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Principles of Economics and Management I

Session 8 · GDP, Measurement and Growth

Introduction

A Change of Scale

We finished microeconomics with the individual, the firm and risk.
Today we change scale.

We stop asking “how much does this firm produce?” and start asking “how much does **the country** produce?” 

First we learn to **measure** the economy. Then we ask what makes it **grow**. 



Today's Map

1. GDP and the expenditure approach
2. Nominal, real and the deflator
3. GDP as a measure of well-being
4. Growth accounting
5. The Solow model, as intuition

Part 1 · Measuring the Economy



Gross Domestic Product

GDP: the market value of all **final** goods and services produced in a country within a period.

“Final” is essential: we count the bread, not the flour that went into it, so as not to count twice.

Portugal's GDP is around **€250 billion** a year. 🇵🇹

Three Ways to Measure the Same Thing

Every euro of output is a euro of spending, and a euro of somebody's income. So GDP can be built three ways:

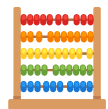
 **Expenditure:** add up everything **bought** as a final good.

 **Income:** add up wages, profits, rents and interest, plus taxes on production.

 **Production:** add up the **value added** at every stage, that is output minus intermediate inputs.

They are identical by construction, not by coincidence. In practice they differ a little, and statistical offices publish the gap. 

 Source: OpenStax *Macro* 3e, [§6.1](#), “GDP Measured by What is Produced” and “Other Ways to Measure the Economy”.



The Expenditure Approach

One way to measure GDP: add up everything **spent** in the economy.

$$GDP = C + I + G + (X - M).$$

Consumption, Investment, Government spending and Net exports (exports minus imports).



The Four Components



Consumption (C): households. It is the largest slice, typically more than half.



Investment (I): firms spending on equipment, construction, inventories.



Government spending (G): the state buying goods and services.

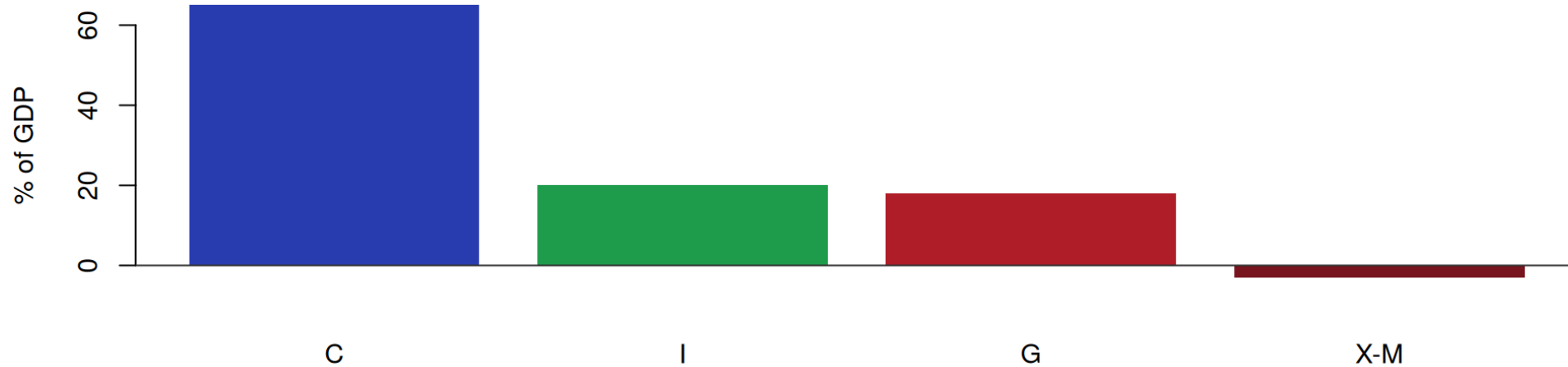


Net exports (X – M): what we sell abroad minus what we buy.

Source: OpenStax *Macro* 3e, [§6.1](#) “Measuring the Size of the Economy: Gross Domestic Product”, “GDP Measured by Components of Demand”. Note its warning in “What does the word ‘investment’ mean?”: here it means new capital, not buying shares.



The Composition of GDP



Illustrative values for a European economy. Consumption dominates; net exports can be negative.

What Counts and What Is Left Out

-  **Intermediate goods:** already counted in the final product.
-  **Second-hand** and purely **financial** transactions (buying a share is not production).
-  **Unpaid work** and the **informal economy:** they escape measurement.

 Source: OpenStax *Macro* 3e, [§6.1](#), “The Problem of Double Counting”, which prints the full two-column list of what is counted in GDP and what is not.

? Multiple Choice 1

A bakery buys 100 euros of flour and sells bread for 250. GDP rises by:

- A. 350, the two transactions added together.
 - B. 100, the value of the input.
 - C. 250, the value of the final good, which equals the value added along the chain.
 - D. Nothing, because bread is consumed rather than invested.
-  **C.** Counting both would be double counting. Check it with the production approach: the miller adds 100 and the baker adds $250 - 100 = 150$, and the two add to 250.

? Multiple Choice 2

A Portuguese household buys a German-made car for 30,000 euros. Portuguese GDP changes by:

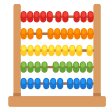
A. Zero: C rises by 30,000 and M rises by 30,000.

B. Plus 30,000, since consumption rose.

C. Minus 30,000, since it is an import.

D. Plus 30,000, since the car is now in Portugal.

✓ **A.** This is what the minus M is **for**. Imports are already counted once, inside C , I or G . Subtracting them removes what was not actually produced here; it has nothing to do with imports being bad.



Numerical Question

An economy has $C = 150$, $I = 40$, $G = 50$, $X = 30$ and $M = 20$, in billion euros.

- a)** Compute GDP.
- b)** The state builds a hospital worth 10. Which component moves, and what is the new GDP?
- c)** Households buy 5 of imported wine, all of it consumed. What happens to GDP?
- d)** A household buys an existing apartment for 200. What happens to GDP?



Solution

- a) $150 + 40 + 50 + (30 - 20) = 250$ billion euros.
- b) G rises by 10, so GDP becomes 260. Public **investment** still sits in G in the national accounts.
- c) C rises by 5 and M rises by 5. GDP is **unchanged**, correctly: nothing extra was produced here.
- d) **Nothing**. The apartment was produced in some earlier year. Only the estate agent's fee is current production. 

Part 2 · Nominal, Real and Well-Being

A Problem With GDP

Imagine GDP rises 5% from one year to the next. Good news?

It depends. If **prices** also rose 5%, we produced the same thing, just more expensively. 🤔

We need to separate **quantities** from **prices**.

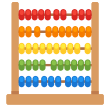


Nominal vs Real GDP

Nominal GDP: valued at the **current** prices of each year.

Real GDP: valued at the prices of a fixed **base year**. It strips out the price effect.

The **economic growth** that matters is growth in **real** GDP. 



The GDP Deflator

The relationship between the two gives a price index:

$$\text{Deflator} = \frac{\text{Nominal GDP}}{\text{Real GDP}} \times 100.$$

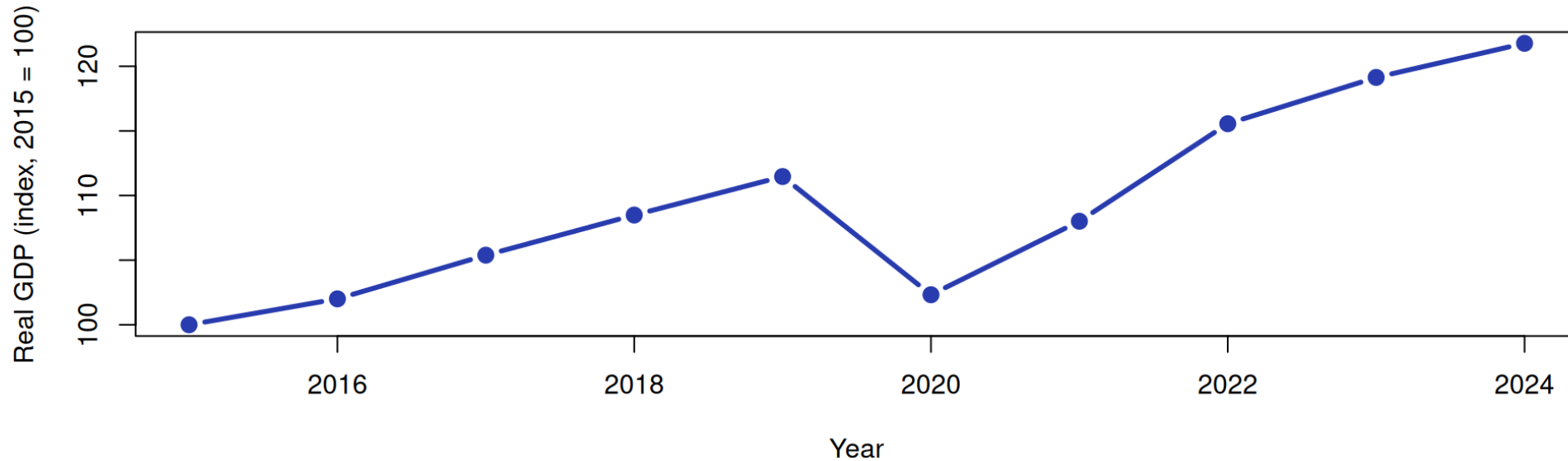
It is a measure of the general price level of the economy. 

It is **not** the same as the HICP of session 9. The deflator covers everything the country **produces**, including exports; the HICP covers what households **consume**, including imports. Energy import prices hit one and not the other. 

 Source: OpenStax *Macro* 3e, §6.2 “Adjusting Nominal Values to Real Values”, “Converting Nominal to Real GDP”, which does the conversion year by year in a table.



Tracking Real GDP Over Time



Note the break: **recessions** show up as falls in real GDP (here, the one in 2020). Source: Eurostat (Portugal, chain linked volumes).

GDP Is Not Everything

GDP is useful, but it is an **imperfect** measure of well-being.

 It ignores the **environment** and the depletion of resources.

 It says nothing about **distribution**: a high GDP can hide inequality.

 It ignores **leisure**, housework and the informal economy.

So Why Do We Use It?

Despite its flaws, GDP **correlates** with health, education and life expectancy.

It is comparable across countries and over time. It is the best **summary** we have, as long as it is used carefully. 🧭

 Source: OpenStax *Macro* 3e, §6.5 “How Well GDP Measures the Well-Being of Society”, and in particular “GDP is Rough, but Useful”, which is this slide’s argument. §6.4 handles comparing GDP across countries.

? Multiple Choice 3

Imported energy prices double, while everything produced domestically is unchanged. Compared with the HICP, the GDP deflator will:

- A. Rise by more, since energy is an input to everything.
 - B. Rise by the same amount, since both are price indices.
 - C. Fall, since imports are subtracted in the GDP identity.
 - D. Rise by less, since it prices what the country produces, not what it consumes.
- ✓ **D.** The HICP tracks the consumption basket, imports included. The deflator tracks domestic production. This gap is exactly why the two inflation numbers separate during an energy shock.

? Multiple Choice 4

One limitation of GDP as a measure of well-being is that:

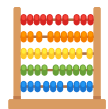
A. It is always too low.

B. It ignores distribution, the environment and leisure.

C. It cannot be compared across countries.

D. It includes housework.

☒ **B.** GDP does not capture distribution, the environment or nonmarket activity.



Numerical Question

Nominal GDP = €260 billion; real GDP (at base year prices) = €250 billion.

What is the GDP deflator? What does it tell us?

Deflator = $(260 / 250) \times 100 = 104$.

It tells us prices rose **4%** relative to the base year. 

Part 3 · What Makes an Economy Grow

The Power of Compound Interest

The **rule of 70**: a value growing at $g\%$ a year doubles in roughly $70/g$ years.

At 2% a year, GDP doubles in 35 years. At 4%, in 17.5 years.

This is why the growth rate is the single most important variable in long-run macroeconomics. 

 Source: OpenStax *Macro* 3e, [§7.2](#), “The Power of Sustained Economic Growth”, which tabulates what an original 100 becomes after 10, 25 and 50 years at different rates. [§7.1](#) is worth reading for how recent sustained growth actually is.

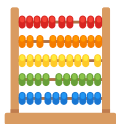


The Aggregate Production Function

Output comes from factors, combined by a technology:

$$Y = A \cdot F(K, L).$$

K is **capital** (machines, infrastructure), L is **labor**, and A is **productivity** (technology, institutions).



Growth Accounting

Decomposing the sources of output growth:

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

Growth comes from **more capital**, **more labor**, or **more productivity** (A). The A part is the “Solow residual”. 🔍

And α is not a free parameter: under competitive factor markets it is the **capital share of income**, which you can read straight off the national accounts. Around 0.3 in most European economies. 📊

Which is why it is called a **residual**: A is not measured directly. It is calculated afterward, as whatever growth capital and labor fail to explain. 🔍

Source: OpenStax *Macro* 3e, [§7.3](#) “Components of Economic Growth”, “Capital Deepening” and “Growth Accounting Studies”.



Productivity Is the Engine

Capital and labor can grow, but they run into limits.

In the long run, what sustains growth in output **per worker** is growth in **productivity** A .

Technology, education, institutions and innovation are what genuinely make a country richer. 

 Source: OpenStax *Macro* 3e, [§7.2](#) “Labor Productivity and Economic Growth”, “Components of the Aggregate Production Function” and “Measuring Productivity”.



Why We Can Work “Per Worker”

The Solow model is written in per worker terms. That step needs a justification, and it has one:

Assume F has **constant returns to scale**: $F(\lambda K, \lambda L) = \lambda F(K, L)$ for any $\lambda > 0$. Doubling every input doubles output.

Take $\lambda = 1/L$:

$$\frac{Y}{L} = F\left(\frac{K}{L}, 1\right) \implies y = f(k)$$

The per worker production function follows directly from constant returns to scale. It is not a separate assumption.

The Law of Motion of Capital

Capital per worker rises with investment and falls with wear:

$$\Delta k = \underbrace{s f(k)}_{\text{investment}} - \underbrace{\delta k}_{\text{depreciation}}$$

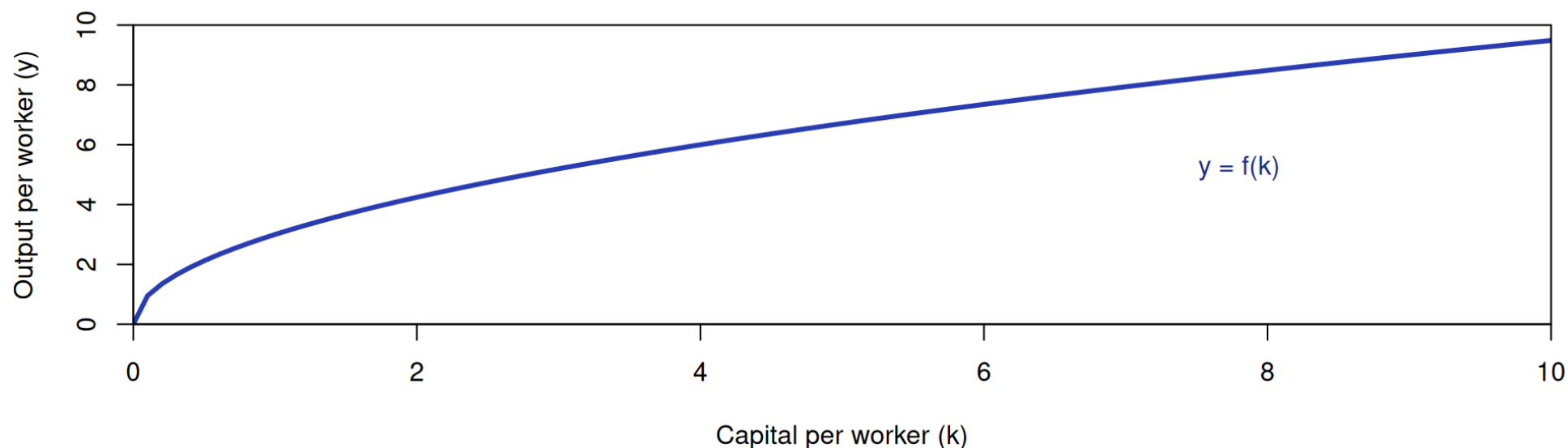
Investment is a **concave** function of k (diminishing returns); depreciation is **linear** in k .

A concave curve through the origin and a straight line through the origin cross exactly once away from zero. That single crossing is what makes the steady state unique and stable. 



Diminishing Returns to Capital

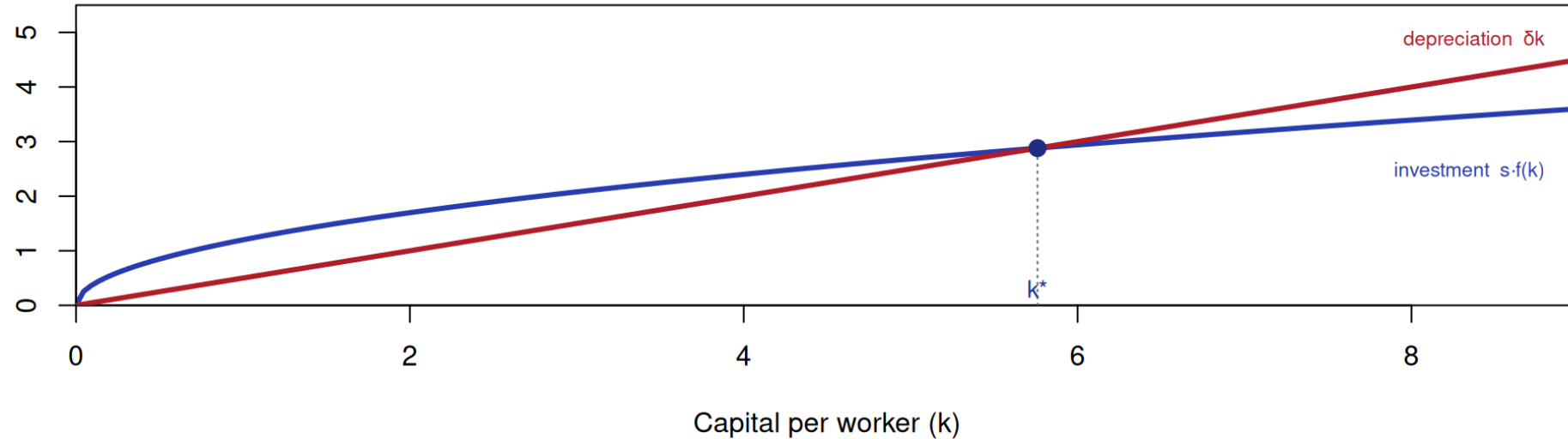
The central idea: giving each worker more capital raises output, but by **less and less**.



The first machine transforms things; the tenth adds little.



The Steady State



Where the two lines cross, $\Delta k = 0$: the **steady state** k^* .



What the Steady State Says

Without technological progress, the economy converges to k^* and output per worker **stabilizes**.

Saving more (a higher s) raises k^* and the standard of living. It does not raise long-run growth: only technology (A) sustains perpetual growth. 🚀

Convergence

Poor countries have little capital, hence **high** returns to capital: they grow fast.

Convergence: economies with less capital tend to grow faster and **catch up** with richer ones.

This is part of the story of European cohesion: Portugal and others converging toward the EU average.  

But careful: convergence is **conditional**. Countries converge to **their own** steady state, which depends on their saving rate, their institutions and their productivity.

Which is why poor countries do not simply catch up automatically in the data. They catch up with where **they** are heading, and that destination is not the same for everyone. 

 Source: OpenStax *Macro* 3e, [§7.4](#) "Economic Convergence", which sets out "Arguments Favoring Convergence" against "Arguments That Convergence Is neither Inevitable nor Likely", then "The Slowness of Convergence".



The Implication for Finance

Long-run growth conditions the **real returns** on assets over decades.

Converging economies offer opportunities, but growth **slows** as they approach the steady state. 

? Multiple Choice 5

An economy sits **below** its steady state, at $k < k^*$. Then:

- A. Capital per worker falls, since depreciation exceeds investment.
 - B. Nothing moves until the saving rate changes.
 - C. Capital per worker rises, and growth is faster the further below k^* it starts.
 - D. It will overshoot k^* and oscillate around it.
- ✓ **C.** Below k^* , $sf(k) > \delta k$ so $\Delta k > 0$, and the gap between the concave curve and the line is widest far from k^* . That mechanism **is** convergence.

? Multiple Choice 6

A country permanently raises its saving rate s . In the long run:

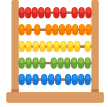
A. Output per worker settles at a higher level, but the growth rate returns to where it was.

B. The growth rate is permanently higher.

C. Nothing changes, since s does not enter the production function.

D. Output per worker falls, because consumption fell.

☒ **A.** A permanently higher saving rate raises the level of output per worker. It does not raise the long-run growth rate; only growth in A does that.



Numerical Question

$f(k) = \sqrt{k}$, with saving rate $s = 0.4$ and depreciation $\delta = 0.1$.

- a) Find the steady state k^* and output per worker y^* .
- b) Compute steady state consumption per worker.
- c) The saving rate rises to 0.5. Find the new k^* and y^* .
- d) Did the long-run growth **rate** change? Explain in one line.



Solution

a) $0.4\sqrt{k} = 0.1k \Rightarrow \sqrt{k} = 4$, so $k^* = 16$ and $y^* = \sqrt{16} = 4$.

b) $c^* = (1 - s) y^* = 0.6 \times 4 = 2.4$.

c) $0.5\sqrt{k} = 0.1k \Rightarrow \sqrt{k} = 5$, so $k^* = 25$ and $y^* = 5$. Note $c^* = 0.5 \times 5 = 2.5$, so consumption rose too, this time.

d) No. Along the transition growth is positive, but once at the new steady state $\Delta k = 0$ again. A higher level, the same long-run rate of zero. 

Wrap-Up

What to Take From This Session

 **GDP** measures the value of final output; by the expenditure approach, $Y = C + I + G + (X - M)$.

 To compare over time you must go from **nominal** to **real**, using the deflator.

 Growth comes from **capital**, **labor** and above all **productivity**.

 With diminishing returns to capital, the economy converges to a **steady state**.

Next Session

Unemployment, Inflation and the Labor Market.

We know how to measure output. Now we measure the two things central banks watch most closely. 

See you next week. 