Economics II – Macroeconomics

IX. Technological progress, unemployment, and living standards in the long run

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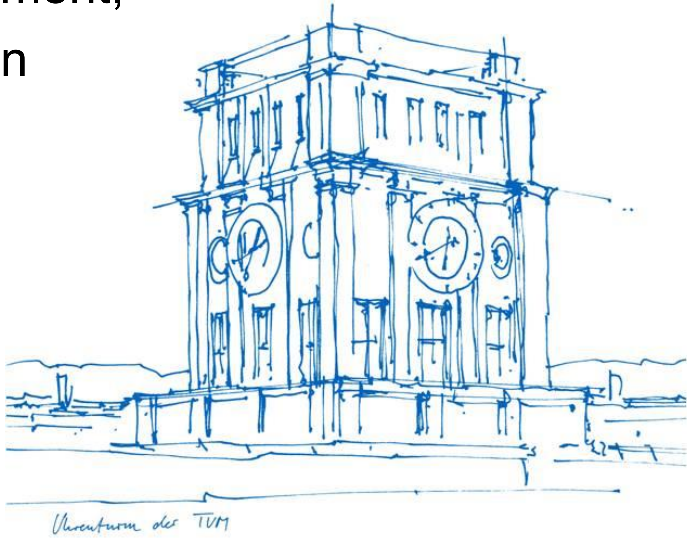

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Outline

IX. Technological progress, unemployment, and living standards in the long run

The Economy Ch. 16

- **I. The context**
- II. The Solow Model
- III. Job creation and unemployment
- IV. Long-run Labour Market Model

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The context

- Technological change improves long-run living standards but can cause short-run unemployment by replacing labor.

- However, long-run patterns of unemployment across countries are not entirely explained by national differences in innovation over time.
  - How can institutions and policies explain these differences?
  - How can we model the effects of institutions and policies on long-run unemployment and economic growth?

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Technological progress and living standards

- Firms can earn **innovation rents** by introducing new technology.
- Firms that cannot keep up with innovation eventually fail (**creative destruction**).

Technological progress and **capital goods** accumulation are complementary:

- New technologies require new machines
- Technological advance is needed for increasingly capital-intensive methods of production to be profitable.
- This process allows a sustained increase in average living standards.

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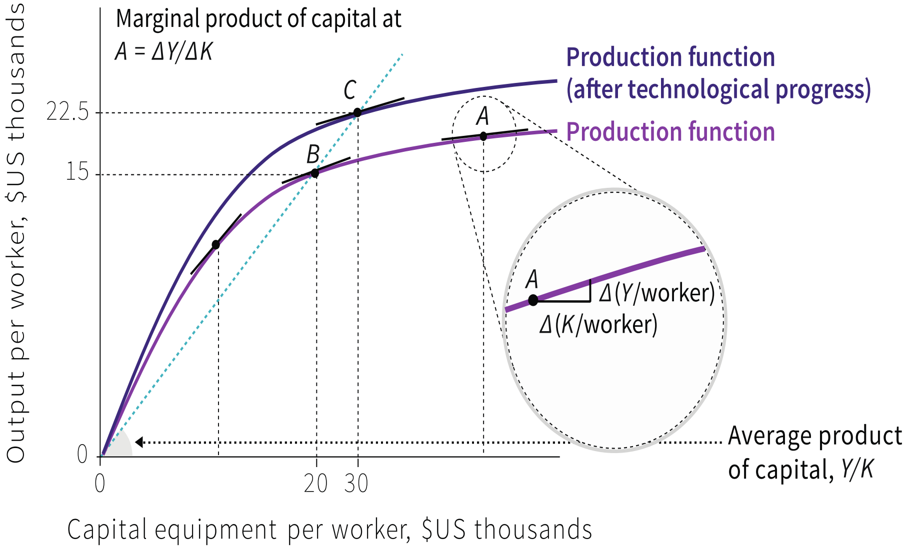
Modelling technological progress

Capital intensity of production: capital goods per worker

Labour productivity: output per worker

Technological progress rotates the production function upwards.

- This increases the APL and offsets the **diminishing marginal returns to capital**…
- Which makes it profitable to invest, leading to increased capital intensity.
- This process allowed average living standards to increase in the long run



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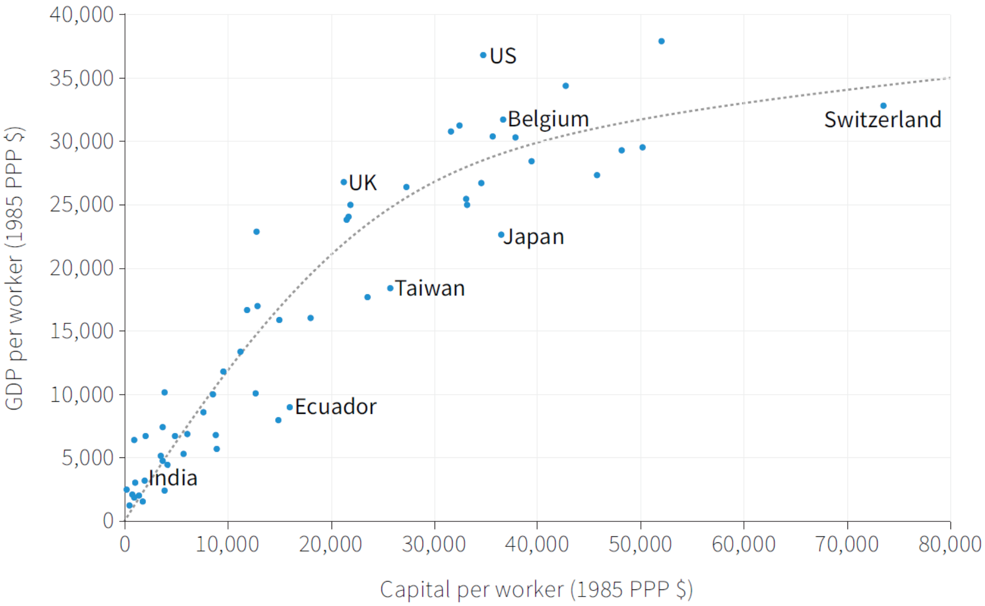
Capital and GDP per Worker

If accumulation of capital proceeded in the absence of technological progress:

An economy might progress in stages

From being like Ecuador
→ Belgium
→ Switzerland

Progresses along the dotted line of the production function: contribution of additional capital goods to increased production would eventually become so small that **capital accumulation** could no longer drive growth in labor productivity and living standards



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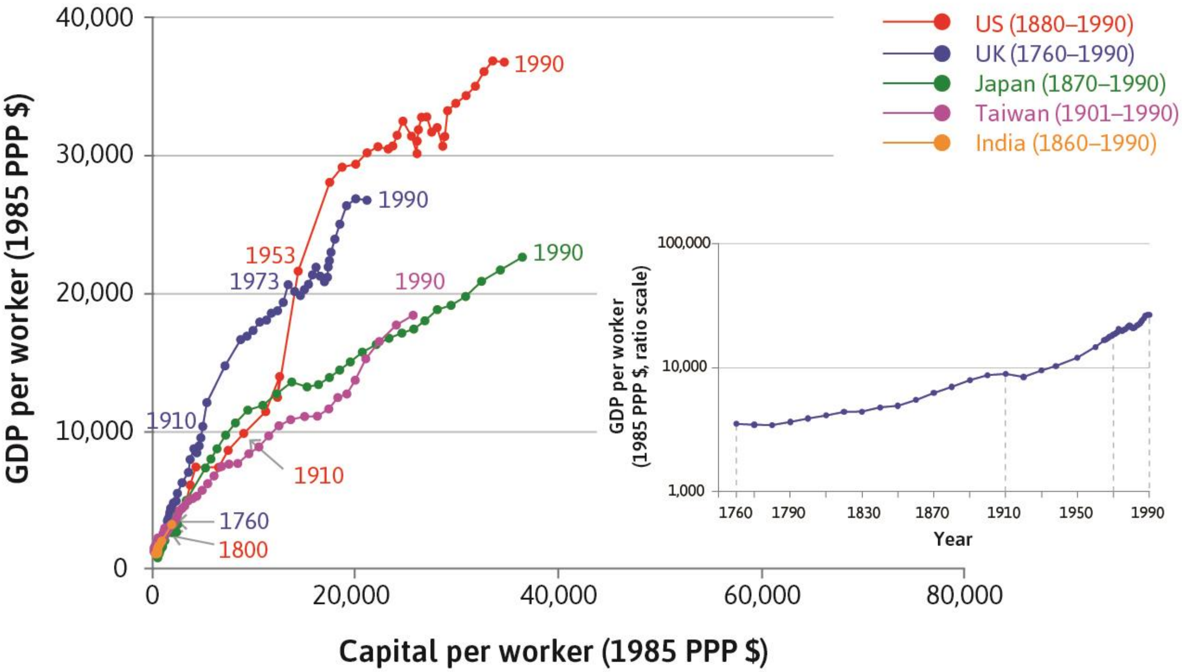
Technological Progress and the production function



Unlike the concave production function, capital productivity remained roughly constant over time in the technology leaders.

This is because these countries experienced a combination of capital accumulation and technological progress!

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The growth model by Solow (Nobel prize 1987)

A model of “exogenous growth” (neoclassical)

- **Technological progress is the engine of growth**
- **Technologies are considered as exogenously given**

There are also models with “endogenous growth” (new growth theory)

- Try to explain the engine of growth
- Understand the economic forces underlying technological progress (and savings)
- Romer (1987, 1990), Grossman and Helpman (1991), Aghion and Howitt (1992)

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Predictions from the Solow model

The Solow model predicts that

Countries with little accumulated capital per capita show higher growth rates in the short-run

→ Explains catching up of developing countries over time

Long-run economic growth is only possible in the presence of technological progress

→ Explains the growth paths that we see in knowledge economies since the industrial revolution

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Assumption in the Solow model

K, the capital stock, is no longer constant:

- ***K*** increases through investments.
- ***K*** decreases through depreciation (depreciation rate δ).

1. ***L***, the number of labor force participants, increases through population growth (growth rate **n**)
2. Technological progress increases the productivity of workers, i.e. labor productivity (efficiency of labour **E**) increases (growth rate **g**).
3. For simplicity, government expenditure (**G**), taxes (**T**), exports (**X**) and imports (**M**) are not part of the model.

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The Solow model

Notation: $y = Y/L$ = Output per capita
$k = K/L$ = Capital per capita

$\boldsymbol{y} = Y/LE$ = Output per unit of effective labour
$\boldsymbol{k} = K/LE$ = Capital per unit of effective labour

Production function per unit of effective labour: $\boldsymbol{y} = f(k)$

Savings (=investments **i**) per unit of effective labour: $s^*\boldsymbol{y} = s^*f(\boldsymbol{k})$

Consumption per unit of effective labour: $c = \boldsymbol{y} - i = f(\boldsymbol{k}) - s\boldsymbol{y}$

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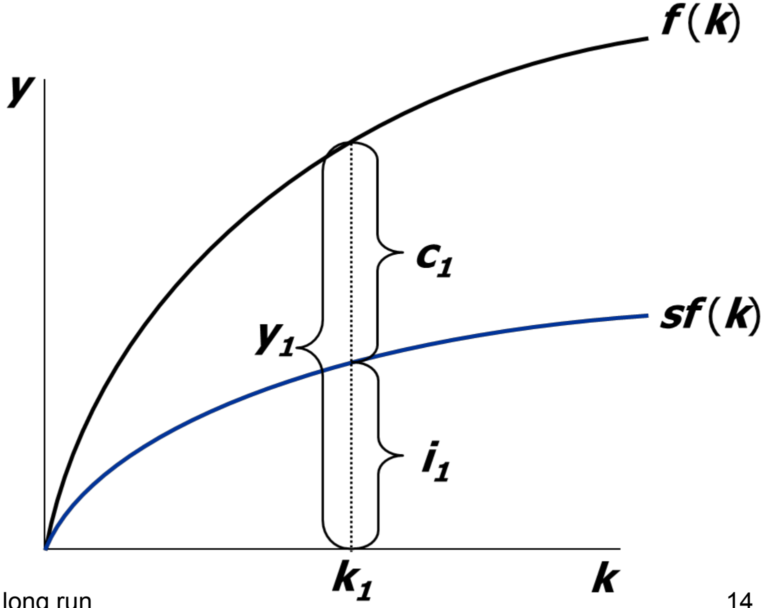
The Solow model

Total output is divided between consumption and investments

Savings are used to finance these investments

Question:

What is the required level of investment to keep ***k*** constant?



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The Solow model

The break even investment, i.e. the steady state is at the point where:

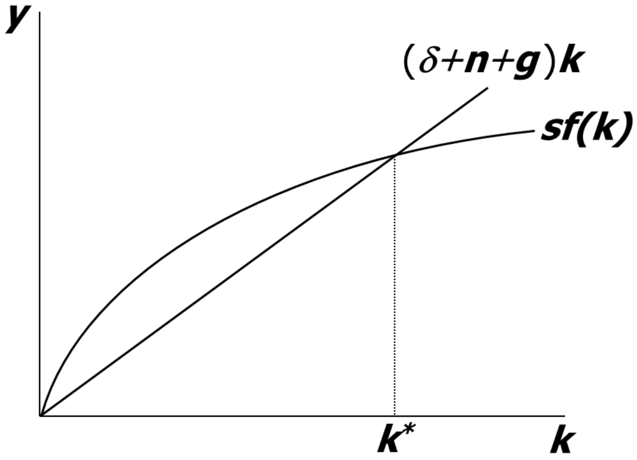
$$s^*f(\boldsymbol{k}) = (\delta + n + g)\boldsymbol{k}$$

Change of the capital stock per unit of effective labour:

$$\boxed{\Delta \boldsymbol{k} = sf(\boldsymbol{k}) - (\delta + n + g)\boldsymbol{k}}$$

The break-even investment comprises:

- $\delta \boldsymbol{k}$, to replace depreciated capital
- $n\boldsymbol{k}$, to endow the increase in the production factor labour caused by population growth with capital
- $g\boldsymbol{k}$, to endow the increase in production factor labour caused by technological progress with capital



- **In the steady state:** capital stock per unit of labour = constant → K and L grow with the same rate!
- **Total output does grow because Y = f(K; L)**

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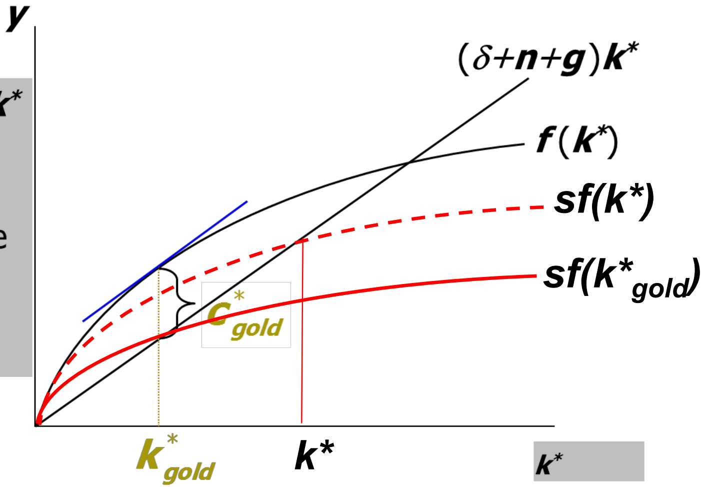
The “Golden-Rule” level of capital stock

$c^* = f(k^*) - (\delta+n+g)k^*$
is greatest where the slope of the production function equals the slope of the break-even investment curve:

$$f'(k^*) = \delta+n+g$$



Assume policy makers can implement policies to determine a steady state level of capital that maximizes consumption per worker.

- This is known as the golden rule level of capital (k^*_{gold}).

Consumption per worker is the difference between output and investment per worker
→ we want to choose k* so that this distance is maximized. **Adjustment via savings!**

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Technological Progress in the Solow Model

Prediction of the Solow model:

- In the steady state:

  capital stock per unit of labour is constant because K and L grow with the same rate
- Total output does grow because $Y = f(K; L)$

But why do we see sustained growth in *output per capita*, i.e. GDP/capita ($y = Y/L$**)?**

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Technological Progress in the Solow Model

- Remember: $y = \frac{Y}{L}$ and $\boldsymbol{y} = \frac{Y}{LE}$ and output per unit of effective labour *y* is constant

→ We can write: $\boldsymbol{yE} = y$ and because $\boldsymbol{y}$ is constant: $\boldsymbol{y}\dot{E} = \dot{y}$

$$\frac{Y}{LE}\dot{E} = \dot{y}$$

$$if \;\; \frac{\dot{E}}{E} \equiv g_E \rightarrow \; y g_E = \dot{y}$$

$$\rightarrow g_E = \frac{\dot{y}}{y} = g_y$$

→ Output (or income) per capita grows with the same rate as technological progress!

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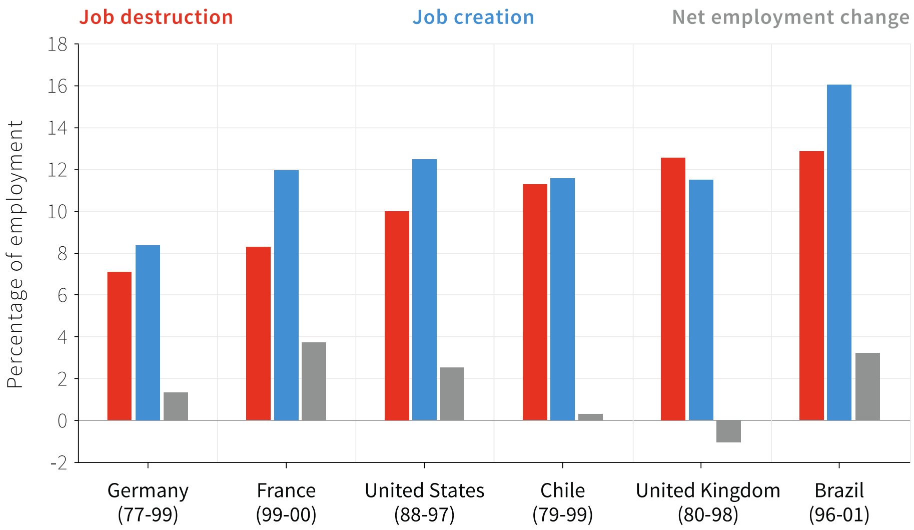
Job creation/destruction



Net employment change = job creation – job destruction

Labor-saving technological progress can also create jobs e.g. reallocation of work from low- to high-productivity firms

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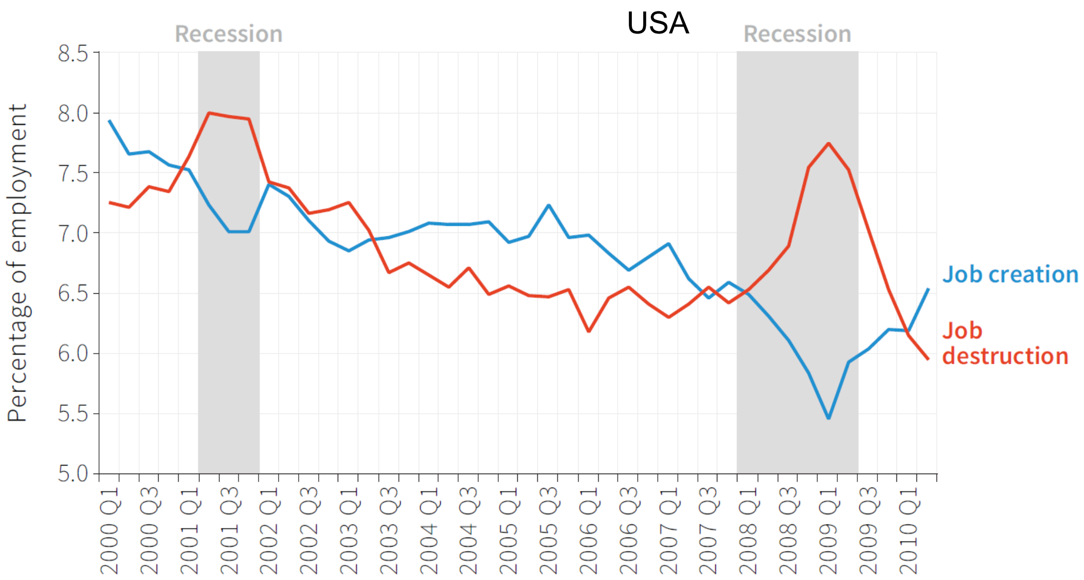
Cyclicality of job creation and destruction



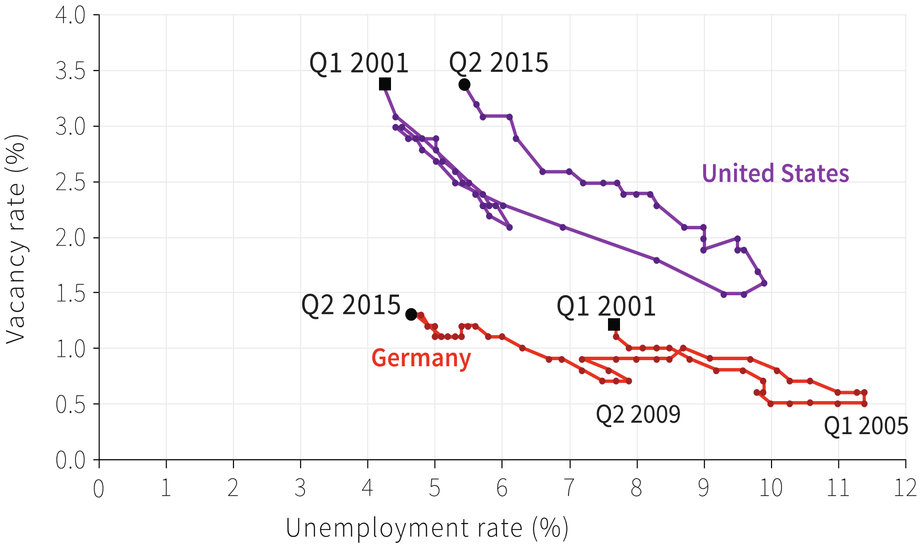
- Job creation is strongly **procyclical**
→ moves in the *same direction* as aggregate output

- Job destruction is **countercyclical**
→ moves in the *opposite direction* to aggregate output

The Beveridge Curve

The **Beveridge curve** shows the inverse relationship between the unemployment rate and the job vacancy rate.

- During recessions, firms post fewer vacancies and lay off more workers due to lower demand.
- During booms, firms post more vacancies and need more workers to cope with rising demand.



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Labour market matching

- Some factors prevent newly unemployed people from being matched with newly posted jobs

- Newly posted vacancies are not filled instantly because of issues with **labor market matching**:

  - Mismatch – unemployed workers may not have the skills required for the job; jobseekers and vacancies may be located in different parts of the country
  - Industry-specific shocks or shocks that prevent workers from moving increase mismatch (lower efficiency)
  - Jobseekers and/or employers may not know about each other

Labour market matching

- Matching should be easier when there is a larger pool of the unemployed from which to select.

- A combination of high unemployment and a large number of vacancies → inefficiency in the matching process in the labour market.

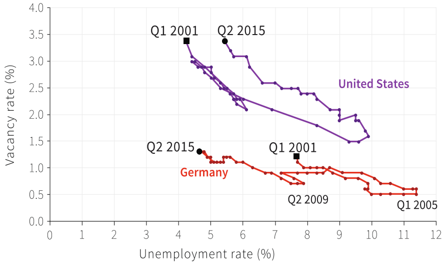
- The Beveridge curve reflects that:
  - German labour market appears to do a better job of matching workers seeking jobs to firms seeking workers.
  - Vacancy rate in Germany is lower than in the US for any year, although the two countries experienced a common range of unemployment rates.
  - Beveridge curves can shift due to reforms: the Hartz reforms provided better guidance to unemployed workers in finding work and reduced the level of unemployment benefits sooner to provide the unemployed with a stronger motive to search

Labour market matching

- Why did the Beveridge Curve move to right for the USA?

  - Many redundancies in one industry: The global financial crisis between 2008 and 2009, and the recession that followed, particularly affected the housing construction industry.
  - Skill-based mismatch between the unemployed and vacancies available.

- Collapse of US housing prices: When house prices fell, many homeowners were trapped in a house that was worth less than they had paid for it.
  - They could not sell their house and move to an area with more job vacancies, and this restricted their choice of jobs.



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V. The role of institutions and policies

Long-run unemployment

- In the long run, firms can enter/exit (so capital stock can change)

Long-run equilibrium in the labor market is when
wages, employment level, <u>and the number of firms</u> are constant

- Long-run employment rate depends on how well policies and institutions deal with:
  - Work incentives - depend on **wage-setting curve**
  - Investment incentives - depend on **price-setting curve**

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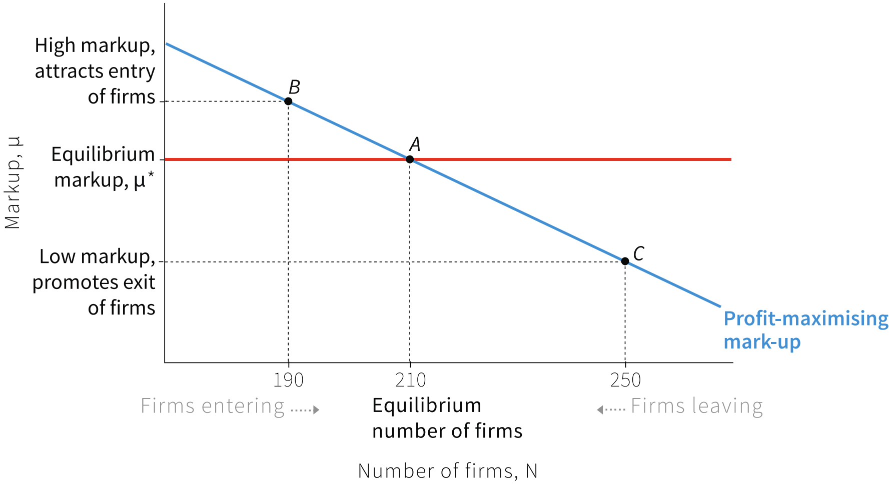
Firm entry and exit

- The more firms, the more competitive the economy.
- Higher elasticity of demand facing the firms when they sell their products (less ‘steep’ demand curves).
- The markup that maximizes the firm’s profits will fall, because, the markup, μ, is 1/(elasticity of demand).
- The markup that is just sufficient to retain the existing number of firms is μ*.



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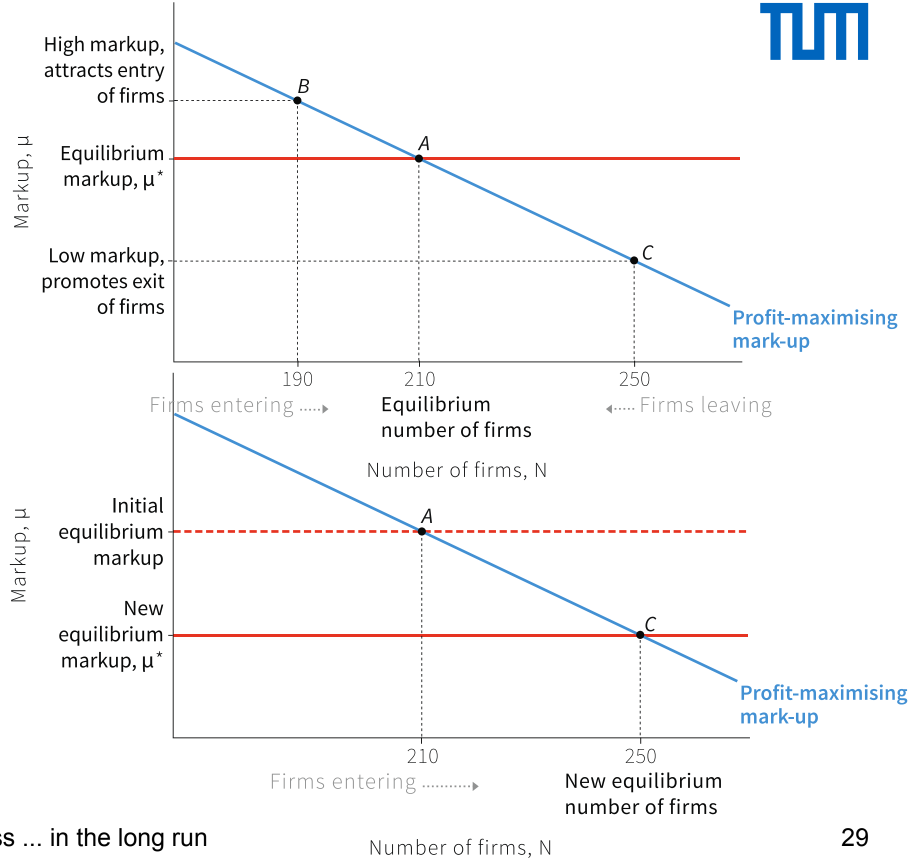
Firm entry and exit

The profit rate determines the number of firms in the market

Self-correcting process:

more firms
= more competition
= higher elasticity of demand
= lower markup
= fewer firms

Equilibrium profits can change due to legislation e.g. property protection or “ease of doing business”



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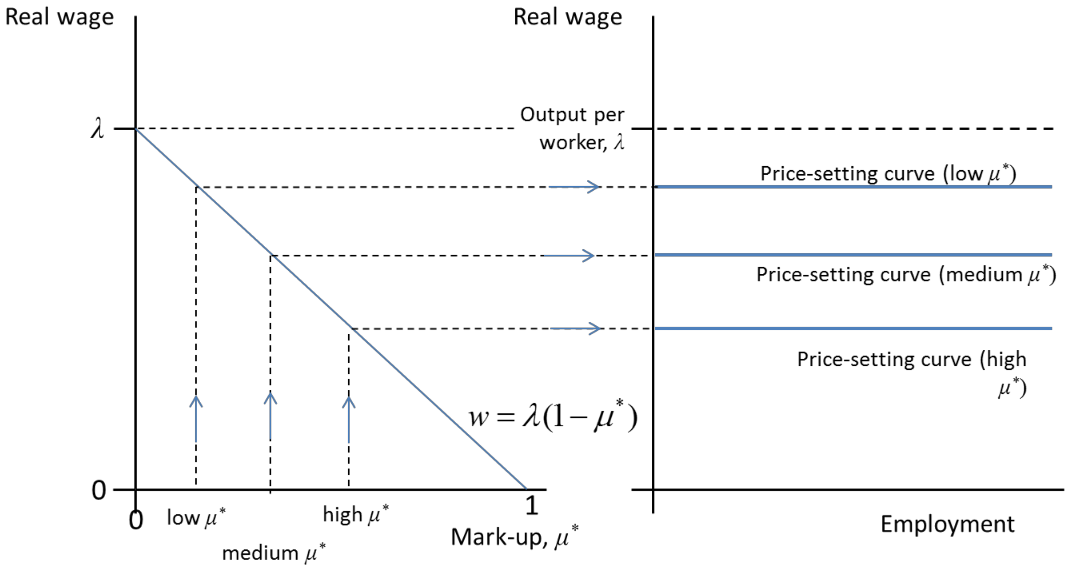
Long-run price-setting curve

Remember: Price-setting by firms produces the price setting curve. It splits output per worker into real profit per worker, and the real wage per worker.

Real wage depends on productivity (λ) and equilibrium profits (μ*).

w = λ(1 - μ*)



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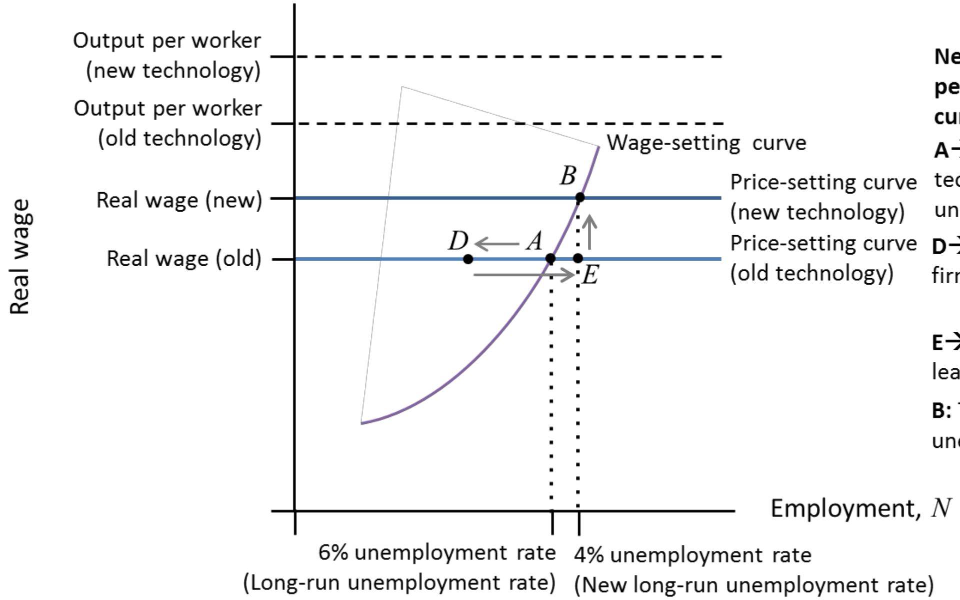
Technological improvement



New technology shifts up output per worker and the price-setting curve

A→D: Introduction of new technology leads to a rise in unemployment

D→E: High profits encourage new firms to enter

E→B: Lower unemployment leads to rising real wages

B: The new long-run rate of unemployment is 4%

Technological improvement

- New technology can increase both real wages and employment in the long-run!
- But: the adjustment process takes time, and may involve job destruction in the short-run.

1. **Adjustment gap:** the lag between some outside change in labor market conditions and the movement to the new equilibrium

2. **Diffusion gap:** the time it takes for whole economy to adopt the innovation

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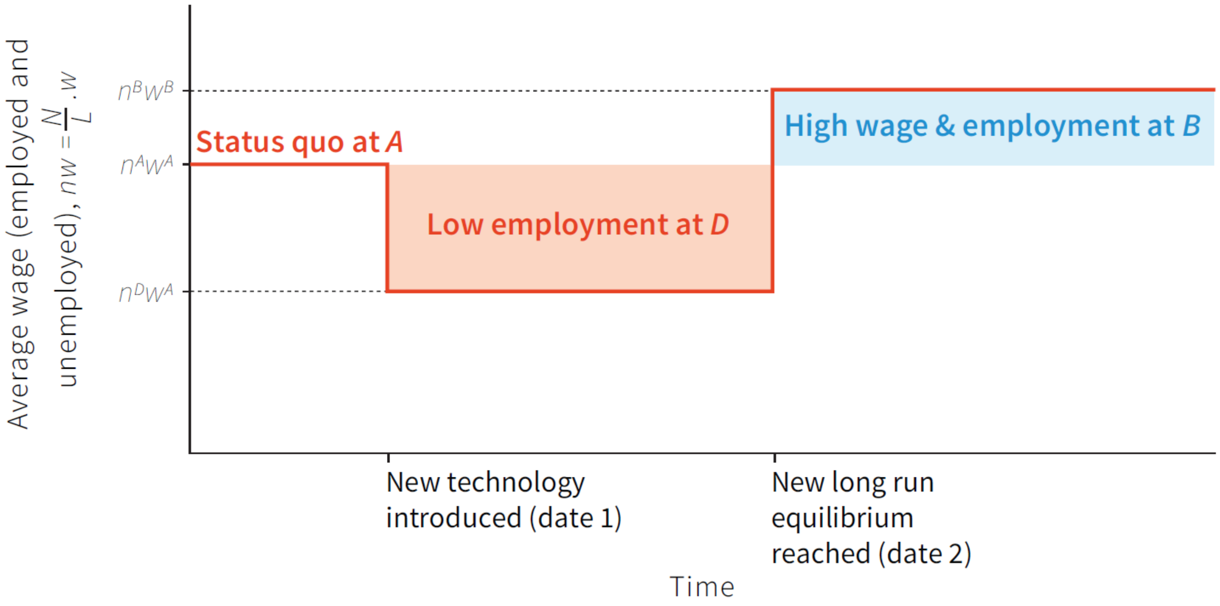
Long-run effects of technological change



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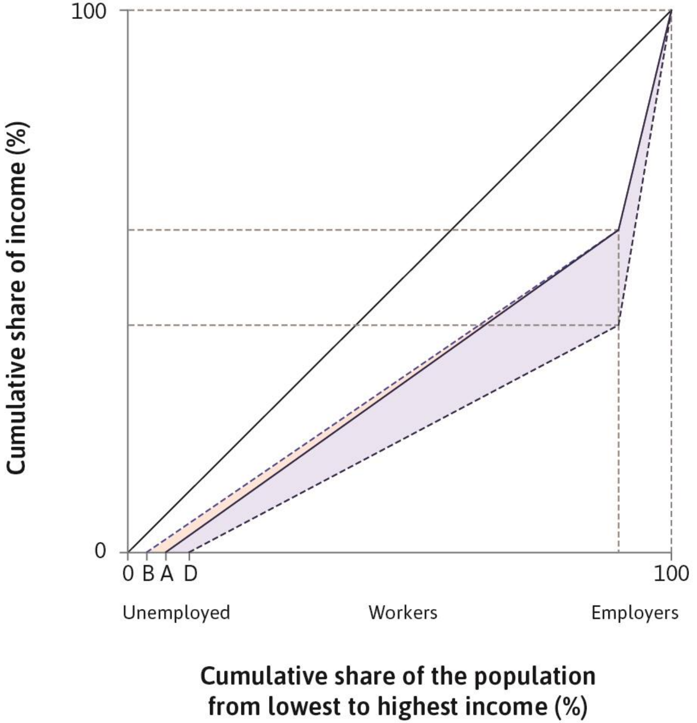
Effect on inequality

In this example, technological change increased inequality in the short run but reduced inequality in the long run:

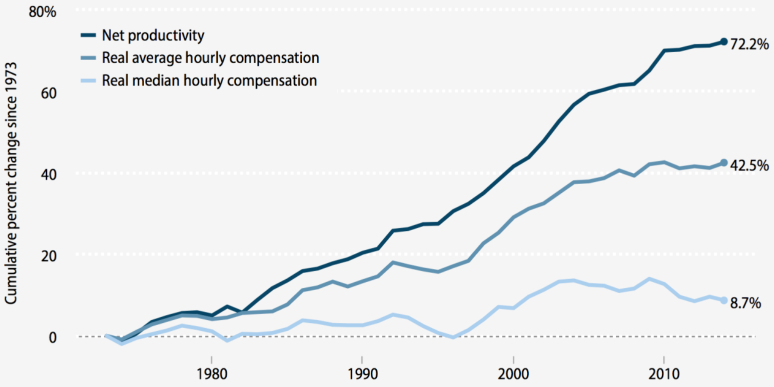
- Employees' share of output returned to initial levels due to an increase in real wages
- The higher real wage motivated employees to work hard at a lower level of unemployment.



Productivity and wages in the long-run

FIGURE B

Growth of productivity, real average compensation, and real median compensation, 1973–2014



Note: Data are for all workers. Net productivity is the growth of output of goods and services minus depreciation, per hour worked.

Source: EPI analysis of data from the BEA, BLS, and CPS ORG (see technical appendix for more detailed information)

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Mark-ups in the long-run

Economist.com

The Economist

Summary

1. The **Solow model** explains catching up and shows that GDP per capita grows with the rate of technological progress

2. The **Beveridge curve** shows efficiency of labour markets

3. The **Long-run labour market model shows how wages and employment evolve**
   - Long-run price-setting curve depends on incentives to invest
   - Long-run wage-setting curve depends on productivity

4. **Differences in labour market outcomes across countries**
   - Institutions and policies matter for long-run outcomes
   - Successful countries reduced the adjustment and diffusion gap due to technological change

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