and the demand side.
- As in the previous model, there is one period, but in this search model there are many **consumers and firms**, rather than a single representative consumer and a single representative firm.
- There are N consumers, who are all potential workers, so we can think of N as the working-age population.
- The number of firms is endogenous, to be determined by the model.

Consumers

- Each of the N consumers can choose to work outside the market or to search for market work.
- Let $\mathcal{Q}$ denotes the quantity of consumers who decide to search for work, so that $N - \mathcal{Q}$ is the number of consumers who choose home production.
- $\mathcal{Q}$ can be interpretted as the labor force, and $N - \mathcal{Q}$ as those working-age people not in the labor force.
- Let $P(\mathcal{Q})$ define a supply curve for workers who choose to search for market work.
- Thus, $P(\mathcal{Q})$ represents the expected payoff to searching for market work that would induce $\mathcal{Q}$ consumers to search.

The Supply Curve of Consumers Searching for Work

- The supply curve $P(\mathcal{Q})$ is depicted in Figure.
- In the figure, the supply curve is upward-sloping because the value of home production is different for different consumers.
- Therefore, if the expected payoff from searching is higher, this induces more consumers to forego home production to search for market work.



Firms

- In order to produce, a firm must post a vacancy in order to (hopefully) match with a worker.
- Recruiting workers is costly, in that we assume it costs the firm k (in units of consumption goods) to post a vacancy.
- Firms that do not post a vacancy are inactive and cannot produce.
- Let A denote the number of active firms, which is the number that choose to post vacancies.

Matching and Matching Function

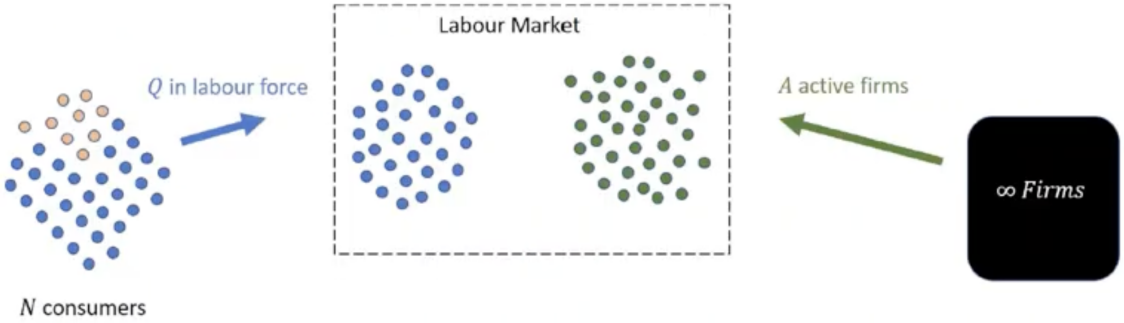
- At the beginning of the period, there will be $\mathcal{Q}$ consumers searching for work and A firms posting vacancies.
- Matching workers with firms is a time-consuming and costly process.
- In general, firms are very different from each other in the kinds of jobs they offer, and workers have very different characteristics.
- This makes the process of matching firms with workers difficult.
- In standard models of labor search, difficulties in matching are captured by a **matching function**.
- Letting M denote the number of successful matches between workers and firms, M is determined by

$$M = em(\mathcal{Q}, A) \tag{5}$$

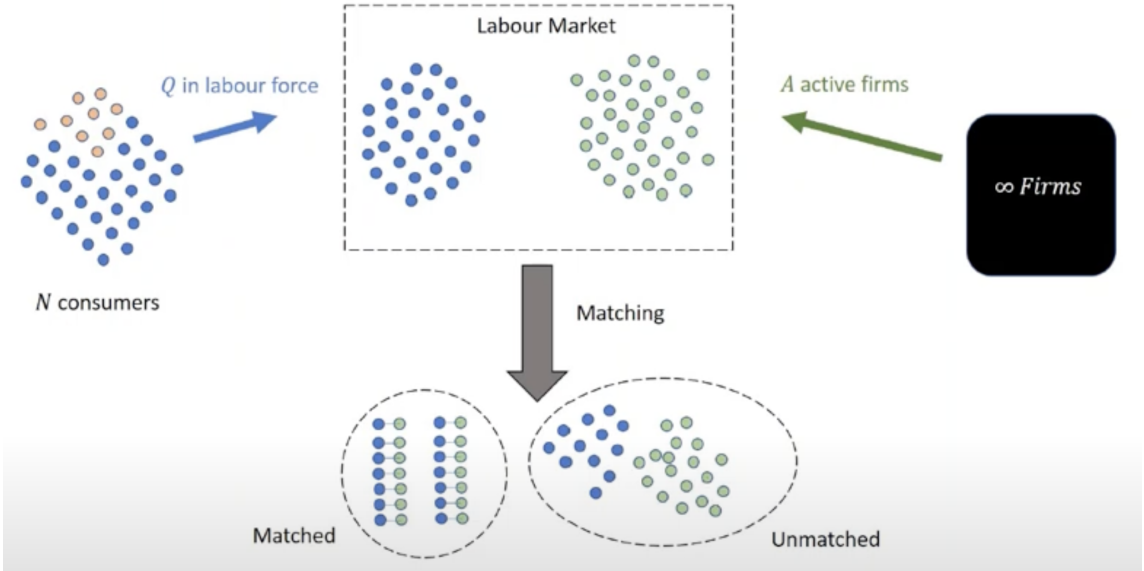
Matching

- Matchin in Eq-5, the matching function on the right-hand side of the equation is much like a production function that "produces" matches between workers and firms as "output," given "inputs" of searching consumers and firms.
- The variable **e** denotes **matching efficiency**, and plays much the same role as does total factor productivity in the production function.
- With higher e, more matches occur given the numbers of consumers and firms searching.
- Matching efficiency, e, can increase in practice due to better information, for example more efficient search technologies such as Internet advertising, or because the skills that consumers have are better-matched to the skills that firms want.

Search and Matching



Search and Matching



Matching Function

- The function m has properties that are very similar to the function F described in the context of production.

1. The function m has constant returns to scale. Recall that this means that

$$\mathrm{em}(x\mathcal{Q}, xA) = \mathrm{xem}(\mathcal{Q}, A) \tag{6}$$

   for any $x > 0$.
   For the matching function, constant returns to scale implies that a large economy is no more efficient at producing matches between workers and firms than a small economy, and vice versa.
2. If there are no consumers searching for work or no firms searching for workers, then there are no matches, or $m(0, A) = m(Q, 0) = 0$.
3. The number of matches M increases when either $\mathcal{Q}$ or A increases.
4. Marginal products are diminishing, in that the increase in matches obtained for a one-unit increase in $\mathcal{Q}$ decreases as $\mathcal{Q}$ increases, and similarly for A.

The Supply Side of the Labor Market: Optimization by Consumers

- If a consumer chooses to search for work, he or she may find a job, in which case the consumer would be counted as **employed** by national statistics institutions (ONS or BLS).
- However, the consumer may not find work even if he or she chooses to search.
- In that case the consumer would be counted as **unemployed**, since he or she has been actively engaged in search, but is not employed.
- If the consumer finds work, he or she earns the real wage w, and we will assume that, if unemployed, the consumer receives an unemployment insurance (UI) benefit b.
- Thus, the consumer knows his or her value of home production, the wage if he or she finds work, and the unemployment benefit if he or she is unemployed.
- The consumer also knows the chances of finding work, given by the matching function.
- If there are $\mathcal{Q}$ consumers searching and M successful matches, then for an individual consumer, the probability of finding work is $M/\mathcal{Q}$ or from the matching function Equation-5,

$$p_c = \frac{em(\mathcal{Q}, A)}{\mathcal{Q}} \tag{7}$$

The Supply Side of the Labor Market: Optimization by Consumers

$$p_c = \frac{em(\mathcal{Q}, A)}{\mathcal{Q}}$$

where p_c is the probability of finding work for a consumer.

- Then, given the constant-returns-to-scale property of the matching function, setting $x = 1/\mathcal{Q}$ in Equation-6, and defining $j \equiv A/\mathcal{Q}$, from Equation-7 we get

$$p_c = em\left(1, \frac{A}{\mathcal{Q}}\right) = em(1, j). \tag{8}$$

- Therefore, from Equation-8, the probability of finding work for a consumer depends only on the ratio $j = A/\mathcal{Q}$, which is the ratio of firms searching for workers relative to consumers searching for work.
- This ratio is a measure of **labor market tightness**.

The Supply Side of the Labor Market: Optimization by Consumers

Since Equation-8 gives the probability of finding work for a consumer, the probability of being unemployed if a consumer chooses to search for work is then

$$1 - p_c = 1 - em(1, j) \tag{9}$$

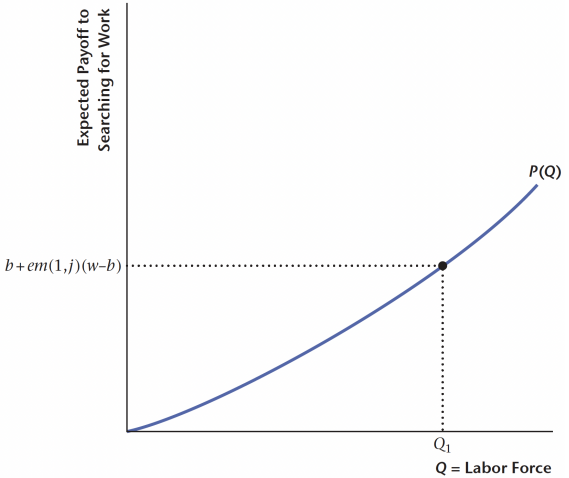
- Recall that $P(Q)$ defines the supply curve for the number of consumers choosing to search for work,Q.
- In equilibrium, $P(Q)$ must be equal to the expected payoff a consumer receives from searching, so

$$P(Q) = p_c w + (1 - p_c)\, b = b + em(1, j)(w - b) \tag{10}$$

- In Equation 10, the expression after the first equality is the expected payoff the consumer obtains from searching for work - the probability of finding a job multiplied by the market wage, plus the probability of being unemployed multiplied by the unemployment insurance benefit.
- The expression after the second equality is obtained by substituting for p_c using Equation-8.

The Supply Side of the Labor Market: Optimization by Consumers

- Figure is an illustration of Equation-10.
- The "market price" for searching workers, or the expected payoff to searching for work on the vertical axis, is determined by the market wage w, the UI benefit b, and market tightness j.
- Then, given this market price, the supply curve for searching workers determines the quantity of searching workers $\mathcal{Q}$.
- A worker in a competitive equilibrium model observes the market wage and then decides how much labour to sell on the market at that wage.
- However, in the two-sided search model, a would-be worker takes into account not just the market wage, but his or her chances of finding work and the UI benefit if his or her job search fails.



The Demand Side of the Labor Market: Optimization by Firms

- Firms bear the cost k of posting a vacancy have a probability $p_f = M/A$ of finding a worker,
- Then, we obtain

$$p_f = \frac{em(\mathcal{Q}, A)}{A} = em\left(\frac{\mathcal{Q}}{A}, 1\right) = em\left(\frac{1}{j}, 1\right), \tag{11}$$

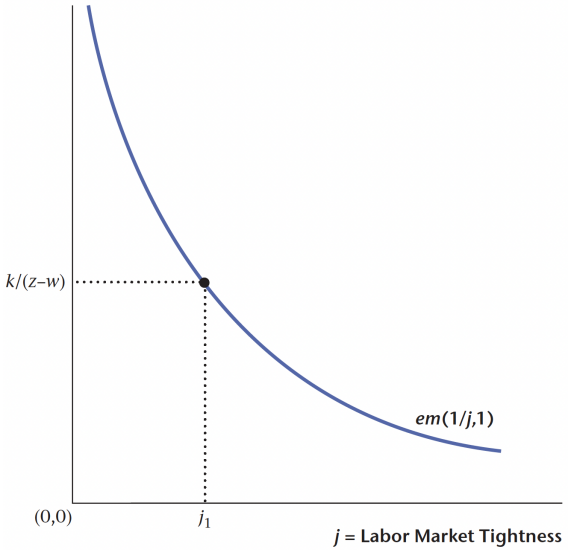
  where the second equality follows from Equation-6, the constant-returns-to-scale property of the matching function.
- Given a successful match with a worker, the firm and worker produce output z,
- So the profit the firm receives from the match is $z - w$, or output minus the wage paid to the worker.

The Demand Side of the Labor Market: Optimization by Firms

- Firms will enter the labor market, posting vacancies, until the expected net payoff from doing so is zero, or $p_f(z-w)-k=0$.
- Given Equation-11, we can write this equation as

$$em\left(\frac{1}{j},1\right)=\frac{k}{z-w}, \qquad (12)$$

  which determines labor market tightness j, given the wage w, productivity z, and the cost of posting a vacancy k.
- This is depicted in Figure, where, given $k/(z-w)$, labor market tightness is j_1.



Equilibrium

- When a firm is matched with a worker, together they can produce output z where one firm and one worker produce z units of output.
- The firm and worker need to come to an agreement concerning the wage w that the worker is to receive.
- In economic theory, there is a large body of work that addresses how economic agents bargain, with one particularly famous contribution made by **John Nash**, who developed what is now known as **Nash bargaining theory**.
- In the Nash bargaining solution, two individuals strike a bargain that depends on what each person faces as an alternative if the two cannot agree, and on the relative bargaining power of the two people.
- Critical to the solution in the case of the firm and the worker in our setup is the notion of **surplus**: the surplus the worker receives as a result of the bargain; the surplus the firm receives;
- And the total surplus available to the firm and the worker, which is what they collectively stand to gain from coming to an agreement.
- In this case, the worker will receive a surplus of $w - b$, which is the wage the worker receives minus the employment insurance benefit, where b represents the alternative for the worker if he or she cannot come to an agreement with the firm.
- The firm's surplus is $z - w$, which is the profit the firm makes.
- Then, if we add the worker's surplus and the firm's surplus, we obtain total surplus, which is $z - b$.

Equilibrium

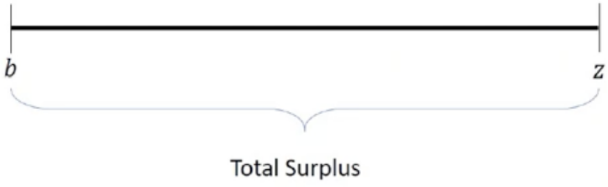
- Nash bargaining theory in this circumstance dictates that the firm and the worker will each receive a constant share of the total surplus.
- Let a denote the worker's share of total surplus, where $0 < a < 1$. Here a represents the bargaining power of the worker.
- Then, the worker and firm agree to a contract such that the worker's surplus is a fraction a of total surplus, or

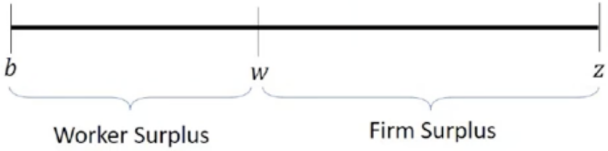
$$w - b = a(z - b), \tag{13}$$

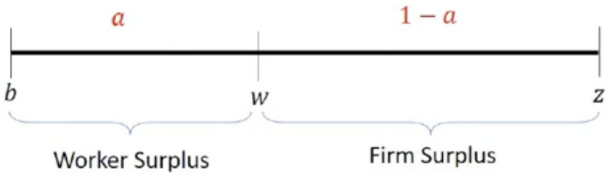
$$w = a(z - b) + b$$

so if we solve Equation13 for the wage, we obtain

$$w = az + (1 - a)b \tag{14}$$


b
z
Total Surplus


b
w
z
Worker Surplus
Firm Surplus


a
1 − a
b
w
z
Worker Surplus
Firm Surplus

Equilibrium

- Then, the last step to determine an equilibrium solution is to substitute for w in Equations-10 and 12 using Equation-14, obtaining

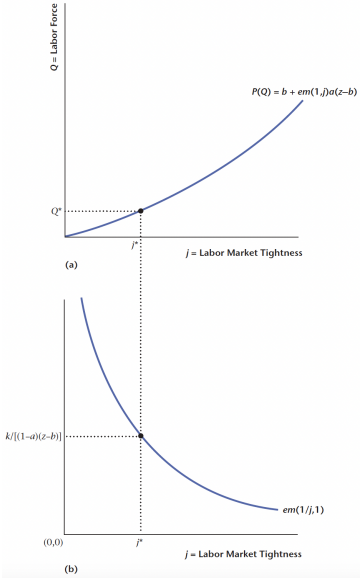
$$P(Q) = b + em(1, j)a(z - b), \qquad (15)$$

and

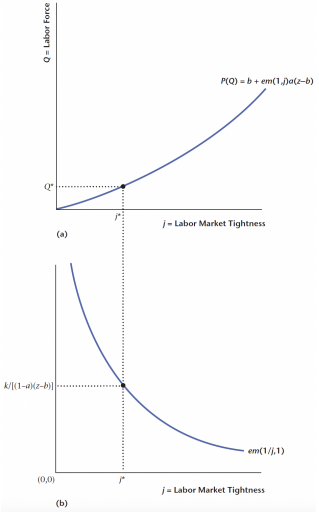
$$\text{em}\left(\frac{1}{j}, 1\right) = \frac{k}{(1-a)(z-b)}, \qquad (16)$$

and then Equation-15 and 16 solve for the endogenous variables j and $\mathcal{Q}$.

- We depict the two Equations 15 and 16 in Figure.



Equilibrium



- In panel (b) of the figure, we depict Equation-16, which determines labor market tightness j.
- The smaller is the cost of posting a vacancy, k, relative to the firm's share of total surplus $(1-a)(z-b)$, the greater will be the inducement for firms to post vacancies and enter the labor market, which will make j larger.
- In panel (a) of the figure, Equation-13 describes an upward-sloping relationship between $\mathcal{Q}$ and j, which is the relationship defined by Equation-15.
- If labor market tightness j is higher, then the chances of finding a job are greater for consumers, more of them will decide to search for work, and therefore $\mathcal{Q}$ will be higher.
- For example, in Figure higher j increases the expected payoff to searching for work, and then a higher supply of searching workers, $\mathcal{Q}$, is forthcoming.
- In Figure, given labor market tightness j^* determined in panel (b); in panel (a) we determine the quantity of consumers who choose to search, $\mathcal{Q}^*$.

Equilibrium

- Once we have determined j and $\mathcal{Q}$, we can work backward to determine all other variables of interest.
- First, the number of consumers who do not search for work is $N - \mathcal{Q}$, and these are the people who would be counted as not in the labor force.
- Second, since $\mathcal{Q}$ is the number of people in the labor force, the unemployment rate is

$$u = \frac{Q\left(1 - p_c\right)}{Q} = 1 - em(1, j), \tag{17}$$

  using Equation-9.
- Similarly, the vacancy rate is the number of vacancies that go unfilled, relative to the number of jobs that were originally posted, so the vacancy rate is

$$v = \frac{A\left(1 - p_f\right)}{A} = 1 - em\left(\frac{1}{j}, 1\right) \tag{18}$$

- Finally, the quantity of aggregate output in this economy is $Y = Mz$, which is the number of matches multiplied by the output produced in each match.
- From Equation- $M = em(\mathcal{Q}, A)$, and using the constant-returns-to-scale property of the matching function, we can express aggregate output as

$$Y = em(Q, A)z = Qem(1, j)z. \tag{19}$$

- In Equation-19, aggregate output is then increasing in $\mathcal{Q}$ and increasing in j.
- Thus, if there is a larger labor force or a tighter labor market, aggregate output will be higher.

Working with the Two-Sided Search Model

Various experiments

1. An increase in the unemployment insurance benefitt, b (propping up incomes in recessions)
2. An increase in productivity, z (expansion)
3. A decrease in matching efficiency, e (sectoral mismatch)

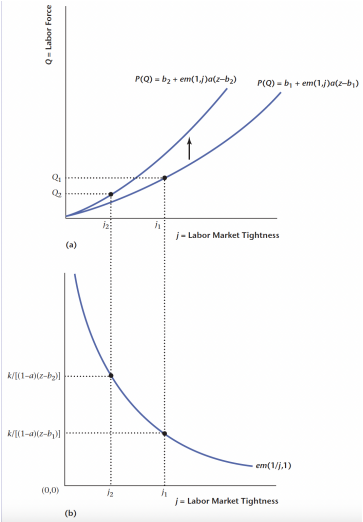
Equations to keep track of

Eqm equations:

$$\begin{cases} P(Q) = b + em(1,j)(w-b) = b + em(1,j)a(z-b) \\ em\left(\frac{1}{j},1\right) = \frac{k}{z-w} = \frac{k}{(1-a)(z-b)} \end{cases}$$

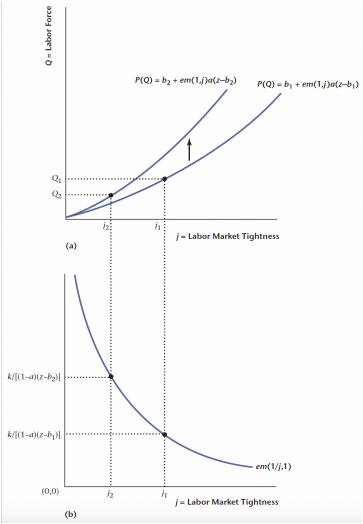
Outcomes of interest:

$$u = 1 - p_c = 1 - em(1,j)$$
$$v = 1 - p_f = 1 - em\left(\frac{1}{j},1\right)$$
$$Y = Q \cdot z \cdot e \cdot m(1,j)$$

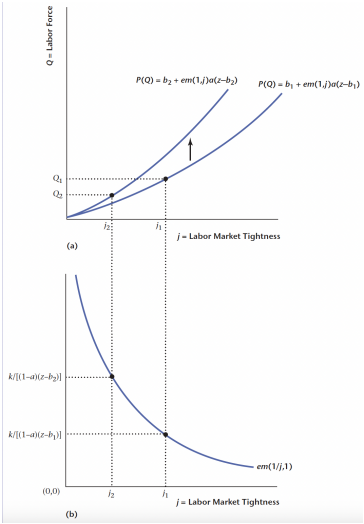


An Increase in the UI Benefit

- If the UI benefit b increases, this has the effect of reducing the total surplus from a match between a worker and a firm, $z - b$, and increasing the wage, w, from Equation-14.
- In Figure, initial labor market tightness is j_1 and initially there are $\mathcal{Q}_1$ consumers in the labor force. With the reduction in total surplus, in panel (b) of the figure, $k/[(1-a)(z-b)]$ increases, and this causes labor market tightness to fall to j_2 in equilibrium, since posting vacancies has now become less attractive for firms.
- In panel (a), the increase in b and decrease in total surplus causes the curve to shift up, as the expected payoff to searching for work increases.



- Then, in equilibrium the labor force $\mathcal{Q}$ could rise or fall, though it is shown decreasing in the figure, to $\mathcal{Q}_2$.
- Because labor market tightness has decreased, this makes job market search less attractive for consumers, and this tends to reduce the size of the labor force.
- However, the increase in the employment insurance benefit b acts to make labor search more attractive, which tends to increase $\mathcal{Q}$.
- With two effects working in different directions, the net effect on the labor force is ambiguous.
- However, from Equations-17 and -18, it is clear that the unemployment rate must rise and the vacancy rate must fall, because of the reduction in labor market tightness, which acts to reduce the probability of finding a job for a consumer, and increase the probability of a successful match for a firm posting a vacancy.



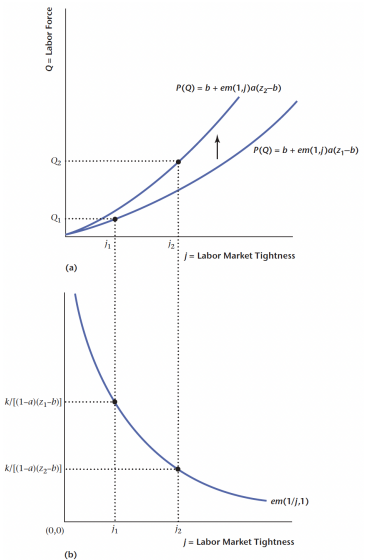
- In terms of aggregate output, from Equation -19, the effect is ambiguous.
- Lower labor market tightness j acts to reduce output, but Q may rise or fall, there could be a decrease or an increase in aggregate output.
- Our intuition might tell us that better social insurance, provided through UI, should reduce real GDP, since people will be less inclined to work.
- However, the model tells us that it is possible that more generous UI could have the effect of drawing more people into the labor force and therefore increasing aggregate output.
- These results in the model are broadly consistent with observations on average unemployment rates across different countries. In particular, the unemployment rates in Canada and Western Europe have tended historically to be higher than in the US
- It is consistent with our model, in that UI is more generous in Canada and Western Europe than in the United States. In general, higher UI benefits act to encourage job search and to increase unemployment.

An Increase in the UI Benefit: Summary

- $z - b$, and the firm's surplus $(1 - a)(z - b) \Rightarrow$ less attractive to post vacancies $\Rightarrow j \downarrow$
- Two counteracting effects on Q: higher b encourages consumers to search, but the chances of finding a job are lower (since lower j) $\Rightarrow$ the end effect on labor force Q is ambiguous.
- Unemployment rate unambiguously rises
- Vacancy rate unambiguously falls
- The effect on output ambiguous; output falls for sure if Q falls

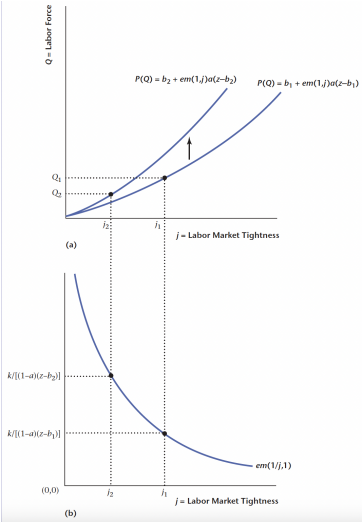
$$
\begin{aligned}
em\left(\frac{1}{j}, 1\right) &= \frac{k}{z - w} = \frac{k}{(1 - a)(z - b)} \\
P(Q) &= b + em(1, j)(w - b) = b + em(1, j)a(z - b) \\
w &= az + (1 - a)b \\
u &= 1 - p_c = 1 - em(1, j) \\
v &= 1 - p_f = 1 - em\left(\frac{1}{j}, 1\right) \\
Y &= Q \cdot z \cdot e \cdot m(1, j)
\end{aligned}
$$

An Increase in Productivity



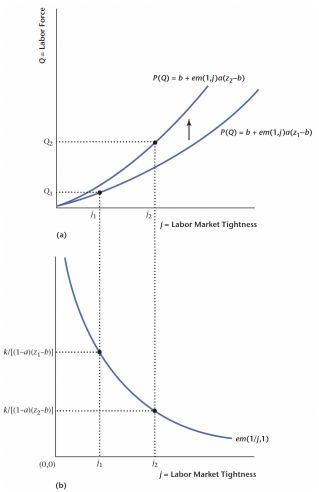
- Next we consider what happens when productivity, z, increases. In Figure, panel (b), this acts to reduce $k/[(1-a)(z-b)]$ and so labor market tightness increases in equilibrium from j_1 to j_2.
- This occurs because higher productivity increases the total surplus available from a match between a firm and a worker, and firms then find it more attractive to post vacancies.
- Then, in panel (b) of Figure, higher z shifts up the curve, and so the labor force increases from Q_1 to Q_2, since consumers find it more attractive to enter the labor force, both because wages are higher and because the chances of finding a job are greater.
- From Equations -17 and -18, since labor market tightness has risen, the unemployment rate falls and the vacancy rate rises.

An Increase in Productivity



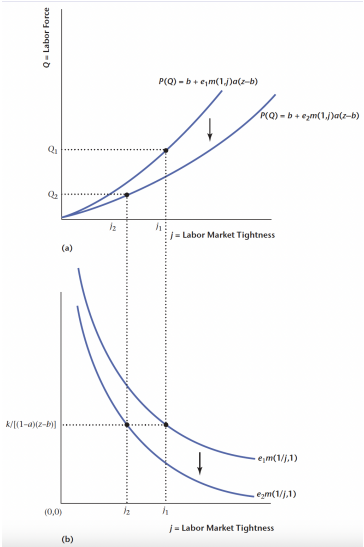
- These predictions are consistent with both long-run observations and the comovements in labor market variables over the business cycle.
- In terms of matching long-run observations, first, we observe an increase over time in productivity in the United States, we see that this coincides with an increase in the labor force participation rate over most of the sample.
- Second, data for the US documents a trend increase in output over time in the United States, which is explained in the model as arising from a productivity increase.
- Third, we observe between 1960 and 2000, a trend increase in the employment/population ratio, which is consistent with the observed trend increase in productivity over that period, and the predictions of the model.

An Increase in Productivity



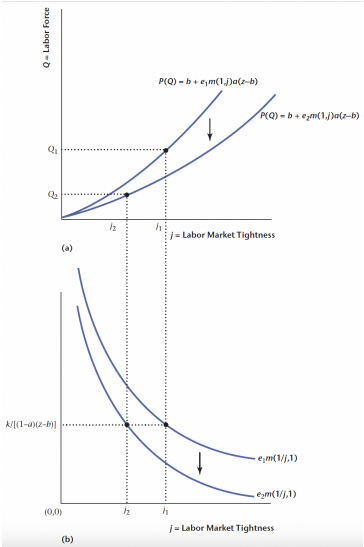
- An increase in productivity in the model also produces an increase in employment (employment is procyclical),
- an increase in the labor force participation rate (labor force participation is procyclical),
- an increase in the vacancy rate (the vacancy rate is procylical),
- and a decrease in the unemployment rate (the unemployment rate is countercyclical).
- All of these predictions of the model are consistent with the data.
- It is important to note that the increase in the vacancy rate and the decrease in the unemployment rate in response to a productivity increase will imply that productivity shocks will produce a downward-sloping Beveridge curve.

Decrease in Matching Efficiency



- The factor e in the matching function represents matching efficiency, which is the ease with which firms and workers can get together.
- Matching efficiency can increase through better information technologies that speed up the matching of jobs with particular skill requirements with workers who have particular skills.
- More importantly, particularly for short-run phenomena, matching efficiency can decrease when the degree of mismatch between the skills firms need and the skills consumers possess increases.
- This can occur, for example, when there is a sectoral shock to the economy. A sectoral shock could be any shock to consumers' preferences or to production technologies that causes factors of production to migrate across sectors of the economy.
- A sector could be defined by the type of product produced, or by geography.
- Examples of changes, economy resulting from sectoral shocks are the long-run shift in production in the United States from manufacturing to services, and the shift in automobile production from the north to the south.

Decrease in Matching Efficiency



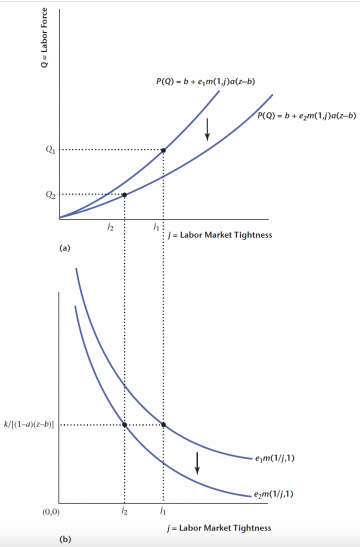
- Sectoral shocks produce mismatch in the labor market, either because the skills of workers leaving a declining sector do not match the skills required in a growing sector (e.g., textile workers do not have the skills required to work in financial services), or because unemployed workers and vacancies are located in different geographical areas (e.g., unemployed auto workers in Michigan find it costly to move to Alabama to fill job vacancies).

- In Figure we show the effects of a decrease in matching efficiency. In panel (b) of the figure, the decrease in e acts to shift the curve to the left, so that labor market tightness falls from j_1 to j_2.

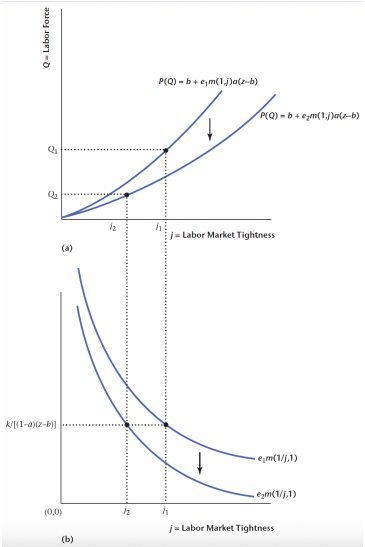
- Essentially, because firms find it more difficult to find the right workers, entry of firms into the labor market decreases, and the labor market becomes less tight. In panel (a) of the figure, the curve shifts to the left, and so Q must fall from Q_1 to Q_2.

Decrease in Matching Efficiency

- Thus, fewer consumers choose to search for work (the labor force contracts) because the chances of finding work are lower, and the chances of finding work are lower for two reasons.
- First, lower matching efficiency reduces the probability of a match and, second, there are fewer firms searching.
- From Equation-17, the unemployment rate must rise when e falls, since j and e have fallen. With respect to vacancies there are two effects working in different directions.
- In Equation-18, the decrease in labor market tightness acts to increase vacancies, but the decrease in e decreases vacancies.
- However, from Equation-16, we know that the right-hand side does not change when e changes, so the left-hand side remains unchanged as well, so from Equation-18 the vacancy rate must remain constant.
- Therefore, since $\mathcal{Q}$ falls and $j = A/Q$ also falls, A must fall as well.



Decrease in Matching Efficiency



- As a result, from Equation-19 aggregate output must go down, since $e, 2$, and j have all fallen.
- Thus, a decrease in the efficiency of matching, for example because of an increase in the mismatch of skills with jobs in the labor market, results in a smaller labor force, fewer job postings, a higher unemployment rate, lower aggregate output, and no change in the vacancy rate.
- All of these predictions are consistent with observations from the 2008-2009 recession, and the recovery from the recession.
- In particular, a decrease in matching efficiency can cause the shift to the right in the Beveridge curve that we observe after late 2009 in Figure 6.8, in that lower e causes the unemployment rate to increase with no effect on the vacancy rate.

Summary

- The key determinants of the unemployment rate are aggregate economic activity, demographics, government intervention, and sectoral shifts.
- The participation rate is affected by demographics and by the different labor market behavior of men and women.
- The unemployment rate is a countercyclical variable, whereas the participation rate is procyclical.
- The employment/population ratio is more cyclically variable than is the participation rate.
- The Beveridge curve is a downward-sloping relationship between the unemployment rate and the vacancy rate. A Beveridge curve relation can be observed in the data, though the Beveridge curve appears to shift at the end of 2009.
- In the two-sided search model, firms pay a cost to post a vacancy, and consumers must decide whether to work at home or to search for market work.

Summary

- In the two-sided search model, when a worker is matched with a firm, they bargain over the wage, which is determined by the outside opportunities of the worker and the firm, and by relative bargaining power.
- The two-sided search model determines labor market tightness (the ratio of firms searching to consumers searching for work), labor force, market wage, vacancy rate, unemployment rate, and real GDP.
- An increase in the UI benefit acts to reduce the surplus of a firm in a match, which acts to reduce labor market tightness, increase the unemployment rate, and reduce the vacancy rate. The size of the labor force may rise or fall, as may aggregate output.
- In the two-sided search model, an increase in productivity acts to increase the surplus of both workers and firms in matches, and this increases labor market tightness and the size of the labor force. The unemployment rate falls, the vacancy rate rises, and aggregate output rises.

Summary

- A decrease in matching efficiency reduces labor market tightness and the size of the labor force.
- The unemployment rate increases, the vacancy rate does not change, and aggregate output falls.
- Changes in matching efficiency are a potential explanation for the recent behavior of unemployment and vacancies in the United States.

Eqm equations:

$$\begin{cases} P(Q) = b + em(1,j)(w-b) = b + em(1,j)a(z-b) \\ em\left(\frac{1}{j},1\right) = \frac{k}{z-w} = \frac{k}{(1-a)(z-b)} \end{cases}$$

Outcomes of interest:

$$u = 1 - p_c = 1 - em(1,j)$$
$$v = 1 - p_f = 1 - em\left(\frac{1}{j},1\right)$$
$$Y = Q \cdot z \cdot e \cdot m(1,j)$$

Source: Chapter 6, Macroeconomics, Global Edition, 6th edition