EFR summary

Macroeconomics, FEB11002X

2025-2026

Lectures 1 to 11

Weeks 1 to 5

Details

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Macroeconomics - IBEB
Lecture 1 - Week 1

What is macroeconomics?

Macroeconomics is the study of **aggregated behaviour and performance of an economy**.
Macroeconomics focuses on **the economic performance of whole countries/regions**. In macroeconomics, we do not track individual decisions – we track **totals, averages, and interactions across markets.**

Economic agents:
- Consumers, producers, government, banks, foreign countries

Markets: demand = supply
- Goods markets, labour market, money market, financial markets

Gross Domestic Product

The gross domestic product (GDP) is the most common measure of an economy's of output/production and income.
- Definition - GDP: An **indicator for the total value of all final goods and services produced within a <u>specific period</u> (per year/quarter) in a <u>specific area</u> (country/region).**

GDP measures the economic activity of the whole economy. IT IS NOT happiness or welfare, but it is **highly correlated with well-being.**
You can measure GDP in **nominal terms** (current prices) or **real terms** (constant prices, volume)

The observation for most countries of GDP is that:
1. There is constant growth of the real GDP in the long-run (rising trend)
2. There are significant and returning fluctuations of the real GDP around this trend.

Since big countries often have a higher GDP, it is hard to compare smaller to bigger countries. Although there is a way: **Gross domestic product per capita**: This is the gross domestic product divided by the number of residents in a country.

Long run and short run

In order to understand how **key economic variables** (GDP, inflation…) evolve, we need to distinguish between **short-run changes** (cycles) versus l**ong-run evolution** (trend). Macroeconomics tries to explain deviations (a short-run pattern) from the trend value, and how to smooth these fluctuations.

Long run (trend): the behavior of the economy over decades
Economic growth

- Measures the rate at which output of a nation increases over time.

Short run (business cycles): temporary output fluctuations around long-run trend
Business cycles can be of **various lengths and magnitudes** and consist of **Booms** and **Recessions**.

- Booms: the period from trough to peak
- Recessions: the period from peak to trough

Short run	Long run
Fixed prices	Flexible prices
Consists of business cycles	Consists of a trend line
Has bigger fluctuations	Is smooth
In case of a shock the supply side usually has to adjust	The economy's capacity to supply enough for the population matters in the long run.

Economic Growth

$$Y_t = GDP\ of\ a\ country\ in\ year\ t$$

$$Y_{t-1} = GDP\ of\ a\ country\ in\ year\ t-1$$

$$Y_t = GDP\ of\ a\ country\ in\ year\ t$$

In practice, GDP growth is often approximated as first-difference of GDP using **a logarithmic scale.**

$$Y_t = Y_{t-1} * (1 + gr.rate_t)$$
$$\ln(Y_t) - \ln(Y_{t-1}) = \ln(1 + gr.rate_t) » gr.rate_t$$

The approximation holds for gr.rate close to zero.

$$\text{Yearly \%Y growth} = [\ln(Y_t) - \ln(Y_{t-1})] * 100$$

Long-run output growth

When we study the **long run** economic performance, we are interested in the **long-run trend growth = average yearly growth over a long period =** $[\ln(Y_t) - \ln(Y_{t-1})]/(T-t) * 100$

Short-run output gap

When we study the **short run** economic performance or **business cycles**, we are interested in the **output gap = short run output deviation from trend = % difference between actual and trend output =** $[\ln(Y_t) - \ln(Y_{trend,t})] * 100$

Flow vs Stock Variables

Flow variable

- Quantity measured over a unit of time

Stock variable:

- Quantity measured at a given point in time

Stocks are the cumulative of the flows.

GDP measures economic activity in a geographical location over a time interval. Hence, GDP is a **flow** variable.

Examples of flow vs stock variables:
- Investments **flow** vs capital **stock**
- Wage **flow** vs wealth **stock**

The three definitions of Gross Domestic Product

All 3 approaches measure the **same GDP**, they are different ways of accounting for the same economic activity.

1) **Expenditure approach**

GDP = Sum of final sales within a geographic location during a period of time, usually a year.
Keep in mind that intermediate sales (resales) are not taken into account with this. This is to avoid double counting.
GDP (Y) = Consumption (C) + Investment (I) + Government Spending (G) + Exports (X) – Imports (Z)
- Consumption = spending by households in durable goods, non-durable goods and services
- Investment = spending by firms on goods that will be used in the future to produce more goods and services
- Government spending = purchases of goods and services by the governments, salaries of government workers
- Exports = purchases of domestically produced goods by foreigners. DO NOT appear in C, I, or G, BUT should be taken into account
- Imports = purchases of goods and services produced outside the country but consumed by residents. Appear in C, I or G, BUT should NOT be taken into account since it is **produced outside the country.**

2) **Production approach**

GDP = Sum of value added occurring within a given geographic location during a period of time.
- Value added: difference between sales and the costs of raw material and intermediate goods

Raw material and intermediate goods are **excluded** to avoid double counting.

3) **Income approach**

GDP = Sum of <u>incomes</u> earned from economic activities within a geographic location during a period of time.

GDP = Labour income (wages, income from self-employment) + Capital income (land, interest, dividends, profits) + Government income (taxes net of transfer)

GDP includes **all incomes earned within a country's borders** (by residents and non-residents alike)

Note that: GDP only measures **officially recorded transactions.** Hence it does not measure:

- Home production: leisure, domestic childcare, cooking, subsistence farming
- Shadow or underground economy: Activities not reported to avoid taxes (e.g. domestic help) or because of illegality (e.g. drug dealing)

Nominal vs Real GDP

Nominal GDP = $P^x Q^x + P^Y Q^Y$ in an economy with 2 products, x and y.

However, prices change, therefore we also have the

Real GDP = $P_0^X Q_T^X + P_0^Y Q_T^Y$.

Prices are kept fixed in real GDP. Thus, real GDP changes over time only if the physical quantity sold changes over time.

Measuring Price Changes

Inflation rate: changes of prices over time
There are 2 main methods of measuring price changes:

1. GDP deflator

GDP deflator = $\frac{nominal\ GDP}{real\ GDP}$.

GDP deflator = P_t = (Nominal GDP_t) / ($\boldsymbol{Real}$ $\text{GDP}_{t,\tau}$)

- Measures **price of output relative to its price in the base year**
- **Average prices** of final goods where each good is implicitly **weighted** by their **share in the GDP**. As shares change over time, so do the weights.

GDP deflator inflation = growth rate of GDP deflator
GDP deflator inflation = (P_t / P_{t-1} - 1)*100
*≈ **% Δ Nominal $\mathbf{GDP_t}$ - % Δ $\boldsymbol{Real}$ $\mathbf{GDP_{t,\tau}}$**

GDP deflator inflation is what remains after we remove real growth from nominal growth.

**Approximation holds for small changes*

2. Consumer price index (CPI)

Measures the **general level of prices** that consumers have to pay for goods and services. They use a basket of goods and services that reflect the spending of a typical household.
CPI inflation approximates changes in the **'cost of living', not the cost of production.**

Consumer Price Index	GDP deflator
Weighted by goods and services **BOUGHT** by the consumers	Weighted by goods and services that are **PRODUCED** domestically
Includes imported goods, but not exported goods	**Includes exports** but not imports

Gross National Income (GNI)

GNI considers a country's economic activity **attributable to its residents**, both people and firms they own, **regardless of where the economic activities take place.** (resident/ownership – based)
GNI = GDP + balance on primary international income
Balance on primary international income: income earned by residents abroad – income generated by non-residents.

A Key Accounting Identity

Using the expenditure approach
(1) Y = C + I + G + X – Z (Definition 1 of GDP)
Y = GDP, C = consumption of households, I = investments of firms, G = government spending, X = export, Z = import

Viewing from the income approach, the total income = Y (total output) in a country can be spend on consumption (C), savings (S) or taxes net of transfers (T = taxes - transfers)
(2) Y = C + S + T
(3) (S-I) + (T-G) = (X-Z)
Main economic actors:
- (S-I): Private sector
- (T-G): Government
- (X-Z): Rest of the world

The private sector (households and firms)
- If (S-I) > 0 private sector is a **net saver**
- If (S-I) < 0 private sector is a **net borrower**

The government
- If (T-G) > 0 the government is **saving**
- If (T-G) < 0 the government is **borrowing**

The rest of the world
- If (X-Z) > 0 the country exports more than it imports**: net exporter**
- If (X-Z) < 0 the country imports more than it exports: **net importer**

If trade is balanced $\boldsymbol{X = Z}$ or a closed economy $\boldsymbol{X = Z = 0}$, then

$$S - I = -(T - G)$$

Net saving of the private sector = net borrowing by the government.
Otherwise, if $(S - I) + T - G > 0$, i.e., domestic economic actors (private sector + government) is net savers $(X - Z > 0)$ the country is a net exporter.
And vice versa: the country is a net borrower, it is also a net importer

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Lecture 2 - Week 1

The Solow growth model

The Solow Model suggests **3 main reasons** why countries grow:

1. Capital accumulation
2. Population growth
3. Technological progress

The model explains **long-run** growth
Other factors can be embedded: institutions, education etc.

The Steady State

The **steady state** is **the long run equilibrium** of the **model** economy.

Steady state is characterized by a **balanced growth path** on which each model variable is **growing at a constant rate.**

An economy not at the steady state will move towards it.

Transition path describes how the economy moves towards the steady state.
In reality:

- We are **never** exactly **at the steady state**, but we permanently **move around it**.
- Steady state growth rate: **long-run average growth rate = trend**

Production Function

There are four main growth factors in the economy. These are:

- Capital (K) (This follows out of savings, which are used for investments).
- Growth of the labour force (L)
- Technological progress (A)
- Other factors which are out of the scope of this course.

The first three of these factors (K, L, A) are in the **Solow model**.

The **general production function** is written as: $Y = F(K_+, L_+)$. The plus signs mean that output will grow when these inputs grow.

- Y = output (real GDP)
- K = capital stock
- L = labour = # of hours * hours per worker

Key assumptions:

- **The law of diminishing returns** (See micro) is also in question for the production functions.
- The Cobb-Douglas function has the property of **Constant Returns To Scale (CRTS**, See micro). Other functions might have increasing or decreasing returns to scale.

Codd-Douglas Production Function

The **Cobb-Douglas function** is written as $Y = K^{a}L^{1-a}$ with a in $0<a<1$. a is the elasticity of capital.

- α is a parameter with $0 < \alpha < 1$
- α = elasticity of output (Y) with respect to capital (K): 1% increase in K results in an α % increase in Y
- $1-\alpha$ = elasticity of output (Y) with respect to labour (L): 1% increase in L results in an $(1-\alpha)$ % increase in Y

Property 1: constant returns to scale
If $\lambda>0$, then we must have that $F(\lambda K, \lambda L) = \lambda F(K,L)$
The Cobb-Douglas function:
$F(\lambda K, \lambda L) = (\lambda K)^{\alpha} (\lambda L)^{1-\alpha} = \lambda^{\alpha+(1-\alpha)} K^{\alpha} L^{1-\alpha} = \lambda K^{\alpha} L^{1-\alpha} = \lambda F(K,L)$
CRS because exponents sum to 1.

Property 2: Diminishing marginal productivity for each factor

- Marginal productivity of each factor = by how much **output** increases for a small increase in K (or L) while holding the other factor L (or K) constant = 1st derivative of Y with respect to K (or L)

$MP\boldsymbol{K} = \frac{\partial y}{\partial K} = \alpha K^{\alpha-1} L^{1-a} = \alpha \left(\frac{L}{K}\right)^{1-a}$ > 0 Y increases with K
$MP\boldsymbol{L} = \frac{\partial y}{\partial L} = (1-\alpha) K^{\alpha} L^{-a} = (1-\alpha)\left(\frac{K}{L}\right)^{a}$ > > 0 Y increases with L

- Changes in the marginal productivity of each factor = by how much the marginal productivity increases for a small increase in K (or L), while holding the other factor L (or K) constant = 2nd derivative of Y with respect to K (or L)

$\frac{\partial^2 Y}{\partial K^2} = \frac{\partial MPK}{\partial K} = \frac{\partial a\left(\frac{L}{K}\right)^{1-a}}{\partial K} = a(a-1)K^{(a-2)}L^{1-a}$ < 0 **MPK decreases with K**
$\frac{\partial^2 Y}{\partial L^2} = \frac{\partial MPL}{\partial L} = \frac{\partial a\left(\frac{K}{L}\right)^{1-a}}{\partial L} = a(1-a)K^{a}L^{-a-1}$ < 0 **MPK decreases with L**

Diminishing marginal productivity: each additional increase in one production factor increases Y, but less and less.

The Intensive Form

Intensive form: focuses on variables that are **relative to labour (L)**

$$\boldsymbol{\frac{Y}{L} = \frac{F(K,L)}{L} = F(\frac{K}{L},1)}$$

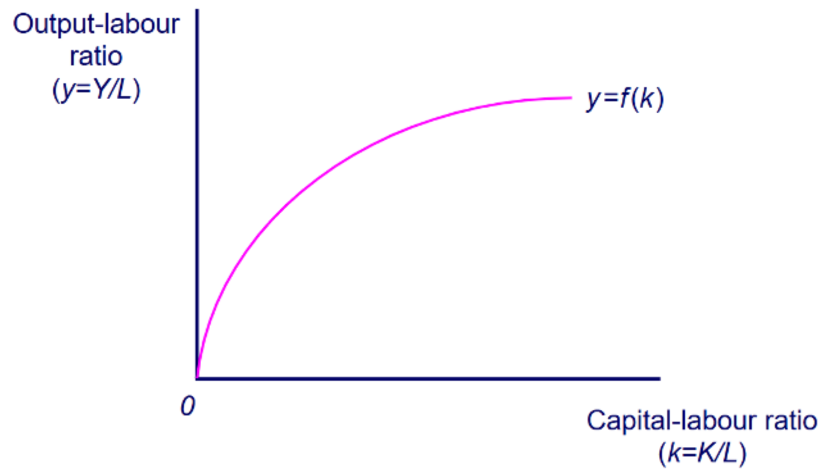
- Can study output as a function of a single variable
- Assume L = population. All our discussion will still hold as long as the proportion between L and the population remains unchanged.
- The intensive form of the production function is expressed in per worker or per capita terms:

y = f(k)

with y = Y/L , the output-labour ratio
and k = K/L , the capital-labour ratio

When using Cobb-Douglas we have

$$\frac{Y}{L} = y = \frac{K^a L^{1-a}}{L} = \left(\frac{K}{L}\right)^a \left(\frac{L}{L}\right)^{1-a} = k^a$$



Savings, investment, and capital accumulation

Start with national accounting identity (Lecture 1):

(S-I) + (T-G) = (X-Z) → I = S + (T-G) + (Z-X)

- In long run, government budget is balanced (T=G) and trade is balanced (Z=X)
- Investment entirely financed by domestic households: **S = I**
- First explanation of growth: **save → invest → grow**
- **s** is the fraction of GDP households save**: I = sY**
- Consider a **Solow model with constant L**. In intensive form, we thus get: I/L = sY/L = sy = sf(k) or the **savings schedule**

δ = depreciation rate of physical capital, i.e. the rate at which machinery becomes obsolescent / wears out every year.

Evolution of the stock of capital: ΔK = I - δK = sY - δK

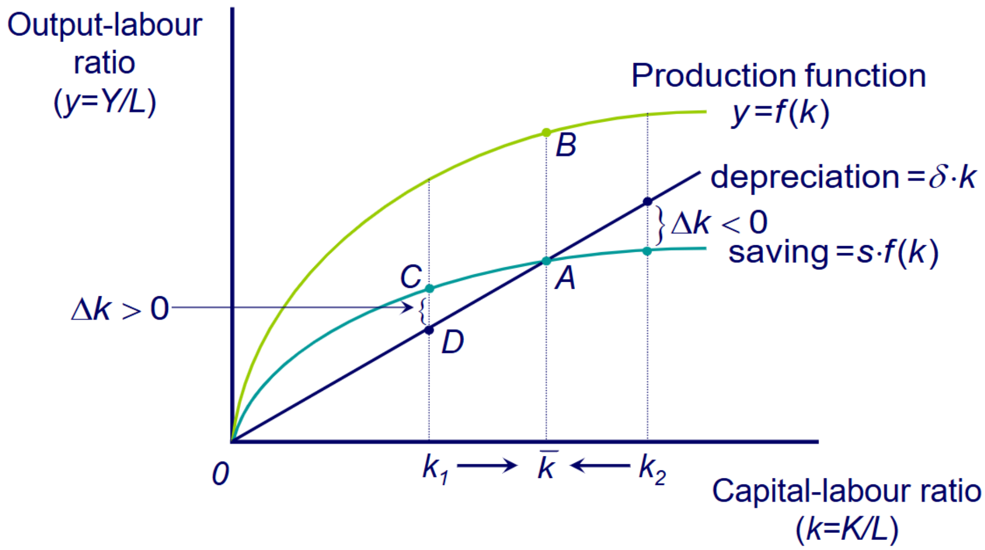
In intensive form: Δk = sy - δk = s f(k) − δk

Higher k has **two opposite consequences on Δk**

- **higher k → higher y → higher savings sy → larger Δk**
- **higher k → higher δk → smaller Δk**

Now we want to know where this steady state is. This is where the quantity of capital doesn't change. In short where: Δk = sy - δk = s f(k) – δk = 0 → s f(k) = δk
This means that the steady state occurs when **savings = depreciation.**

Below this steady state is illustrated with point A:



When savings > depreciation, k2:

- On the transition path, capital stock **rises**, and output **grows**
- The further *k* is from the steady state, the faster the economy grows (**catch up growth**). As *k* comes ever closer to k bar, output growth slows down

When savings < depreciation, k1:

- On the transition path, capital stock **decreases** and output **decreases**
- The further k is from the steady state the faster the economy shrinks. As k comes ever closer to k bar, output decreases slow down

Solving for the steady state:
What is the steady state growth rate of k?
At the steady state, growth rate of capital = $\boldsymbol{\Delta k}$ = 0: $\boldsymbol{\Delta k = sy - \delta k = 0}$
Investment is exactly enough to compensate for depreciation.
Assuming Cobb-Douglas function $y = k^a$

$$sk^a - \delta k = 0$$
$$sk^a = \delta k$$

$$\frac{s}{\delta} = k^{1-a}$$

$$k\ bar = \left(\frac{s}{\delta}\right)^{\frac{1}{1-a}}$$

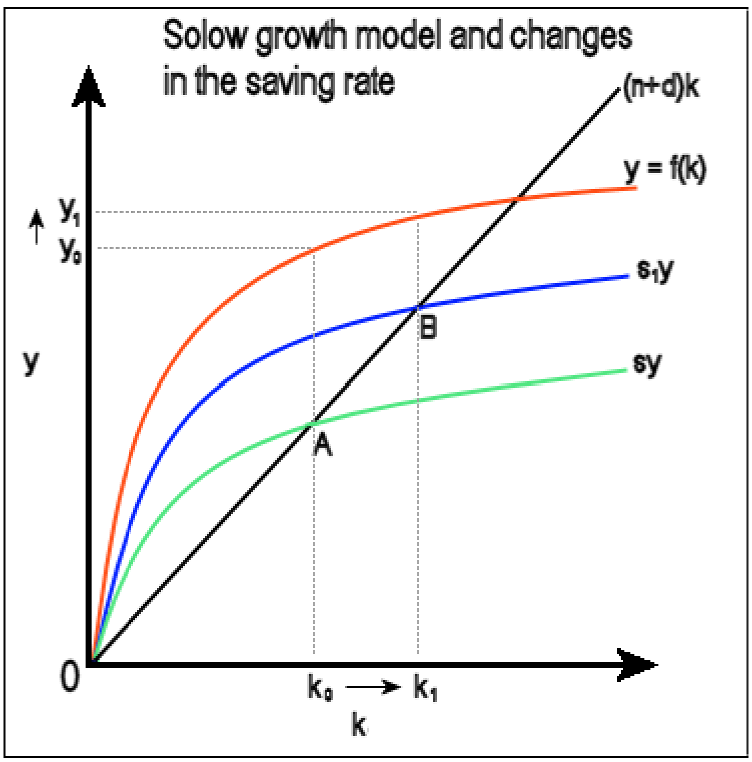
And the steady state output: $y\ bar = k\ bar^{a} = \left(\frac{s}{\delta}\right)^{\frac{1}{1-a}}$

In a Solow model with constant L, at steady state, capital per worker and output per worker do not grow → no sustained growth due to capital accumulation!

Changes in the savings rate:

What happens if people save more? **s1 > s**

New steady state y moves from **y0 to y1** with **higher output per worker**. Once at y1 , output per worker becomes constant again.



The role of savings for growth:

In the long run, a **change in the saving rate** affects **only** the **level** of output per worker/GDP per capita.

A change in the saving rate does **NOT** affect the on **the long-run growth rate** of output per worker/GDP per capita.

Why?

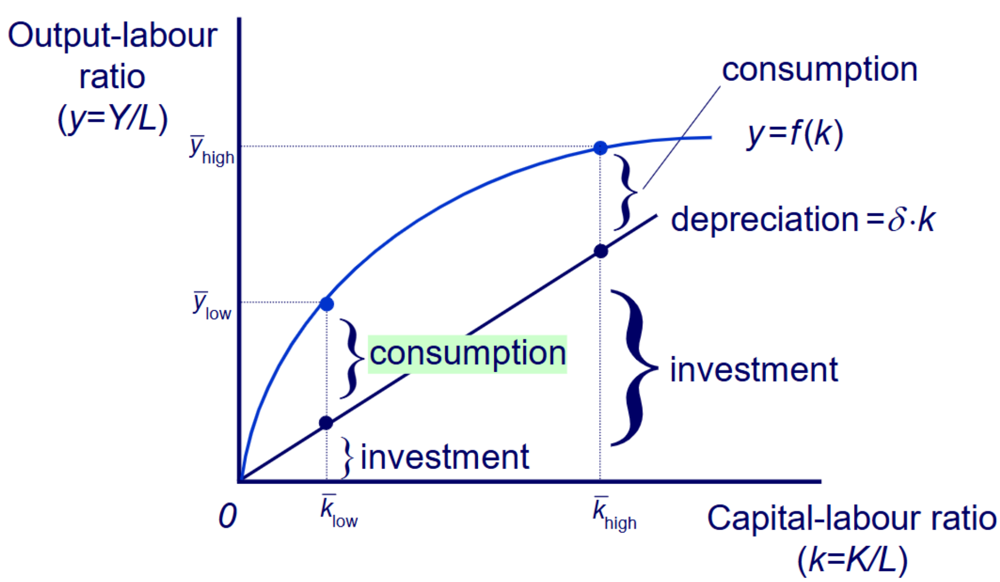
- Because of **diminishing returns**, higher k leads to ever smaller increases in sf(k).
- However, **depreciation** is linear in **k**.
- As soon as sf(k) meets depreciation line, investment = depreciation → steady state with stable k and y
- **Higher saving/investment does not lead to sustained growth**

The "Golden Rule"

You might think that saving a lot might help for increasing the GDP. Although this isn't true. Saving money is a sacrifice because you are delaying consumption. Consumption is essential for welfare.

The **Golden Rule** describes that maximizing welfare is equal to maximizing consumption per capita in the steady state, when **MPK = depreciation.** There is **only ONE saving rate** that is consistent with the Golden Rule.

This can be mathematically written as:
$c = y - sy = f(k) - \delta k$. When you maximise this formula you find the maximum of consumption - depreciation. This is illustrated below:



When you solve the maximising problem you will find that $MPK = \delta$. Where the slope coefficient of the production function is equal to the depreciation the income (Y/GDP) is at its maximum.

Below are a few exercises on the Solow model.
Give the intensive form of the production function:

Y=$K^{0,5}L^{0,5}$

A) Calculate the values for k, y and i in the steady state (use Question A):

With $s = \delta = 0{,}1 \; \& \; n = a = 0$

B) What is the golden rule value of S if:

Y=$K^{0,5}L^{0,5}$

$\delta = 0{,}1$

$n = a = 0$

The solution are given below:

A) $\frac{Y}{L} = \frac{K^{0,5}}{L^{0,5}} \Leftrightarrow \frac{Y}{L} = (\frac{K}{L})^{0,5} \Leftrightarrow y = k^{0,5}$

B) $dk = sy - \delta k = 0$

$$sk^{0,5} = \delta k$$
$$k = (\frac{s}{\delta})^2 = (0.1/0.1)^2 = 1$$
$$y = k^{0,5} = 1$$
$$i = sy = 0.1$$

C) $MPK = \delta$

$$0.5k^{-0,5} = 0.1 \Rightarrow k = (0.5/0.1)^2 = 25$$
$$y = 25^{0.5} = 5$$
$$sy = \delta k \Rightarrow s = \frac{\delta k}{y} = 0.1 * 25/5 = 0.5$$

Conclude: there is sustained growth through capital accumulation.

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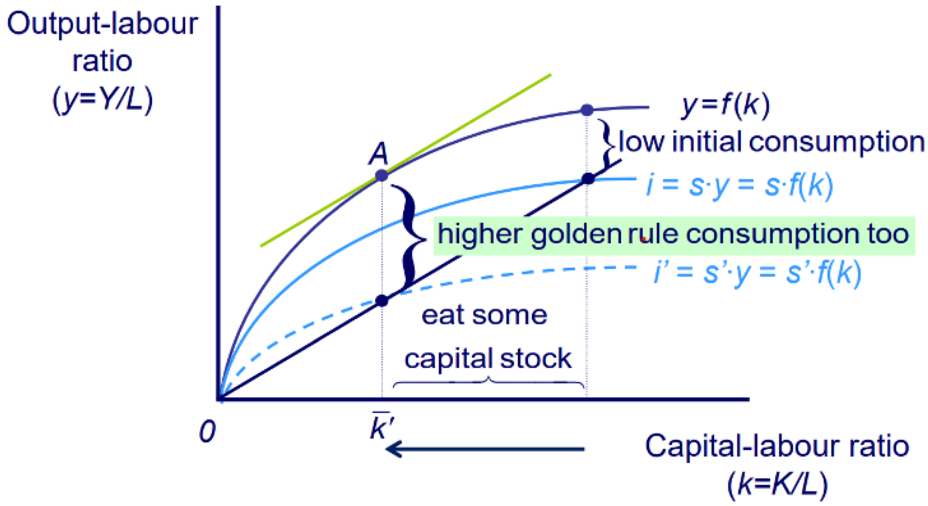
Lecture 3 - Week 1

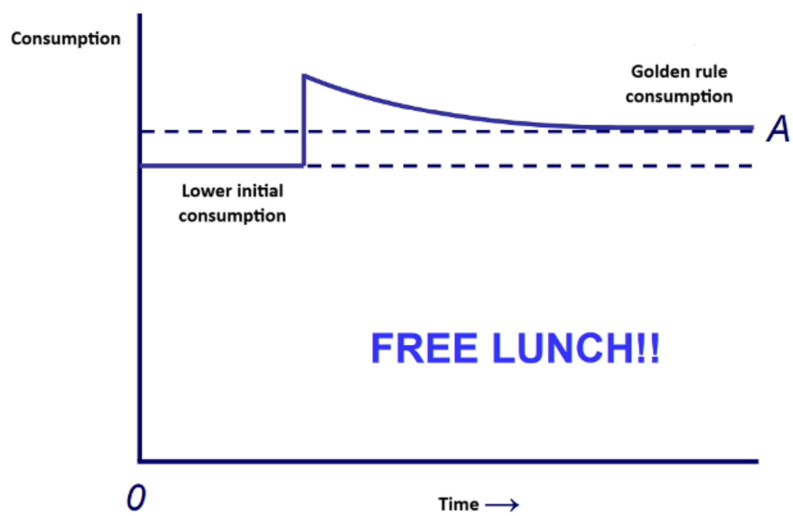
The transition to the Golden Rule steady state

In the summary of the last lecture, we have learned how to calculate the Golden Rule steady state savings growth rate. The economy won't move by itself to the Golden Rule steady state. If the policymakers want to reach the Golden Rule steady state, they shall have to change the savings growth rate. This change will lead to a new steady state with a higher consumption.

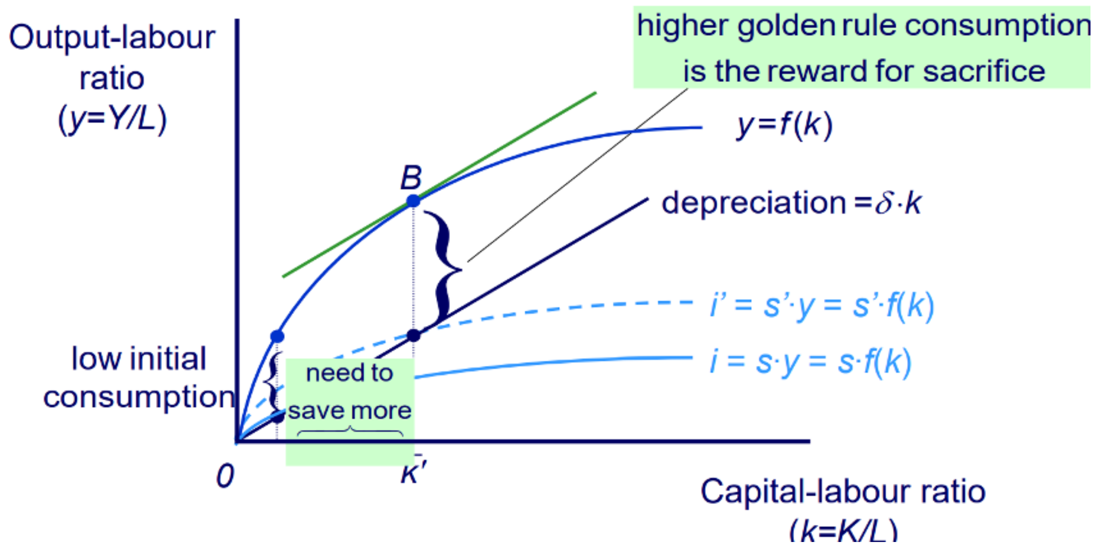
An economy is **dynamically inefficient** if it's possible to raise the consumption of all generations (possibly to the golden rule consumption) by lowering the savings. In short: there is too much capital.



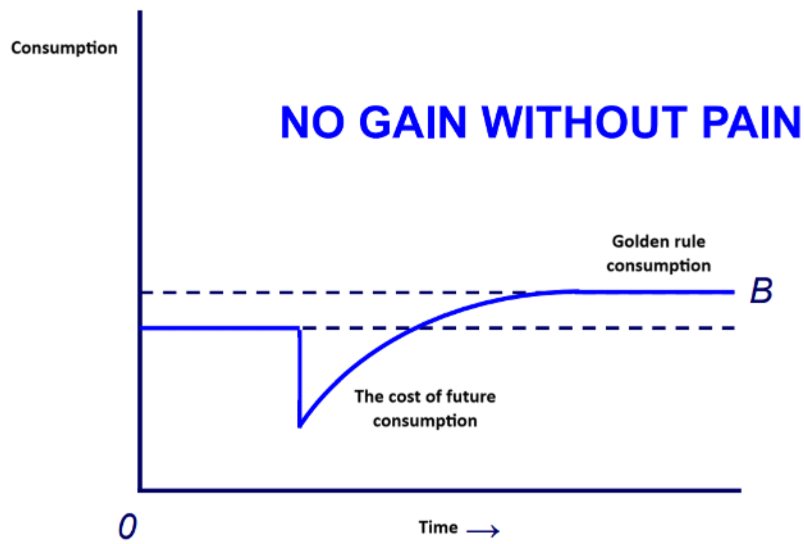
In the illustration above, we can see that by lowering the savings, which can be done by changing the investments to i' with savings growth rate of s', the golden rule consumption can be reached and it is also possible to first eat some capital stock. Which gives even more short-term consumption. In the end of course the amount produced isn't the goal but the amount of consumption is the goal. In the illustration below, you can see that by lowering the savings it will be possible to in the short-run get even more consumption, and in the long-run move to the golden rule amount of consumption.



An economy is **dynamically efficient** if it's possible to raise the consumption of future generations (possibly to the golden rule consumption) by raising the savings in the short-run. In short: Too little capital.



In the illustration above, we can see that by raising the savings, which can be done by changing the investments to i' with savings growth rate of s', the golden rule consumption can be reached. This comes at the cost of sacrifice of consumption in the short-run. In the long-run the golden rule of consumption will be reached. This is illustrated below.



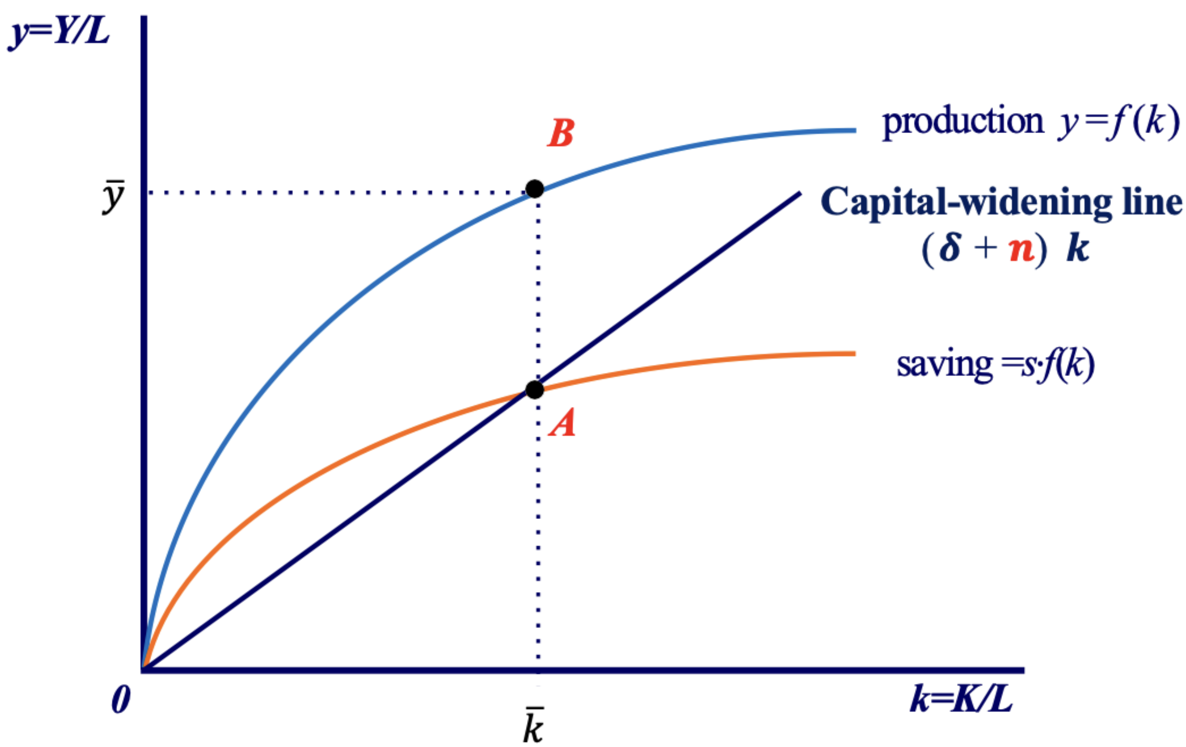
Population Growth in the Solow-model

n = population/work force growth rate

Recap: evolution of the stock of capital: ΔK = I - δK = sY - δK
Now, in intensive form: Δk = sy - $(\delta$+n$)k$
Capital per worker k = K/L decreases for two reasons:

- Capital depreciation (machines wear out), **δK increases → *k* decreases**
- Capital dilution (more workers share the same machines**), *n* increases → *k* decreases**

To compensate for the capital dilution, investment must also provide **new workers** with capital → **capital-widening**
Capital-widening line: $(\delta$+n$)k$
Steady state capital with population growth:
$\mathbf{\Delta k = s \cdot f\ k - \delta + n \cdot k = 0}$



At steady state:

- $y = \frac{Y}{L}$ is **constant**
- $Y = yL$ **grows at the rate of n**: the growth rate of L

An **increase in population growth** causes the capital widening line to become steeper, and will grow at the new rate.

Hence, there is sustained growth in Y, but not in y.

Technological Progress in the Solow-model

Technological progress, =a.

Y = F(A+, K+, L+)
If A increases, Y increases, even if K and L remain unchanged. A often called Total Factor Productivity (TFP)

Two assumptions about A in the Solow model:
1. *A* **grows at constant rate 'a'** and it is **exogenous** (the model is silent on how or why A grows)
2. *A* is **labour augmenting** (for Y, change in A same as change in L): Y=F(K, AL)
A: efficiency of labour (= available technology)
AL: effective labour

Effective labour can grow because of:
- more labour (L increases at rate n)
- greater efficiency of L (A increases at rate a) →**AL grows at rate a + n**

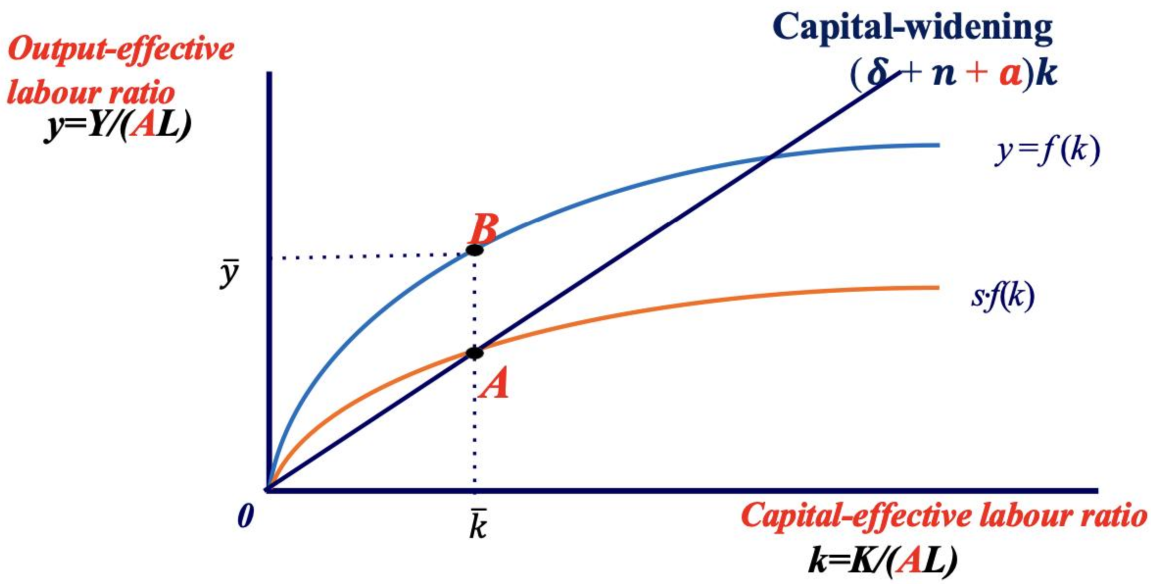
Now we can redefine our variable in the intensive form in terms effective labour (AL) rather than only labour (L)
Output-effective labour ratio: y=Y/(AL)
Capital-effective labour ratio: k=K/(AL)
y = f(k) since with CRS: F(K,AL)/(AL) = F(K/(AL), 1)

Expanded Steady State Equation

Evolution of the capital-effective labour ratio: $\Delta k = sf(k) - (\delta + n + a)k$
Capital per effective worker decreases due to:
- Depreciation: δ
- Capital dilution due to population growth: n
- Growth in labour efficiency: a. As labour efficiency A grows, effective labour AL grows, so k = K /(AL) decreases

Steady state capital with population growth and technological progress

$\Delta\mathrm{k} = \mathrm{s} \cdot f\ k - (\delta + n + a) \cdot k = 0 \rightarrow \mathrm{s} \cdot f\ k = (\delta + n + a) \cdot k$



At steady state:

- Output effective labour ratio, y=Y/(AL) is **constant**
- **Output per labour, yA, grows at the rate of a**
- **Y=yAL grows at the rate of (a+n)**

An **increase in technological progress** causes the capital widening line to become steeper and will grow at the new rate.

Hence, there is sustained growth in Y and Y/L. However, no explanation on why and how technology progresses → endogenous growth model.

Exogenous vs. Endogenous Variables

Endogenous variables: variables to be explained in an economic model
Exogenous variables: variables that the model does not explain
The model explains how changes in **exogenous** variables result in changes in **endogenous** variables.
In the Solow model with labour growth and technological progress
Endogenous variables:

- capital K
- output Y
- consumption C

Exogenous variables:

- labour L
- technological progress A

The distinction between exogenous and endogenous variables changes with the questions asked and the model used.

The modified Golden Rule

At what level of capital/savings rate does an economy with population growth and technological progress maximize steady state consumption per effective labour / consumption-effective-labour ratio?

$\boldsymbol{c = f(k) - s \cdot f(k) = f(k) - (\delta + n + a) \cdot k}$

The 'modified' Golden Rule: $\boldsymbol{MPK = \delta + n + a}$

Consumption per effective labour is maximized in the steady state when the marginal productivity of capital-effective labour ratio (MPK) = depreciation $\boldsymbol{\delta}$ + capital-widening investment $\boldsymbol{n}$ + technological progress $\boldsymbol{a}$

Growth Accounting

How do we measure the contribution of the 3 variables (s, n, a) to the growth. Technological growth is hard to measure. This is done as a residual factor: The **Solow residual**.

But first a few **rules with growth rates** to keep in mind!

- Definition of a growth rate: $\frac{\Delta X}{X}$
- The growth rate of a product: $\frac{\Delta(xy)}{xy} \approx \frac{\Delta x}{x} + \frac{\Delta y}{y}$
- The growth rate of a ratio: $\frac{\Delta(x/y)}{x/y} \approx \frac{\Delta x}{x} - \frac{\Delta y}{y}$
- The growth rate of a power: $\frac{\Delta(x^a)}{x^a} \approx a\frac{\Delta x}{x}$

Now let's see how to find the Solow residual out of the Cobb-Douglas function, keep in mind that $\alpha \neq a$(alpha isn't a):

$Y = AK^{\alpha}L^{1-\alpha}$

$\frac{\Delta Y}{Y} = \frac{\Delta A}{A} + \alpha\frac{\Delta K}{K} + (1-\alpha)\frac{\Delta L}{L}$

Solow residual: $\frac{\Delta A}{A} = \frac{\Delta Y}{Y} - \alpha\frac{\Delta K}{K} - (1-\alpha)\frac{\Delta L}{L}$

There is still some criticism on the Solow model. The Solow model sees technological progress as exogenous and the savings rate also. This does a poor job at reflecting reality because it doesn't explain why these variables are what they are.

Convergence Hypothesis

Steady state output per capita is determined by s, n, a, δ and f(k)
Implications:

- If all similar across countries → **convergence** to the same steady state → output per capita of all countries grow at ***same growth rate a***
- If k below the steady state level → the further away, the faster it grows until reaching the steady state → **poor countries grow faster (catch up)**

However, in reality:

- Substantial heterogeneity in terms of GDP per capita growth rate
- Poorer countries not necessarily grow faster. Many poor countries seem to be 'stuck' in **growth traps.**

To explain **why some countries catch up** while **others do not**, move from original unconditional to conditional convergence.
Conditional convergence: countries with **different production functions** will converge to **different steady states**, characterized by different levels of output per (effective) labour.
Simple extension of Solow model can explain **'growth clubs'**

Augmenting the Solow Model

What determines the position of the production function?

- Human capital
- Public infrastructure
- Social infrastructure (institutions)

Macroeconomics - IBEB
Lecture 4 - Week 2

Labour Supply (LS)

Consumption-leisure trade off

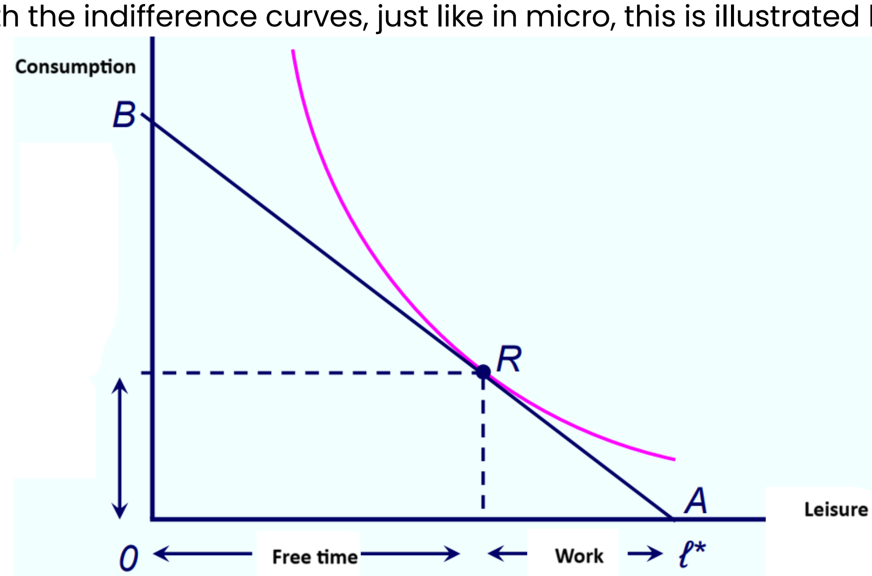
- In order to **consume goods**, individuals must **work**, i.e. **give up** some of their free time **(leisure)**

Individuals will want to **choose and optimize** their combination of leisure and consumption, given their **budget constraint** (same as microeconomics). Individuals base their decision on the returns they get from working: the **real wage, w.**

The next part will be a lot like microeconomics. Therefore, we use indifference curves and budget constraints. Let's first look at the supply of labour:

- **The budget constraint:** $C = al + b$
  With C being the real consumption. L is the free time in hours (leisure)
- The consumptive spendings being P(price) * C(consumption)
- The amount of available hours being: $l*$ and the hours worked being: $l* - l$
- The income being a function of the nominal hourly wage: W($l* - l$)
- The slope coefficient of the budget constraint = -w with w = W/P

Together with the indifference curves, just like in micro, this is illustrated below:



Utility is maximized at **R**, where **indifference curve = budget line**

Substitution vs Income Effect

Ambiguous effect of **increase in *w*** on **individual labour supply:**
Substitution effect → more labour supplied

- More money for 1 hour of work can incentivize individuals to work more

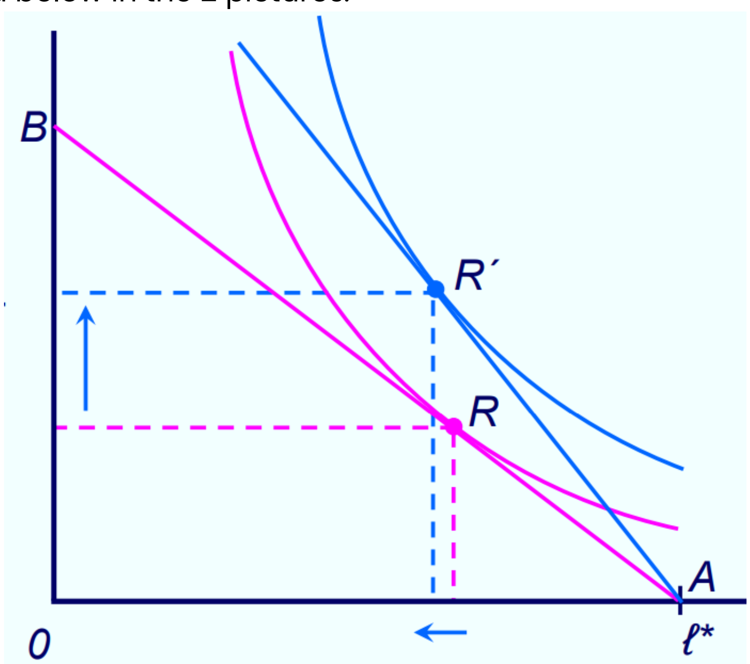
Income effect → less labour supplied

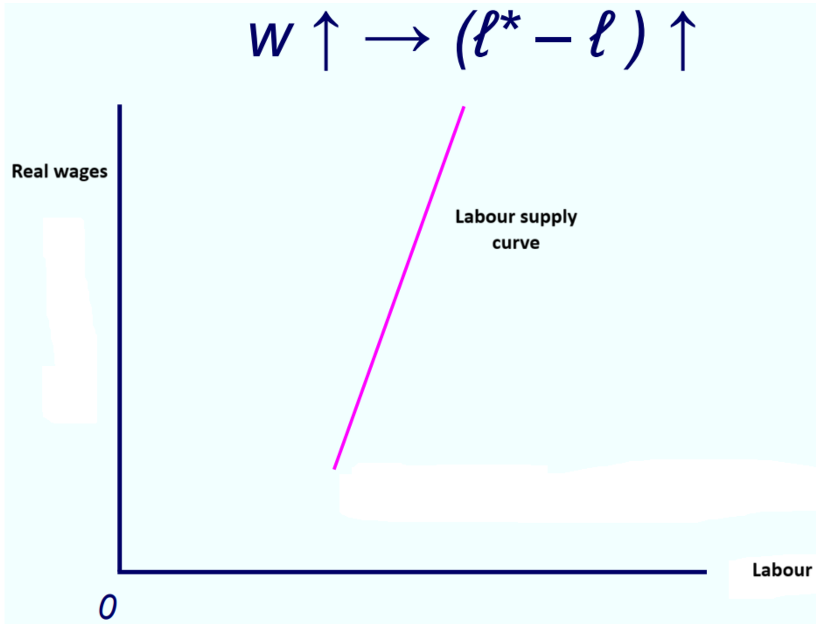
- Individuals can earn the same amount even while reducing working hours

Which effect dominates depends on the **slope** of an individuals consumption-leisure indifference curve.

- If substitution effect > income effect: ***w* increases → labour supply increases**
- If substitution effect < income effect: ***w* increases → labour supply decreases**

If there is an **increase in real wages**, with **substitution > income effect,** the graph can be illustrated below in the 2 pictures:





Aggregate Labour Supply

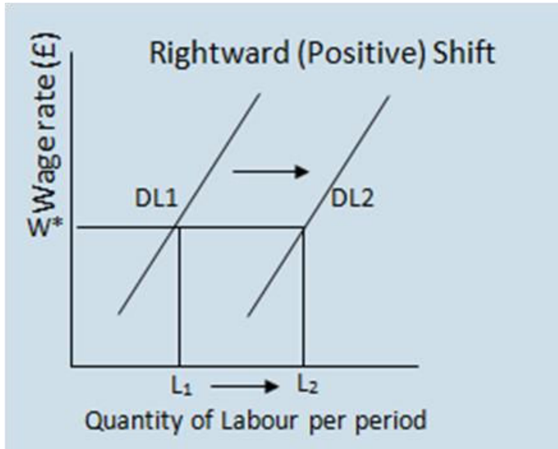
Aggregate supply: total number of hours supplied by all workers in the economy (measured in person-hours)
Two important properties of the aggregate labour supply (relative to the individual labour supply):

- **if w increases**: even if working individuals may not increase or even decrease their LS (i.e. strong income effect), some who preferred not to work may now join the labour force → **aggregate LS more likely upward sloping**
- Summing over many individual LS curves leads to a **flatter aggregate LS curve**

Change in Aggregate Labour Supply

Increase in aggregate LS ⇒ shifts curve to the right. This may be due to…

- Population growth
- Women entering the work force
- Immigration
- Etc.



Labour demand (LD)

Firms maximise profits (denoted as π):

$$\pi = pF(L,K) - WL$$

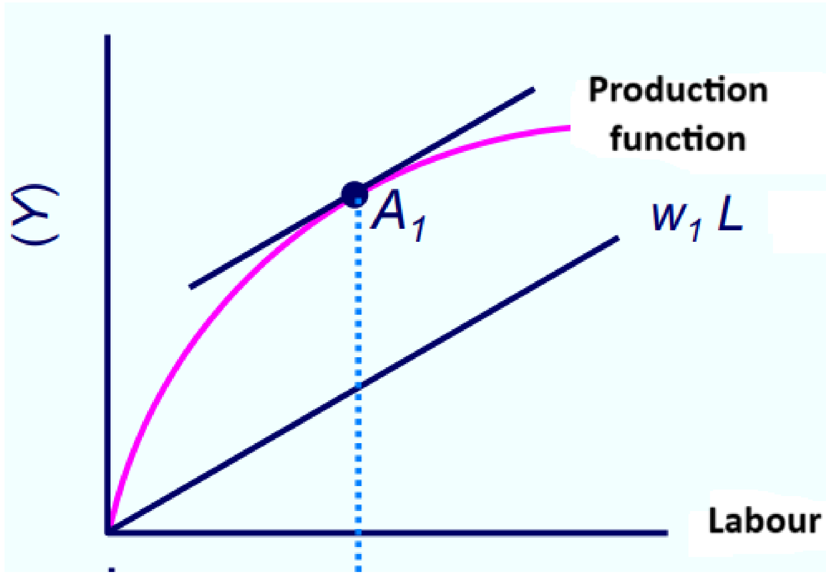
Where,
WL = nominal wage

First order condition with respect to L:

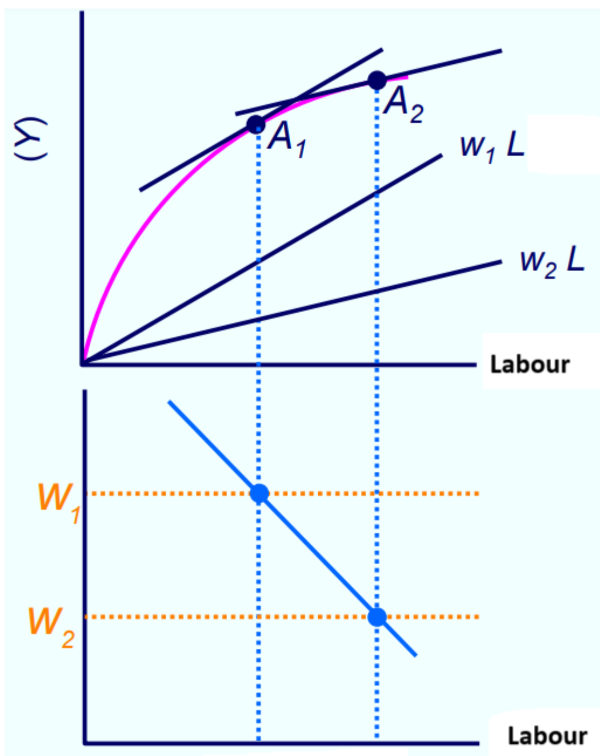
$$pF(L)' = W \leftrightarrow F(L)' = \frac{W}{p} = w$$

Where,
F(L)′ = marginal product of labour (MPL)
W = real wage

To derive labour demand, we find the maximum profit: when MPL = real wage. This illustrated below, and is done by taking the derivative of the production function minus the real wages and setting it to 0.



We now want to derive the **labour demand** curve. This is done by changing the wage rate (w) and taking the profit maximizing point for each rate. This is illustrated below, and can be illustrated in the demand curve.

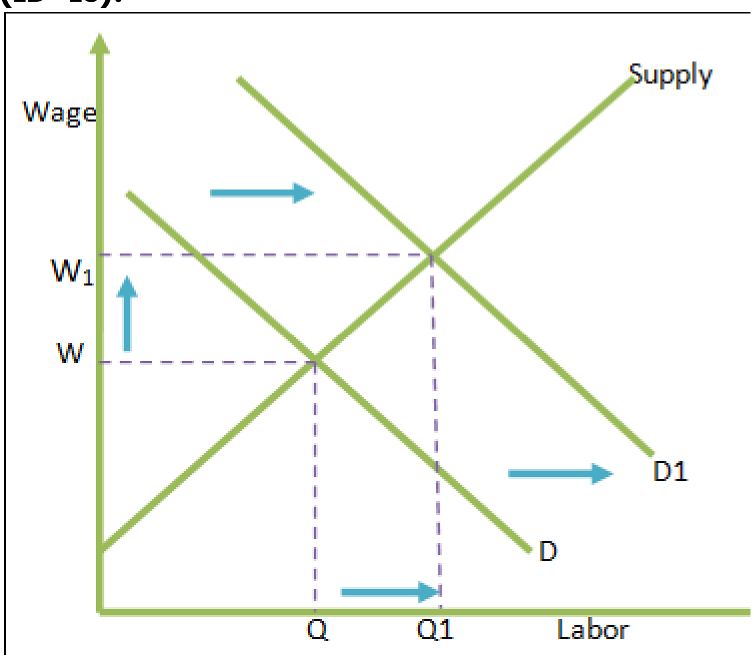


The demand of labour decreases if the real wages rise and **rises because of increases in capital and technological progress.** This is a pitfall for lots of students. You might think demand for labour decreases because of technological progress, although technological progress makes labour more efficient. Therefore, the demand of labour rise.

With an increase in the demand for labour, there will be **increased labour productivity**. This will lead to **an upward scaling of the production function**, and **an upward shift in the labour demand curve.**

Equilibrium in the Labour Market

At the **equilibrium wage**, **w,** the market clears when **labour demand = labour supply (LD=LS).**



If demand or supply shifts, the equilibrium wage and the equilibrium quantity of labour will change.
In the graph able, demand shifts outwards from D to D1, causing there to be an increase in wage (w to w1) and an increase in the quantity of labour (Q to Q1).

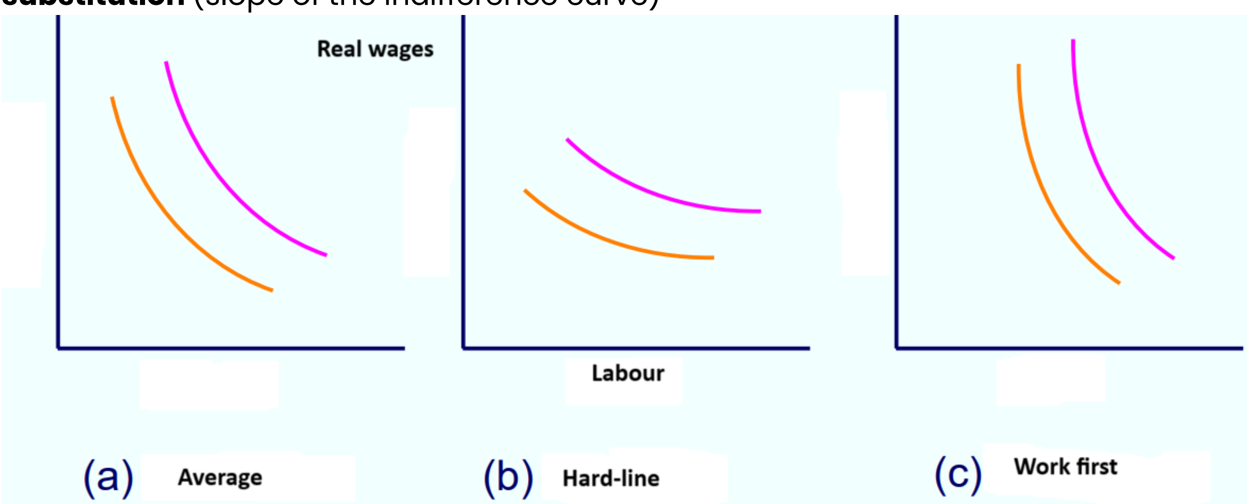
In this model, **all unemployment is voluntary** (the excess quantity of labour above Q). This reflects the **choice of individuals** who would **only supply labour at a higher wage than the equilibrium wage.**

Types of unemployment

Voluntary unemployment is unemployment where people looking for work, can find it. They choose not to work however, because they find the wages too low.
Involuntary unemployment is unemployment where people are willing to do work for the prevailing wage, although that work isn't there for everyone. This unemployment is structural in its nature. This is explained by **downward real wage rigidity**. This means the failure of the wage to adjust until equilibrium is reached.

There are 3 explanations for wage rigidity:
- Collective bargaining by trade or **labour unions**
- Existence of **wage regulation** and other social minima
- Firms themselves choose to pay **efficiency wage**

<u>**Collective Bargaining: Unions and Unemployment**</u>
Wages are mostly not negotiated by individuals and employers, but by **labour unions (LS) and employers' associations (LD)**.
Unions have 2 primary objectives: **higher wages or more jobs.**
Preferences of a union over labor and wages can be represented by **indifference curves**.
The union is willing to **trade off** jobs for wages at a rate given by the **marginal rate of substitution** (slope of the indifference curve)



The collective LS curve is **flatter** for **jobs first union** and **steeper** for **hard-line union**.
The extra power a labour union has makes for it that the collective labour supply lies higher than the household labour supply. This makes for it that the real wages are higher, but there is more unemployment.

Labour unions try to negotiate a wage above equilibrium value for different types of people:
Insiders: when employed individuals with little unemployment risk dominate the union ⇒ preference for higher wages and less concern about unemployment
Outsiders: unemployed lose to the advantage of organized insiders
Solutions: representation of unemployed in wage negotiations (e.g. SWE); participation of economist advisers (e.g. NLD)

Wage Regulation

A minimum wage is a wage higher than the equilibrium. This is regulated by law and prevents exploitation. However, firms don't hire employees with a lower labour productivity than the real wages. This leads to involuntary unemployment.
The difference between the labour force who is willing to work for the minimum wage and the labour demand at the minimum wage is the involuntary unemployment.

Efficiency Wages

Efficiency wages: **employers themselves** choose to **pay high wages** to their workers
This is because higher wages can lead to increased productivity via:

- Better nutrition and better health
- Reduced labour turn-over
- Decreased moral hazard problem
- Positive self-selection of workers

The model of unemployment

Changes in unemployment:

$$\Delta U = sL - fU$$

U: number of unemployed
L: number of workers with a job
s: **separation rate,** the fraction of workers losing their job over a given time period
f: **job finding rate,** the fraction of unemployed who find a job over a given time period

U increases when more people lose their job than find one

Unemployment rate:

$$u = \frac{U}{L^s}$$

i.e. the number of unemployed over the total labour force

Equilibrium unemployment rate: the rate of unemployment towards which the economy gravitates in the long run, usually about 5%.
This is also called the **natural rate of unemployment** or the **stead state unemployment rate.**

In **equilibrium,** the **unemployment rate is neither rising nor falling.**
Equilibrium unemployment rate = when inflow and outflow out of unemployment are equal:

$$\Delta U = sL - fU = 0$$
$$sL = fU$$

Using $L = (L^s - U)$, we can reformulate:

$$fU = s(L^s - U) \rightarrow \frac{fU}{L^s} = s\left(1 - \frac{U}{L^s}\right) \rightarrow \frac{U}{L^s} = \frac{s}{s+f}$$
$$u^n = \frac{s}{s+f}$$

Where u^n is the equilibrium unemployment rate

u^n= frictional unemployment + structural unemployment
Structural unemployment:

- **involuntary unemployment**, due to **wage rigidities**
- **fundamental mismatch** between the **number of people who want to work** and the **number of jobs** that are available (vacancies) at the going wage rate: LS > LD

Frictional unemployment (dynamics of labour force movement, labour turnover: when a worker quits a job, it takes time to find a new one)

- **natural consequence of job creation and job destruction**
- Always exists: even if **LS = LD and w at equilibrium level**

Why does frictional unemployment exist?

- Not all workers are identical: different preferences in jobs, abilities

- **Different jobs require different skills** → matching process between firms and workers takes time

More **efficient matching = less frictional unemployment**
- frictional unemployment will be higher, the higher the separation rate and the lower the finding rate: $u^n = \frac{s}{s+f}$
- i.e. less unemployment the faster unemployed individuals find new jobs or the lower the labour turnover

Will an increase in unemployment benefits increase or decrease frictional unemployment?
The answer is ambiguous because...
- More time may be taken to find a new job, because for a certain period of time individuals can get a fraction of my previous wage, f ↓
- It takes time to find a new job that really suits the individual, hence they are less likely to become unemployed again soon, s↓

Macroeconomics - IBEB
Lecture 5 - Week 2

Money

Definition of money:
Any generally accepted **medium of exchange** which enables a society to trade goods without the need for barter; any objects or tokens regarded as a **store of value** and used as a medium of exchange.
- Coins and banknotes collectively as a medium of exchange. Later also more widely: **any written, printed, or electronic record of ownership of the values represented** by coins and notes which **is generally accepted** as equivalent to or exchangeable for these.

Functions of Money

Money facilitates our life because it is…

1. A medium of exchange
2. A store of value
3. A unit of account: makes all prices easily comparably

An economy without money is called **a barter economy**

There are 2 types of money:

1. Fiat money: has little intrinsic value
   Example: the paper currency we use

2. Commodity money: has high intrinsic value
   Example: gold coins, salt ("salary"), cigarettes

Over time, money has evolved from commodity to fiat money

Money Supply (MS)

Who determines the MS of an economy?

- **Monetary authorities** issue coins and banknotes [European Central Bank (ECB), Federal Reserve Bank (FED), Bank of England (BoE), Bank of Japan (BoJ) …]
- **Private commercial banks** supply bank deposits (more in later on)

Historically:
Commodity money systems: mining corporations supply precious metals that are then coined by private or public mints
Free banking systems: coins and banknotes issued by private banks

Money Demand (MD)

How much money does the economy demand (MD)?

Transaction motive: Households hold part of their income as money to carry out transactions

Transactions (T) are a primary motive for the money demanded (M). People keep a share (k) of their money to fulfill their purchases. The expenditure is equal to the amount of transactions times the average price per transaction (P*Y). Transactions (T) depend on the real GDP (Y).
From this the **Cambridge equation** can be set up:

$$M = kPT \Leftrightarrow M = kPY$$

Note that: PY = nominal GDP

Money Market

Money market equilibrium: Money supply = Money demand

$$M^s = M^D = kPY$$

For fixed k: $\frac{\Delta M}{M} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y}$

<u>Analyzing inflation with money growth:</u>
$\frac{\Delta P}{P}$ reflects the price adjustment in the economy, which is also the same as inflation. We denote inflation by π.

$$\pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y}$$

Inflation occurs if M grows faster than Y:

- Individuals try to spend the additional money
- If firms' production cannot keep up with higher demand **too much money chases too few goods** → price adjustment (in this case, prices increase)

<u>Analyzing real output growth with money growth:</u>

$$\frac{\Delta Y}{Y} = \frac{\Delta M}{M} - \pi$$

Real output growth occurs if **M grows faster than π:**

- Individuals try to spend the additional money
- Firms' successfully **expanded production meets the additional demand** → quantity adjustment (in this case, output increases)

For given values of k and Y, changes in M^s imply directly proportional changes in P. This is called the **quantity theory of money**.

Neutrality of Money

Neutrality of money: money supply changes only affect nominal variable (prices, wages…), while they do not affect real variables (real output, real wage…)

Long-run money neutrality is a popular assumption in macroeconomics.
Money is not an argument in long-run production functions and economies cannot grow rich by simply printing money. (Recap Solow model)

Money growth and inflation when money is neutral:

$$\pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y}$$

This shows that changes in M **do not** affect real GDP. Also, changes in M lead to **directly proportional changes** in P.

If the average prices rise it is possible to do less transactions with the given M.
Therefore the real cash is relevant: $\frac{M}{P}$.
We can rewrite the to: $\frac{M}{P} = kY$. This is a **constant.**

The Dichotomy Principle

The **neutrality of money** is a manifestation of the **dichotomy principle**.
Dichotomy principle: Nominal and real variables are determined independently from each other.

- This means they can be analysed separately
- Helps to simplify many macro-models (e.g. Solow model)

However, there are some reasons for why the dichotomy principle and money neutrality might not hold, even in the long run.
Hysteresis effects:

- Temporary decline in R&D can permanently lower technological progress, *A*
- Temporary unemployment prevents learning on the job (scarring)
- High inflation can lead to real misallocation of resources

Exchange rates

The nominal exchange rates can be written in two main ways:

1. The British definition: Amount of foreign valuta / 1 domestic valuta (S = 1,35$/1€)

2. The European definition: Amount of domestic valutas / 1 foreign valuta (X€/1$)

In this course and in the book we use the **British definition**. We'll define S as the nominal exchange rate.
If S **increases**, it is called **appreciation** (an increase in the exchange rate)
- You will get **more foreign currency** for 1 unit of local currency

If S **decreases**, it is called **depreciation** (a decrease in the exchange rate)
- You will get **less foreign currency** for 1 unit of local currency

Nominal exchange rate: Converts one currency into another
The higher the price level of a region, the **lower the purchasing power** of that region's currency.
Purchasing power: the amount of goods you can get for 1 unit of currency.

Real exchange rate: relative price of the goods of two countries. The rate at which we can trade foods of one country for the goods of another country.
Real exchange rate is given by: $\sigma = \frac{SP}{P*}$.

Definitions:
- S = nominal exchange rate (British definition)
- P* = Prices of foreign goods (in $)
- P = Prices of domestic goods (in €)
- σ = Real exchange rate, or the amount of domestic goods in terms of foreign goods

Real exchange rate **appreciates** due to…
1. Nominal exchange rate **increasing**
2. Change in P > change in P*

Domestic goods become **relatively more expensive** → current account decreases (exports **decrease**, imports **increase**)

Real exchange rate **depreciates** due to the opposite reasons
1. Nominal exchange rate **decreasing**
2. Change in P < change in P*

Domestic goods become **relatively cheaper** → current account increases (exports **increase**, imports **decrease**)

Purchasing power parity (PPP)

Relative purchasing power parity gives that the real exchange rate is constant in the long-run:

$$\frac{\Delta\sigma}{\sigma} = \frac{\Delta S}{S} + \pi - \pi^* = 0$$

And therefore: $-\frac{\Delta S}{S} = \pi - \pi^*$

If **domestic inflation is higher than foreign inflation,** the **real exchange rate appreciates** (for given S)

Absolute purchasing power parity (Law of One Price) gives that the price of a good should be the same everywhere once converted into the same currency, where real exchange rate equals 1:

- $\frac{\Delta\sigma}{\sigma} = \frac{\Delta S}{S} + \pi - \pi^* = 0$
- $\sigma = \frac{SP}{P*} = 1 \Rightarrow \mathrm{S} = \frac{P*}{P}$

Relative purchasing power parity (PPP) holds if the real exchange rate is constant:

$$\sigma = \frac{SP}{P*} = constant \to \frac{\Delta S}{S} + \pi - \pi^* = 0$$

This requires that countries with relatively **high inflation rate** see their **currencies depreciate:**

$$\frac{\Delta S}{S} = \pi^* - \pi$$

Under relative PPP the **nominal exchange rate offsets price level changes** but allows for a constant wedge between home and foreign prices.

Relative PPP establishes the neutrality of money with respect to the real exchange rate.

Neutrality: $\pi = \frac{\Delta M}{M}$ (no real GDP growth)

Relative PPP: $\frac{\Delta S}{S} = \pi^* - \pi = \frac{\Delta M^*}{M^*} - \frac{\Delta M}{M}$

→ Money is neutral with respect to real exchange rate which is constant.

Under relative PPP, the **nominal exchange rate offsets** international differences in **money growth** (monetary policy)

Macroeconomics - IBEB
Lecture 6 - Week 2

Intemporal budget constraint

Intemporal budget constraints are equations which connect the past, today and the future for different sectors.
We are gonna look different sectors:

- Consumers
- Producers
- Government
- Economies of countries as a whole

Consumers

Let's start with the budget constraint for the consumer, in this case there are two periods: present and future.

- Income present/future: Y_1/Y_2
- Consumption present/future: C_1/C_2
- Real interest: r
- Vision from period 2: $C_1*(1+r) + C_2 = Y_1*(1+r) + Y_2$
- Vision from period 1: $C_1 + C_2 /(1+r) = Y_1 + Y_2/(1+r)$
- It is always possible to consume Y_1 in period 1 and Y_2 in period 2 ($C_1=Y_1$ & $C_2=Y_2$)

Hence, intertemporal budget constraint in present discounted value terms:

$$C1 + \frac{C2}{1+r} = Y1 + \frac{Y2}{1+r} \equiv \Omega$$

Discounting: valuing future income (or consumption) in terms of income today

Determinants of household savings and borrowing decisions:

- Preferences
- Interest rate
- Expectations about the future

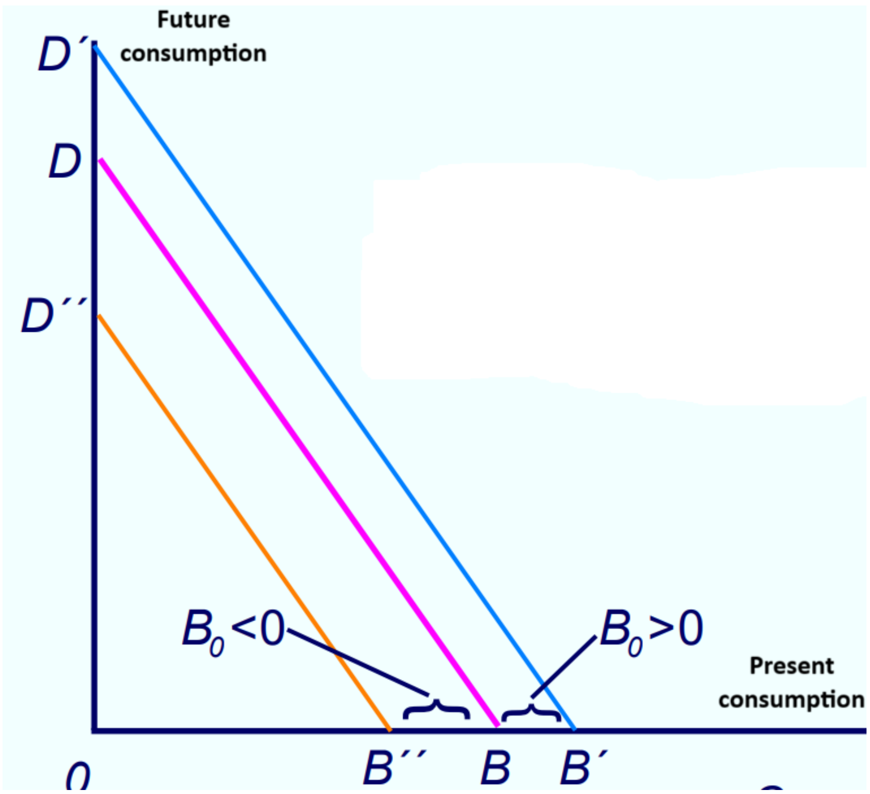
Rational expectation hypothesis

Absent uncertainty: rational expectations imply perfect foresight
With uncertainty: expectations can deviate from outcomes, but only randomly

Now let's say you own a heritage since the start of period 1. We call this heritage B_0. This changes the intemporal budget constraint to:

- $C_1*(1+r) + C_2 = (Y_1+B_0)*(1+r) + Y_2$

It is also possible that the heritage is a debt. Then B_0 will be negative.
Below is an illustration of this:



This subject is for big parts so if you find it challenging so far it is suggested to look into the microeconomics summary of intertemporal budget constraints.

Producers

Investment demand arises from firms' investment decisions, which are determined by:

- Production function
- Interest rate
- Expectations about the future

We know that the production-function is given by Y = F(L, K) although in lecture 2 & 3 of week 1 we learned how to write the production function in its intensive form: Y = F(K). We are interested in the capital because it's possible to invest in capital instead of saving money for interest.

Present value of profit from investment:

$$V = \frac{F(K)}{1+r} - K$$

We want to invest in physical capital if this yields more than a financial investment, when V>0. Formally this is written as: F(K) > K(1+r) where the yields of a financial investment are given by K(1+r).

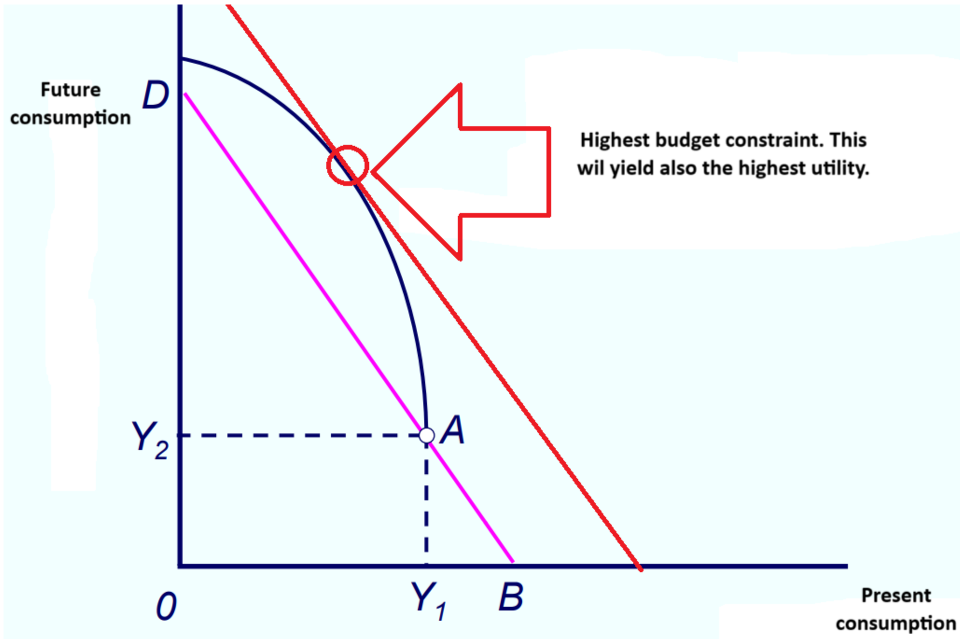
This can be rewritten as $\frac{F(K)-K}{K} > r$. Which translates to the net return on physical investment > return on financial investment. So as long as the production function line is above the opportunity cost line of investment (K(1+R)) profits are being made.

Wealth effect: We know that consumers have a big influence on producers. They are the producers (CEO's, investors, etc). Therefore, profitable investment increases household wealth:

$$\Omega = \mathrm{Y1} + \frac{\mathrm{Y2}}{1+\mathrm{r}} + \mathrm{V}$$

This shifts the household intertemporal budget constraint.

Below is illustrated how this is visualised. Note that the production function is mirrored because if we move to the left with present consumption, more is invested. Therefore, because of diminishing returns, the production function will first increase a lot after which the increases diminish. Our goal is to reach the highest budget constraint with the production function. Therefore, it isn't smart to invest everything in this particular production function.



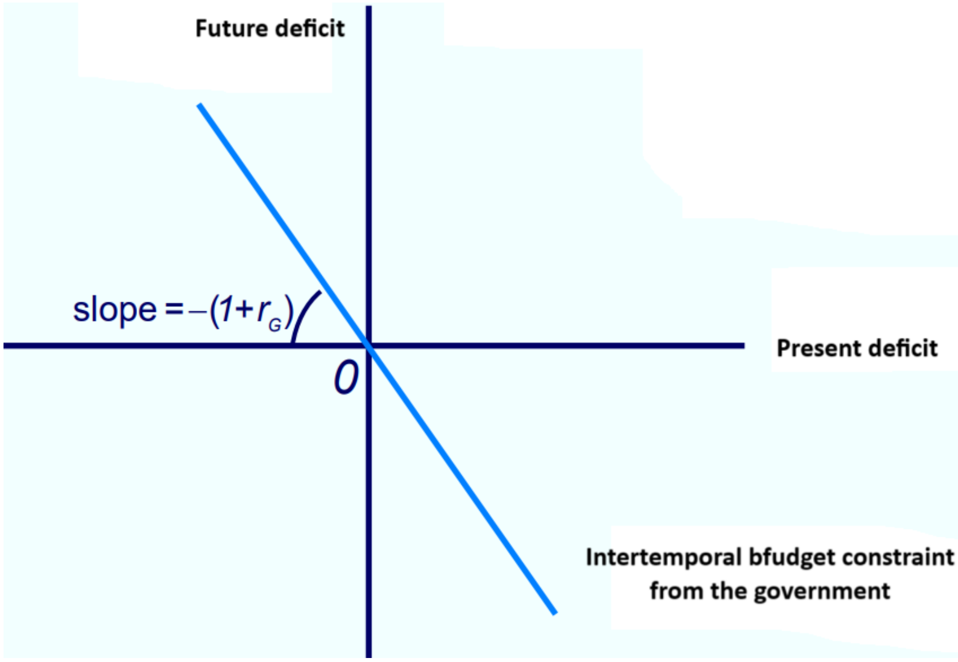
Profitable investment also allows households to consume beyond the initial budget constraint. The distance between the 2 parallel lines represents the additional goods that become available through investment.

Government

The government's intertemporal budget constraint is also very relevant in macroeconomics. Governments decide how much of its tax revenues (T) to spend (G).

- T-G > 0: **Primary budget surplus** (government lends)
- T-G < 0: **Primary budget deficit** (government borrows)

Government often faces lower interest rates than the private sector: $r_g < r$
Government IBC in 2-period setting: $G_1 + \frac{G_2}{1+r_g} = T_1 + \frac{T_1}{1+r_g}$



We can see that at points where there is a future deficit there is no present deficit and at points where there is a present deficit there is no future deficit.

The taxes used by the government to finance public spending are ultimately paid by individuals.

The **consolidated budget constraint** reflects this interdependence of private and public budget constraints:

Individuals: $C_1 + \frac{C_2}{1+r} = Y_1 - T_1 + \frac{Y_2 - T_2}{1+r}$

Government: $G_1 + \frac{G_2}{1+r_g} = T_1 + \frac{T_1}{1+r_g}$

Combining the individual and government constraints,

$$C_1 + \frac{C_2}{1+r} = (Y_1 - G_1) + \frac{Y_2 - G_2}{1+r} + \frac{r - r_g}{1+r}(G_1 - T_1)$$

Where,

$$C_1 + \frac{C_2}{1+r} = present\ value\ of\ consumption$$

$$(Y_1 - G_1) + \frac{Y_2 - G_2}{1+r} = present\ value\ of\ disposable\ income$$

$$\frac{r - r_g}{1+r}(G_1 - T_1) = present\ value\ of\ government's finance\ advantage$$

Assuming $r_g = r$, the expression can be simplified to:

$$C_1 + \frac{C_2}{1+r} = (Y_1 - G_1) + \frac{Y_2 - G_2}{1+r}$$

→ Households can only consume the resources that remain after government consumption

Ricardian equivalence

The consolidated budget constraint rearranged:

$$C_1 + \frac{C_2}{1+r} = Y_1 + \frac{Y_2}{1+r} - (G_1 + \frac{G_2}{1+r})$$

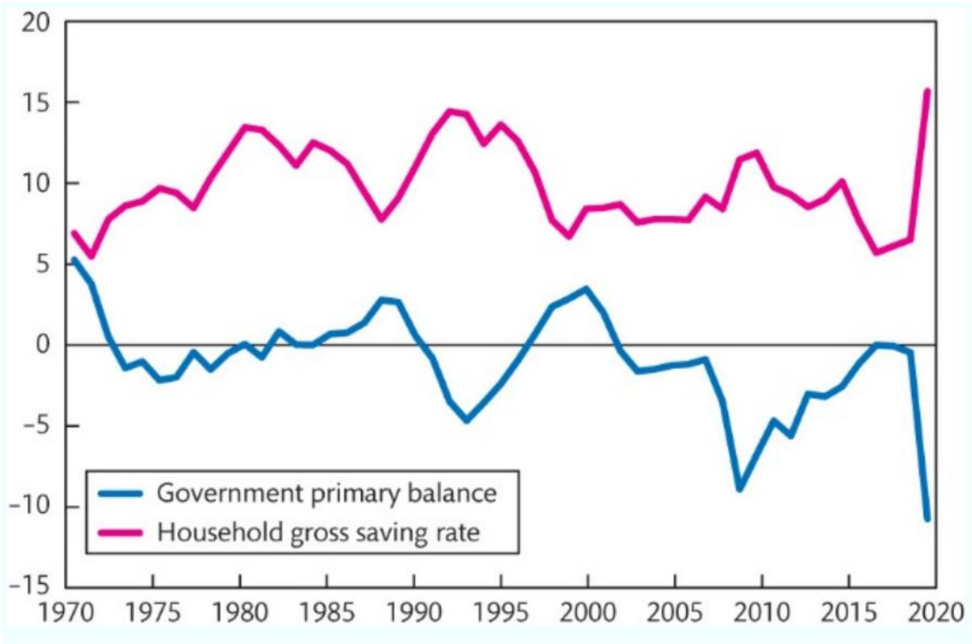
Ricardian equivalence assumes consumers are very smart. They keep the government's budget constraint (less tax now is more future tax). We see that in this ricardian budget constraint the consumer keep the government spending in mind. We can also see that taxing (T) has disappeared out of the constraint. **Tax changes don't influence the consumption anymore**.

There are a few reasons why Ricardian equivalence doesn't apply:

- $r_g \neq r$:The government pays a different interest than the private sector
- Finite lifespans: Keynes: "In the long run we are all dead". The consumer doesn't care if there is a shortage for the government when he dies.
- Credit constraints: The consumer doesn't get credit, for example a loan.
- Distortionary taxation: individuals change their behaviour in response to taxes
- Unemployed resources: government's financing decision can affect the level of income → shifts in the IBC

Credit constraints in more detail:
When a consumer is unable to get a loan, their consumption is limited to their income in the first period, hence they have a lower indifference curve. Governments can make households **better off** by **reducing taxes today**. Government borrowing today extends households'' budget constraints to a point that they want to consume, that they were initially unable to.
→ Ricardian equivalence failure as taxation pattern affects consumption choice
Here, the government borrows on behalf of its citizens.

Below you can see an illustration in which it looks like Ricardian equivalence is relevant until 1995, because the government primary balance and household gross saving rate are inversely related.



Whole economy (country)

Consolidated budget constraint = budget constraint of a nation

$$C_1 + \frac{C_2}{1+r} = (Y_1 - G_1) + \frac{Y_2 - G_2}{1+r}$$

$$\rightarrow C_1 + G_1 + \frac{C_2+G_2}{1+r} = Y_1 + \frac{Y_2}{1+r}$$

Where,

$$C_1 + G_1 + \frac{C_2 + G_2}{1+r} = present\ value\ of\ national\ consumption$$

$$Y_1 + \frac{Y_2}{1+r} = present\ value\ of\ national\ income$$

Borrow from rest of the world to **consume more in period 1:**
(C1 + G1) > Y1 ⇒ primary current account (PCA) deficit in period 1
(C2 + G2) < Y2 ⇒ PCA surplus in period 2

Borrow from rest of the world to **consume more in period 2:**
(C1 + G1) < Y1 ⇒ PCA surplus in period 1
(C2 + G2) > Y2 ⇒ PCA deficit in period 2

<u>External Debt Default</u>
Within countries: legal system resolves creditor-debtor conflicts

- Bankruptcy laws penalize defaults ⇒ incentive not to default (e.g. retention of income)

Internationally: enforcement of sovereign loan contracts is legally difficult

Why don't countries just walk away from their debt?
External debt default is still associated with some costs:
- Reputation effect: higher financing costs; exclusion from international capital markets
- Output losses

Macroeconomics - IBEB
Lecture 7 - Week 3

Consumption

Consumption is LESS volatile than investment.
This is because consumers are restricted to their budget constraints.

<u>Example: borrower</u>
Low income today and high income in the future.
Today, they experience debt-financed consumption and will need to borrow to consume at the optimal point.
Tomorrow, they can repay their debt (including interest) with the higher income they have.

<u>Example: lender</u>
High income today and low income in the future.
Today, they can save the high income and consume at a lower point most likely at the optimal consumption point.
Tomorrow, they can consume above their income with the money they saved in the 1st period.

Temporary income change
If **income increases today**, consumers will want to **save today**.

If **income increases tomorrow**, consumers will want to **borrow today** and **pays back tomorrow**.
This is called **consumption smoothing**; hence it explains the low variability in aggregate consumption.

Permanent income change: equal change in income in both periods.

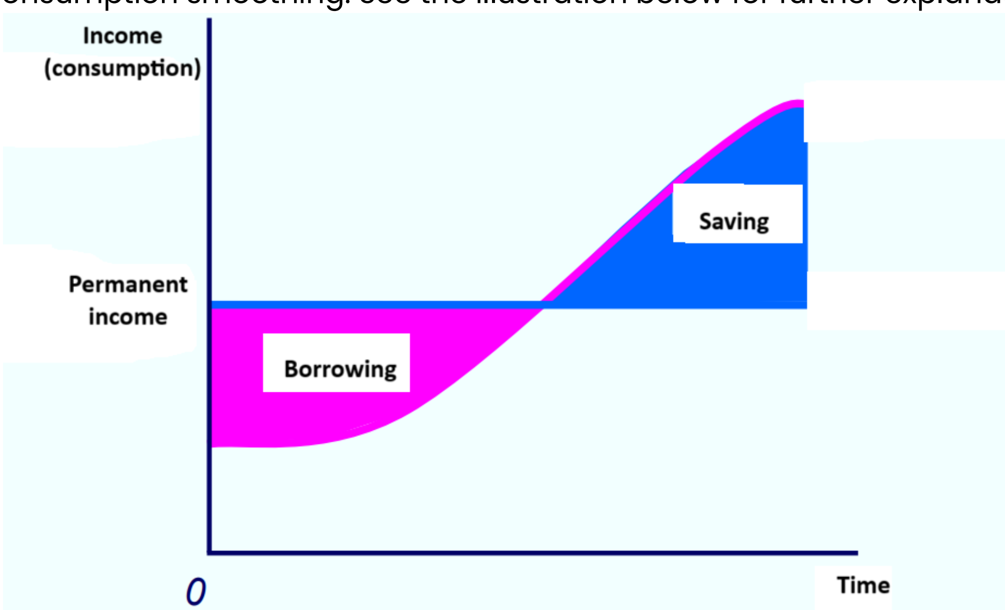
Consumption depends on **life-time income (wealth)**
$C_1 + C_2/(1+r) = Y_1 + Y_2/(1+r) = \Omega$
For consumption to change, wealth must change **unpredictably.**

- Wealth only changes if there is new information about future incomes.
- **Rational expectations →** only unpredictable changes count as news (e.g. lottery win)

So, changes in consumption should be unpredictable.

- Consumption should follow a **random walk**: $c_t = c_{t-1} + \varepsilon_t$ (however, this was not stressed a lot in the lecture)

The permanent income hypothesis (Also known as Life-cycle consumption) is a hypothesis in which a consumer spreads out its income over his lifetime. This is called consumption smoothing. See the illustration below for further explanation.



The permanent income is calculated by setting Ω (present value of current and future incomes) equal to the present value of a permanent income. This is mathematically illustrated below:

$$\Omega = Y_1 + \frac{Y_2}{1+r} = Y^P + \frac{Y^P}{1+r}$$

Exercise:
Y_1=100000, Y_2=200000, r=0.05
Calculate the permanent income.

Answer:

$$\Omega = 100000 + 200000/1.05 = 290476$$
$$290476 = Y_P + Y_P/1.05 \Leftrightarrow Y_P = 148780$$

Let's return to the consumption function,
$C = C(W, Y^d)$

What is the more important determinant, the permanent income, or the disposable income? According to the permanent income hypothesis and the life-cycle consumption is wealth (or permanent income) the most important determinant. According to the Keynesians is the disposable income the most important determinant.

The answer depends on the case, in case of credit restrictions for consumers the Keynesians might be more right, because it's not possible to create a permanent income. This is because it is not possible to take loans.

So, in conclusion the consumption function is given by $C = C(\Omega, Y^d)$. The influence of real interest is negative via Ω. Consumption is not very volatile if only the permanent income (Ω) has influence on C. Take in mind that this consumption function is simplified and in Ω financial assets and house prices should be added.

Investment

Investment is also known as **gross domestic capital formation.**

- Definition: demand for durable intermediate goods (e.g machine tools, computers, factory, buildings etc)

Investment goods enable the **production of goods and services for future consumption.**
Investment decision is an **intertemporal decision**.

In the previous lecture we learned that producers would invest if $\Pi(profit) > 0$. This is also written as $F(K) > (1+r)K$. If we want to optimize this the following principle will show up: $MPK = 1 + r$. When the interest (r) goes up the amount of capital invested will go down. Therefore, the interest has a negative impact on investment.

Tobin's q = Market Value / Replacement Value

The q theory of investments: links investments to Tobin's q.

If Tobin's q > 1: there are positive investments. An example of this is if the purchase of capital of 100, increases the market value with 120.

If Tobin's q<1: Negative investments, they will sell capital for the replacement value.

Market value of a firm is affected by the present discounted value of its future profits:

$$Q_t = \pi_t + \frac{\pi_{t+1}}{1+r} + \frac{\pi_{t+2}}{(1+r)^2} + \cdots$$

If the real interest increases, the present value of the expected future profits of the company will decrease. This will lower the market value and therefore indirectly lower the investments.
Expectations over the performance of the firm, the sector or macro-economic conditions will influence q and therefore the investments. Since expectations are often volatile this will lead to volatile investments. We often see that investments are way more volatile than consumption.

Macroeconomics - IBEB

Lecture 8 - Week 3

Money and monetary policy

The functions of money are:

- Medium of exchange
- Unit of account

- Purchasing power reserve

You can use goods as money: “commodity money” <-> fiduciary money (“fiat money”, intrinsically useless).

Types of money:
- M0 (“monetary basis”):
  -Currency in circulation (C)
  -Reserves of commercial banks (R)
- M1:
  -Currency: banknotes and coins (C)
  -Cashless money: Sight deposits at commercial banks (D)
- M2:
  -M1
  -Saving accounts
- M3:
  -M2
  -Larger, fixed term deposits
  -Accounts at non-bank institutions (e.g. money market fund accounts)

This is in reverse order of increasing liquidity, where M0 is the most liquid and M3 is the least.

Money-making institutions

- The central bank (ECB)
  -Legal mandate to control money and credit conditions
  -Brings banknotes and coins in circulation (C)
  -Reserves of commercial banks (R)
  -This is the monetary basis (M0)

$$M0 = C + R$$

- The commercial banks
  -Issue (short term) demand deposits (D)
  -Make (long term) loans (L)

$$M1 = C + D$$

  -D: liquid asset that (usually) yields higher returns than cash
  -**Maturity mismatch:** banks run risk
  -**Deposit insurance:** bank supervision and regulation

Fractional-reserve banking: commercial banks hold a fraction of deposits as reserves at the central bank.

- The central bank can indirectly control deposits (D) with a **reserve ratio requirement**

Reserve ratio rr: rr% of the deposits goes into the reserves. This is to make sure that banks can meet possible requests

Example:
Let's say Mr. A. deposits 1000 euro into the bank and the reserve ratio is rr=0.1. 900 will be lent out and 100 will go to the reserves. The 900 euro lent out will eventually be deposited into the bank again. This process continues until the 1000 euro is in the reserves. The total money "created" is 1000/0.1=10000, of which 9000 are lent out and 1000 are in the reserves.
Chain of deposit and credit creation **converges to finite values:**
Deposits (D) = 10,000 Loans (L) = 9,000 Reserves (R) = 1,000
This is called the **money multiplier** or the **reserve multiplier.**

This can be calculated with the formula,

$$x + (1 - rr)x + (1 - rr)^2 x + \cdots = \frac{x}{1 - (1 - rr)} = \frac{x}{rr}$$

Example: find the total increase in deposits (D) after an initial injection of x=$2000 into an economy with a reserve ratio (rr) of 5%.

$$D = \left(\frac{1}{rr}\right) * x = \left(\frac{1}{0.05}\right) * 2000 = 40{,}000$$
$$R = rr * D = 0.05 * 40{,}000 = 2000$$

Reserve multiplier: $\frac{1}{rr}$
Increase in deposits (D) = $\left(\frac{1}{rr}\right) * R$
Using these formulas, the formula for M1 can be written as:

$$M1 = C + \left(\frac{1}{rr}\right) * R$$

Knowing how the balances of the banks are structured is very important to understand monetary policy.
The **Central Bank:**

Assets	**Liabilities**
Foreign reserves	Money in circulation
Loans to commercial banks	Cash and reserves of commercial banks
Investments	Credits of the government
	Net assets

The **Central Bank:**

Assets	**Liabilities**
Cash and reserves at the central bank	Liabilities to the central bank
Investments	Credits of the private sector
Loans	Net assets

Instruments of Monetary Policy

1. Reserve requirements
   -rr increases → M1 decreases (contractionary)
   -rr decreases → M1 increases (expansionary)

2. Open-market operations
   -Central bank buys bonds → R increases → M1 increases (expansionary)
   - Central bank buys bonds → R decreases → M1 decreases (contractionary)

3. Interbank rate (i)
   -central bank lowers I → banks borrow more reserves, R increases, and offer cheaper loans, L increases → D increases → M1 increases (expansionary)
   - central bank increases I → more expensive to borrow so banks borrow less reserves, R decreases, and offer more expensive loans, L decreases, so D decreases → M1 decreases (contractionary)

The money-market

The demand for money is given by: $M^d = kPY$
Although keep in mind that the nominal interest rate (i) also influences the demand for money: $i = r + \pi$.
We can rewrite the demand for money by: $M^d = k(i)PY$
Recall that k is a constant fraction of income for transactions. k depends on the interest rate (i) and is the **opportunity cost of holding money.** So, the demand for money is **negatively** related to the interest rate.

The demand for money implies an indirect demand for monetary basis by the banks. Banks with too much or too little reserves can go to the **interbank market**. There they can lend and borrow among themselves for interbank interest. **Interbank interest in the eurozone is the ESTR** (European Short Term Rate, before it was called the EONIA).

The supply of money is controlled by the central bank (ECB - European Central Bank). If the banks would like more reserves then the central bank can create them via:

- Loans to the banks
- Via purchases of short-term assets of the banks.

In short: The monetary basis is controlled by the central bank. If the bank doesn't react to a rise in the demand for money the interbank interest will rise. If the central bank would like to keep the interbank interest constant they should supply more money to the monetary basis. The central bank can choose every combination of monetary basis money and interest rate along the demand curve.

The central bank has a hard time controlling the amount of money, because they use the interest rate as a monetary policy instrument.

There are 3 basic types of interest:

- Refinancing interest (**refi**): A weekly auction for the market to help the weekly liquidity of banks
- Marginal loan interest: A daily interest for the daily liquidity of banks
- Deposit interest: For if banks deposit money at the ECB.

Normally -> Marginal loan interest > Refinancing interest > Deposit interest

Monetary policy

Monetary policy is a task of the central bank. This is done with **instruments (explained before)**, for example interest or mandatory reserves. It's done via **monetary strategy**, for example money growth rules and it's done with specific objectives in mind, for example 2% inflation a year.

Monetary policies at the zero lower bound:
Quantitative Easing (QE):
- CB buys bonds of longer maturity (government and corporate)
- Goal: lower long-term interest rates

Forward Guidance:
- Central bank announces intentions about future policy
- Goal: lower long-term interest rates

Monetary Financing (more covered in lecture 15):
- CB credits government account at the central bank with reserves
- Goal: soften budget constraint for the government's fiscal branch

Helicopter money
- Hand out new money to citizens
- Goal: income and demand stabilization

Monetary policy is a task of the central bank. This is done with **instruments**, for example interest or mandatory reserves. It's done via **monetary strategy**, for example money growth rules and it's done with specific objectives in mind, for example 2% inflation a year.

Objectives of the monetary policy: Price stability, for example 2% interest, employment and economic growth.
Strategy of the monetary policy: Money growth targeting and inflation targeting.

Potential tradeoff:
- M increases: growth and employment increases in the short-run
- M increases: may lead to inflation in the long-run

Monetary targeting
- Money supply as an intermediate target
- Requires stable money demand equation and stable relation between M0 and higher aggregates

Inflation targeting
- Explicit target for inflation
- Inflation forecasts play an important role

• expected inflation high ⇒ increases policy rate
• expected inflation low ⇒ decreases policy rate

An important equation which describes the monetary policy relatively well is the **Taylor Rule**:

- $i = \underline{i} + a(\pi - \underline{\pi}) + b\frac{Y-\underline{Y}}{\underline{Y}}$

Where,

- $\underline{\pi}$: desired inflation (inflation target)
- $\underline{Y}$: desired output (potential output)
- $a \& b$ objective weights
- $\pi > \underline{\pi}$ or $Y > \underline{Y}$: central bank increases i
- $\pi < \underline{\pi}$ or $Y < \underline{Y}$: central bank decreases i

- $Y - \underline{Y}$ reflects the output stability. It is the output gap.
- $\pi - \underline{\pi}$ reflects the price stability. It is the difference between the real inflation and the target inflation.
- It's important to see that when economic activity is low, interest is lowered and when economic activity is high, interest is increased.

Natural interest rate ($\underline{i}$):

- Equilibrium rate at which the economy operates at potential.
- Determined by structural factors: technological progress, demographics, inequality.

Macroeconomics - IBEB

Lecture 9 - Week 4

IS-TR Model Introduction and Keynesian economics

In the short run: <u>**prices are fixed.**</u>

- Aggregate demand **determines output of firms**. If aggregate demand ≠ supply: Supply adjusts to demand.

- **Real side** and **nominal side** of the economy interact with each other. IS curve describes the equilibrium in the goods market. TR curve describes equilibrium in the money market.

Together, IS-TR determines the real GDP (Y) and interest rate (i).

Keynesian economics: A theory of total spending in the economy (called **aggregate demand)** and of **its effects on output and inflation**.

Aggregate Supply & Aggregate Demand

GDP: Y = C + I + G + NX
Aggregate Supply (Y): Total volume of goods and services brought to the market by producers at a given price level.
Aggregate Demand (C+I+G+NX): Sum of consumption, investment, government purchases of goods and services, and net exports.
In the short run: Prices are fixed, and **supply adapts to demand.**

Determinants of aggregate demand:
Consumption (C): depends *positively* on **wealth and disposable income (Y-T, taxes are exogenous).**

$$C(\Omega+,(Y-T)-)$$

Investment (I): depends *positively* on the **Tobin's q** and *negatively* on the **interest rate i.** Prices are fixed: **nominal interest rate = real interest rate.**

$$I(q+,i-)$$

Government spending (G): assumed to be exogenous.
Net exports (NX)

- Demand for exports (X): depends *positively* on **foreign income Y*** and *negatively* on the **real exchange rate σ**
- Demand for Imports (Z): depends *positively* on **income at home Y** and *positively* on the **real exchange rate σ**

$$NX(Y-,Y^{*}+,\sigma-)$$

If we add all these components together, we can get the equation for desired demand (DD).

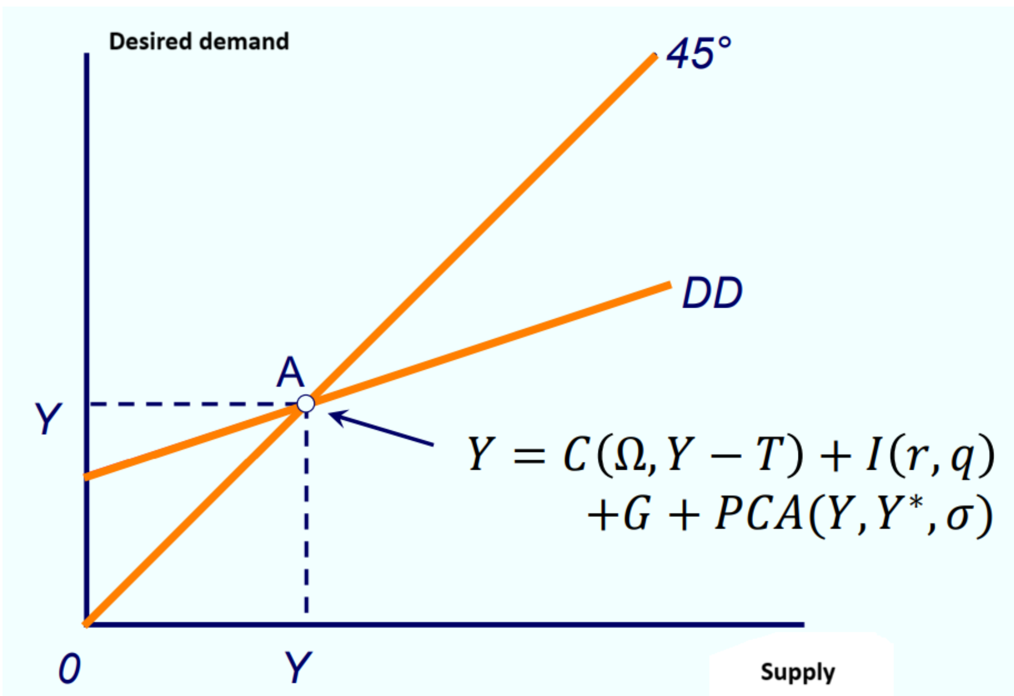
$$DD = C(\Omega, Y-T) + I(q,i) + G + NX(Y, Y*, \sigma)$$

Desired demand: amount of goods economic agents would like to consume given disposable income, wealth, interest rate, etc.
Y: actual supply of goods
In equilibrium: Y=DD

This means that **total supply of goods = total demand for goods**.

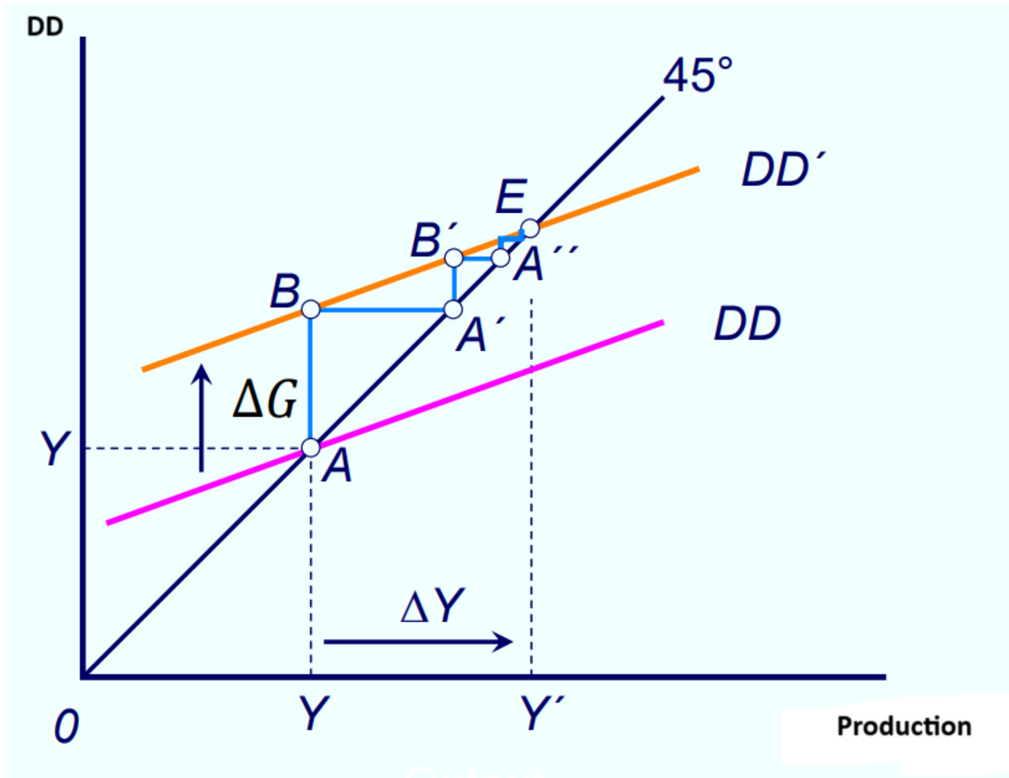
Interactions of markets in a closed economy

Let's first start with the equilibrium scenario where Y = C + I + G + NX. We do this with the desired demand curve (C+I+G+NX) and the 45* diagram. Which is also called the Keynesian cross. The desired demand has to equal supply therefore we can set a 45* equilibrium curve: Ydemand=Ysupply. All points on this curve can be a equilibrium depending on the desired demand curve. This is illustrated below.



The **Keynesian Multiplier** is a situation where the government increases its spendings which leads to an increase of income/production greater than its increase of spendings. It is given by: $\frac{\Delta Y}{\Delta G}$

This is illustrated below:



Eventually this multiplier effect will come to an end. This is because one of the following three leaks:

- A percentage of income will be saved: savings leaks.
- A percentage of income will be spent on import: import leak
- A percentage of income will be taxed: tax leak.

When these percentages increase the multiplier will decrease.

It's possible to derive the Keynesian Multiplier yourself.
First, we need to assume that:

- Consumption: $C = \Omega + c(Y - T)$, where c is the marginal propensity to consume, 0<c<1.
- Government spending: G
- Investment: $I = b_0 - b_1 i$, where i is the interest rate
- Exports: X
- Imports: Z= zC, where z is the proportion of consumption spent on imported goods, 0<z<1.

$$Y = DD = C + I + G + X - Z$$
$$Y = DD = \Omega + c(Y - T) + G + b_0 - b_1 i + X - z[\Omega + c(Y - T)]$$
$$Y = DD = (1 - z)[\Omega + c(Y - T)] + G + b_0 - b_1 i + X$$

$$Y = \frac{1}{1-(1-z)c}[(1-z)[\Omega - cT] + G + b_0 - b_1 i + X$$

$$\frac{\partial Y}{\partial G} = \frac{1}{1-(1-z)c} > 1$$

Hence, the Keynesian Multiplier is $\frac{1}{1-(1-z)c}$.

Multiplier: how much income changes in response to a small, exogenous increase in demand.

The larger the c and the smaller the z, the bigger the multiplier.

Empirical effect of fiscal policy on output

Empirical correspondence of the Keynesian multiplier w.r.t. fiscal policy: fiscal multipliers

Fiscal multipliers measure the empirical effect that **fiscal shocks have on output**. Fiscal multipliers are usually defined as the percentage change in real GDP that follows a fiscal shock totaling 1% of GDP.

There has been a long debate about the size of the fiscal multiplier in the literature. The empirical estimates vary substantially from 0 to 2, and the size of the fiscal multiplier is **context dependent**.

- t depends on (c) the marginal propensity to consume,
- the level of trade openness (z)
- the state of public finances etc., • on the fiscal instrument, e.g., tax, military spending
- on the sign of fiscal policy change (expansionary/increase vs. austerity/contractionary/decrease)
- on what happens on the nominal side of the economy, in particular the response of monetary policy (Ch. 11b) and exchange rate (Ch. 12)
- General equilibrium effect matters! → more on this later in the IS-TR(- IFM) framework

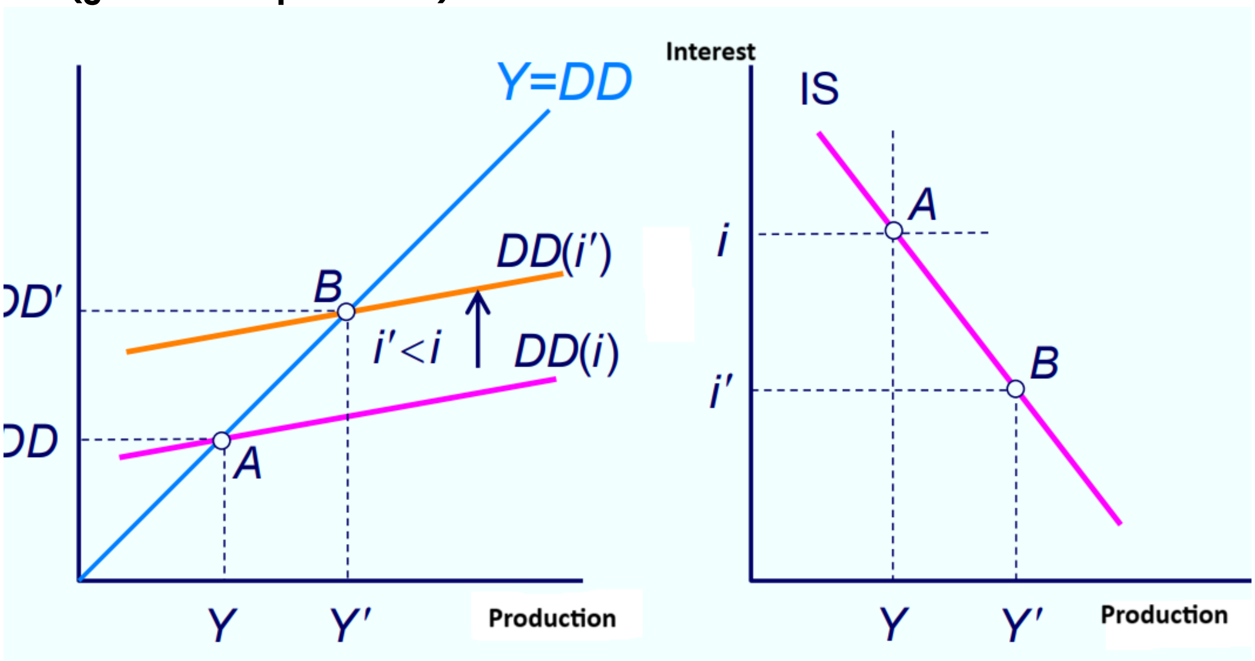
IS Curve

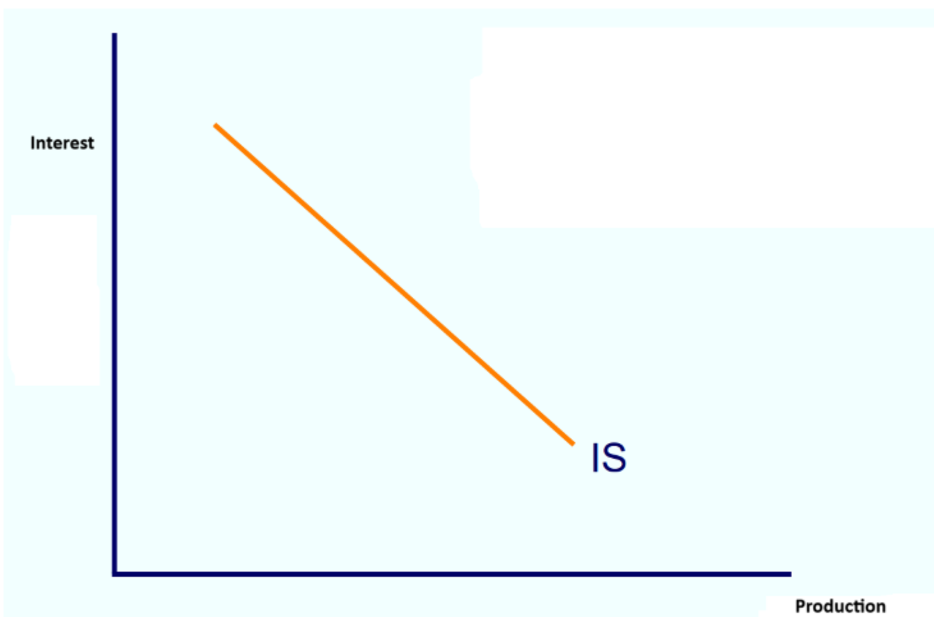
We'll start out with the **IS-curve**. This curve will describe the market of goods. These are combinations of interest (i) and production/income (Y) for each DD=Y equilibrium. Because the desired demand is a function of i it's possible to create a function for the interest and production/income for when all the other variables are ceteris paribus.

$$Y = DD = C(\Omega, Y - T) + I(q, i) + G + NX(Y, Y*, \sigma)$$

Based on the investment equation, as i increases, investment decreases, leading to a lower DD and Y. Hence, the IS curve is **downward sloping.**

The IS-curve is illustrated below. Make sure you understand that a **change in interest causes a movement along the line.** A **change in for example exogenous variables as G(government purchases) causes the line to shift**.





What shifts the IS Curve **to the right?**
Anything that **increases DD** (an increase in C, I, G or NX) **but not the interest rate!**
Examples:

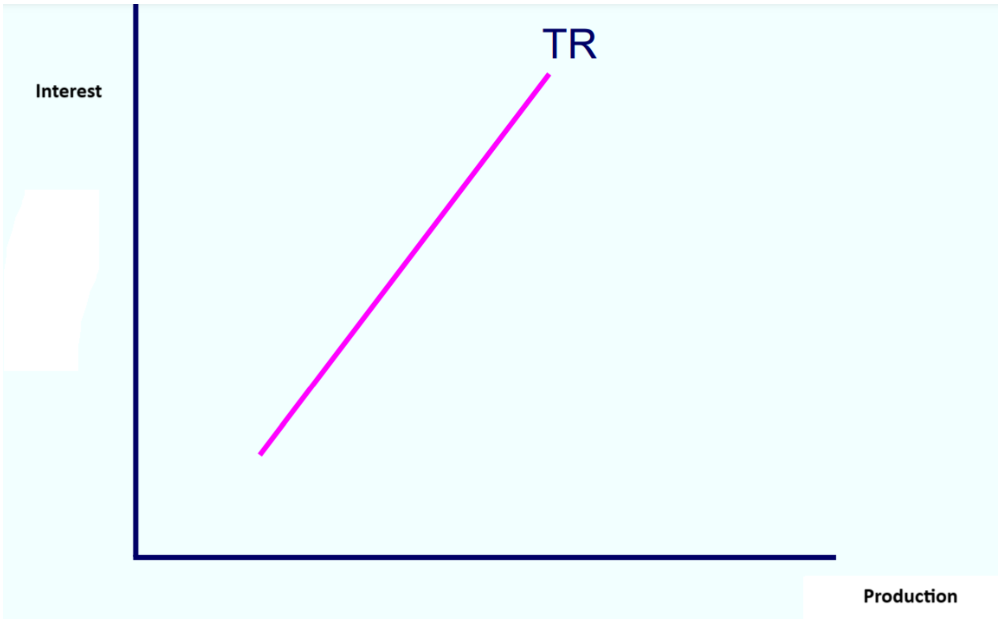
- Higher wealth (increases C)
- Lower taxes (increases C)
- Higher Tobin's q (increases I)
- Higher government spending (increases G)
- Higher foreign income (increases NX)

More DD → rightward/upward shift of IS
Less DD → leftward/downward shift of IS

Macroeconomics - IBEB
Lecture 10 - Week 5

TR Curve

The **TR-curve** describes the money markets and in particular the monetary policy of the central banks. The monetary policy is described by the Taylor Rule. Because **prices are constant in the short run,** the Taylor rule given by: $i = \underline{i} + b(Y - \underline{Y})/\underline{Y}$.
A while ago we learned about monetary policy. The central banks are leaning "against the wind" therefore its slope is positive. This is illustrated below.



Changes in b changes the **slope** of the TR curve.
Changes in the natural interest rate $\underline{i}$ **shifts** the TR curve.

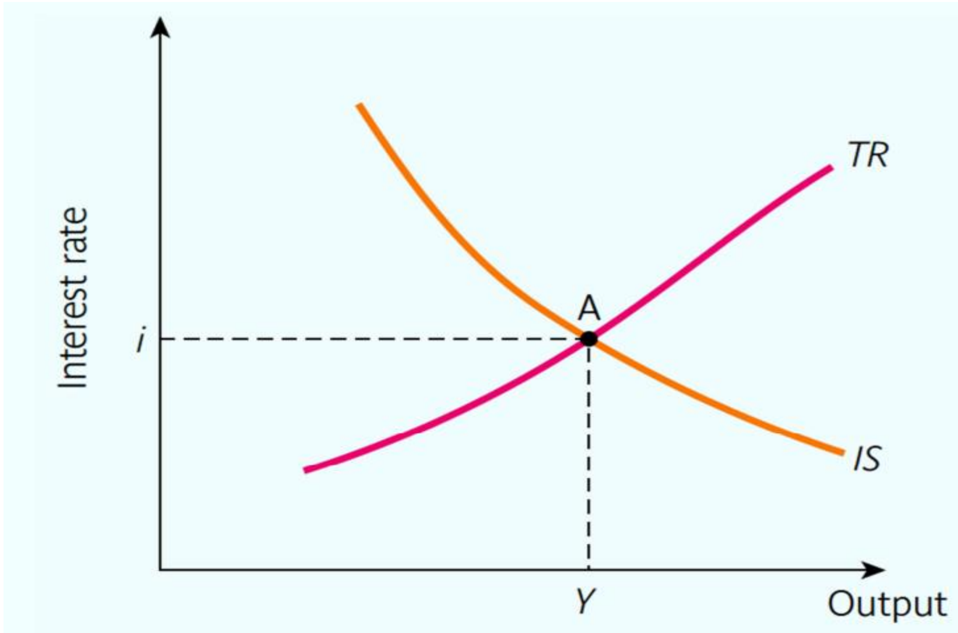
Monetary Policy Shocks: TR-curve

Monetary policy shocks/disturbances affect the TR curve in the same way as changes in the natural rate. But shocks/disturbances can only be temporary.
$i=(\underline{i}+\varepsilon)+b(Y-\underline{Y})/\underline{Y}$
ε: represents the shocks

Expansionary monetary policy: central bank **lowers** its policy rate to provide stimulus for the economy (AKA negative shock)
Contractionary monetary policy: central bank **increases** its policy rates.

IS-TR Equilibrium

The equilibrium will be reached where the IS and TR curve intersect. This is where the market of goods and the market of money are in equilibrium.



The central bank must provide as much money supply as demanded at the policy rate to ensure money market equilibrium.

Disturbances may come from the real side (IS shifts) or the monetary side (TR shifts) of the economy.
IS or TR shifts can be caused by:

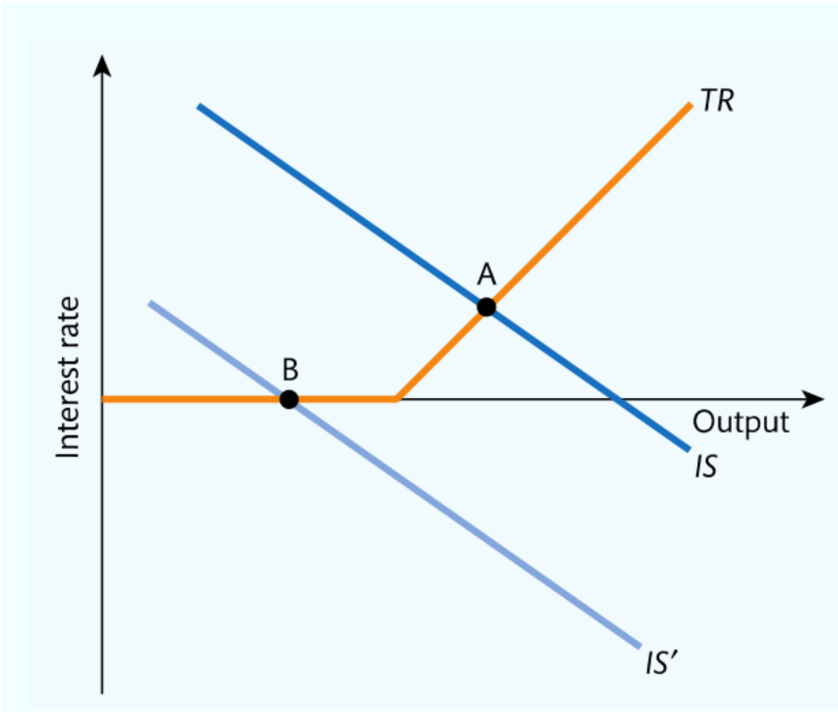
- Policy: shifts in taxes and in government spending as well as changes in monetary policy
- Shocks: shifts in firms' confidence, households' wealth…

Example: If there is a positive demand shock…
IS curve shifts upwards. Keynesian multiplier effect in goods market increases output Y. Central bank reacts to the increase in Y by increasing interest rate which in turn leads to a movement along the IS to a higher interest rate to limit the output gap. Hence, Y and i increases.

Example: If there is an increase in government spending, IS shifts up
This is a fiscal multiplier which measures the empirical effect that fiscal shocks have on output.
Partial equilibrium: if we consider only the goods in the market equilibrium (IS curve) while ignoring the effect of the increase in G on interest rate i, only output increases without an increase in i.

General equilibrium: if we consider both the goods and money market (IS and TR curves), output increases depend on monetary policy. This means that, depending on how steep the TR curve is, the increase rate will change accordingly.

We can also keep in mind that there is a **zero lower bound/effective lower bound** on interest, where the interest rate cannot fall below 0, hence the horizontal part of the TR curve. We can apply this to the TR curve.



We can use quantitative easing (=large scale purchases of assets by central banks, usually of long-maturity government debt but also of private assets). QE does not affect the TR curve. But, it **shifts the IS curve to the right**.
This is done by:

- Increasing stock prices → Tobin's q increases leads to higher investment
- Household wealth increases → higher consumption.
- Longer term interest rate decreases → housing and firm investment increases

Expansionary fiscal policy can also help to shift the IS curve to the right, to move the economy away from the effective lower bound. This can be done though **increases in government spending or decreases in tax**.

Macroeconomics - IBEB
Lecture 11 - Week 5

The Mundell-Fleming Model

- An extension of the IS-TR model for the **open economy** with internationally integrated financial markets.
- The key variable is the **exchange rate.**

Key assumptions:

- Sticky (fixed) prices
- Small open economy (small: affected by the rest of the world, but cannot affect it // open: free international trade & **perfect capital mobility**)

Perfect capital mobility: the rate of return (in the same currency) on assets sharing the same risk profile should be identical.

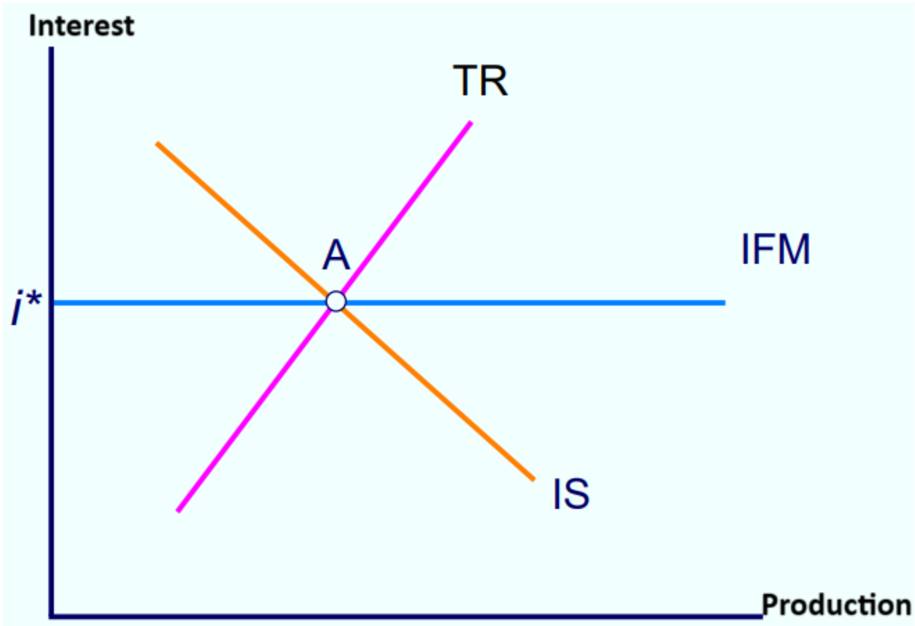
$$i = i^*$$

i: domestic interest rate
i*: international rate of return
If i≠i*, investors would be able to make profits by borrowing in one market and lending in the other (arbitrage occurs)

When i>I*, **capital flows in** because it is more attractive to invest in domestic currency. This leads to **appreciation** of the exchange rate. This leads to **domestic goods being relatively more expensive**, so exports decrease while imports increase, causing **IS to shift left**.

When i<i*, **capital flows out** because it is more attractive to invest in foreign currency. This leads to **depreciation** of the exchange rate. This leads to **domestic goods being relatively cheaper**, so exports increase while imports decrease, causing **IS to shift to the right**.

It is important to note that changes in the exchange rate does not impact the TR curve.



The **IFM-curve** is a horizontal curve at the set international interest rate (i*).

Exchange Rate Regimes

Flexible rates (floating):

- the exchange rate level is determined by the underlying private supply and demand for the currency
- Central banks do not intervene in the foreign exchange market. The exchange rate adjusts freely to equate the private supply and demand

Fixed rates (peg):

- the exchange rate is prevented by the central bank to move freely against another currency
- Central banks intervenes in the foreign exchange market to ensure that the target exchange rate does not change when private demand/supply changes, via adjustments in the money supply. (E.g. High private demand for domestic currency → upward pressure on the exchange rate → CB sells currency (i.e. increases money supply) → exchange rate remains unchanged

Intermediate:

- e.g., target zones, crawling peg, ...

IS-TR-IFM Equilibrium with Flexible Interest Rates

<u>If there is a positive demand shock (e.g. increase in G)…</u>

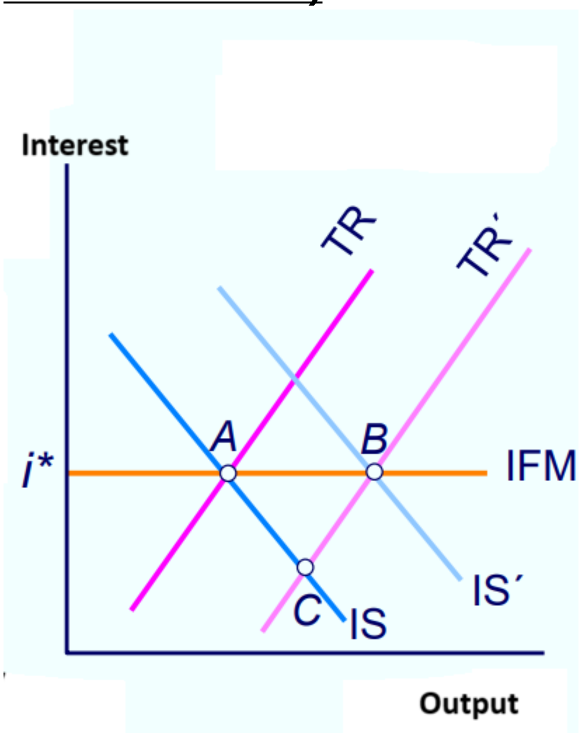
- Goods market: increases G → IS shifts right → Y increases
- Money market: increase in Y → increases interest rate (movement along TR)

Usually, this is where the new equilibrium would lie in a **closed economy**.
However, since we are dealing with an **open economy**, things are different.

- Foreign exchange market: the new interest rate is higher than i*, thus there is capital inflow, causing the exchange rate to appreciate
- Goods market: as the exchange rate appreciates, NX decreases → IS shifts left **back to initial position.**

This example shows that in an open economy, **fiscal policy is ineffective in affecting output.**

<u>If there is an expansionary/negative monetary policy shock (e.g. decrease in the natural interest rate)</u>



- Money market: TR shifts right due to decrease in interest rate
- Foreign exchange market: interest rate is smaller than i* → capital output, leading to depreciation in exchange rate

On the graph, this moves from point A to C.

- Goods market: since exchange rate decreases, NX increases → IS shifts right

- Money market: Y increases → interest rate increases (movement along the TR curve)

Moves from point C to B.
So, equilibrium changes from A to B with i* remaining unchanged, and with a higher output Y and the exchange rate depreciating.
Hence, in an open economy, **monetary policy is highly effective in affective output.**

<u>If there is an increase in i* → i'* > i*</u>

- Foreign exchange market: i<i'* → capital outflow → exchange rate depreciates
- Goods market: since exchange rate depreciates → NX increases causing IS to shift right and output to increase
- Money market: Y increases → i increases to i=i'* (movement along the TR)

So, equilibrium increases to a higher interest rate, higher output level, and exchange rate depreciates.

IS-TR-IFM Equilibrium with Fixed Interest Rates

Fixed exchange rate + full capital mobility

- The central bank intervenes in the foreign exchange market to keep the exchange rate constant when private demand for the currency changes → **interventions require adjusting the money supply.**
- The central bank cannot set money supply and the interest rate independently.
- Fixed exchange rate → money supply determined by the need to stabilize the exchange rate → central bank loses control over the domestic interest rate

Hence, Fixed exchange rate + full capital mobility ⇒ loss of monetary autonomy
NO TR curve ⇒ equilibrium determines by IS-IFM

<u>If there is a positive demand shock (e.g. increase in G)</u>

- Goods market: increase in G → IS shifts right and Y increases
- Money market: Y → higher demand for money → increase in interest rate
- Foreign exchange market: i>i* → capital inflow → upward pressure on the currency
- Money market: central bank increases money supply, interest rate decreases until i=i* to ensure exchange rate is **unchanged**

So, i(=i*) and exchange rate remain unchanged while Y increases.

This shows that in an open economy, fiscal policy is **highly effective in affecting output.**

<u>If there is an increase in i* → i'* > i*</u>

- Foreign exchange market: i< i'* → capital outflow → downward pressure on exchange rate
- Money market: central bank decreases money supply, so interest rate increases until i=I'* to ensure exchange rate remains **unchanged**

So i(=I'*) is higher, while output is lower and exchange rate is unchanged.

To maintain a fixed exchange rate, central bank must reverse the increase in money supply or the decrease in the interest rate, neutralising the initial effect.
No independent monetary policy under fixed exchange rate and perfect capital mobility.

Simple summary:

		Open economy	
	Closed economy	**Fixed Rate**	**Flexible Rate**
Positive demand shock	Output Y: increases Interest rate: increases	Output Y: increases Interest rate: unchanged Exchange rate: unchanged (fixed) Effectiveness of fiscal policy: HIGHLY EFFECTIVE	Output Y: increases Interest rate: increases Exchange rate: appreciates Effectiveness of fiscal policy: INEFFECTIVE
Expansionary monetary policy	Output Y: increases Interest rate: decreases	Output Y: decreases Interest rate: increases Exchange rate: unchanged (fixed) Effectiveness of monetary policy: INEFFECTIVE	Output Y: increases Interest rate: unchanged Exchange rate: depreciates Effectiveness of monetary policy: HIGHLY EFFECTIVE

Beggar-Thy-Neighbor Policy

Consider a world that consists of two countries A (Home) and B. A no longer a small open economy so it can influence B.

- Country A: Monetary expansion → depreciation of A's currency → an increase in net exports to country B → Increase in GDP of country A
- Country B: appreciation of B's currency → decrease net exports to country A → decrease in GDP of country B

Monetary expansion only **shifts demand** from one country to another, **doesn't increase the total demand for goods.**
Competitive devaluation ("currency war"): A depreciates its currency → B responds by depreciating as well (e.g. during the Great Depression)

The Impossible Trinity (Trilemma)

Trilemma: When exchange rate is fixed and capital is perfectly mobile, countries do not have the monetary policy autonomy

Countries have to pick one of three:

- Free capital mobility
- Exchange rate management
- Monetary autonomy

Independent monetary policy only possible if:

- Exchange rate is flexible
- Capital immobile (through capital control) = no IFM