Macroeconomics: Economic Growth (Licence 3) Aamphi IV. PANTHEON Lesson 1: Syllabus

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Economic Growth

Presentation of course

- This course "L3 Macroeconomics: Economic Growth" offers an introduction to economic growth theory

- Growth economics offers models and empirical evidence to understand determinants of economic growth

- **Method:** Interplay between theory and observation

- **Goals:**

    - Coherent explanation (theory) of the observations
    - Policy recommendations to create better condition for economic growth

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Presentation of course

- A branch of economics is interested in the differences in terms of income and quality of life of a country over time, and between countries:

    - Some countries are very rich, some very poor
    - Some countries grow at a faster rate, some do not grow
    - Some poor countries become rich after some periods,
    - Other rich countries become poor after some periods

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Main reference

- Jones, C. and Vollrath, D. (2013), Introduction to economic growth, 3rd edition (international student edition), WW Norton & Co.

Additional reference

- Acemoglu, D. and Robinson, J. A. (2012), Why nations fail: The origins of power, prosperity, and poverty, Crown Publishers.
- Aghion, P. and Howitt, P. (2008), The economics of growth, MIT Press.
- Barro, R. and Sala-i-Martin, X. (2004), Economic growth, 2nd edition, MIT Press.
- Romer, D. (2019), Advanced macroeconomics, McGraw-Hill. Weil D. N. (2009), Economic growth, Pearson.

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Organization of the course

- Tutorials: each TD group has 8 sessions of 1h30.

Grades

- **Final grade** is an average between the grade in the tutorials and the final exam.

    - Grades received during tutorials (CC) will count for the 50% of the grade for the course

    - Grade in the final exam (Partiel) in January will count for the remaining 50% of the grade for the course

    - **Final exam:** consist in exercises similar to the ones done in the tutorials and also general questions based on this course.

    - Examples of previous exams in the TD booklet available on the EPI.

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Lesson 1

- Presentation

- Main Stylized Facts

- Main Questions of Economic Growth

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Lesson 1: main questions

- How do we measure Economic Growth?

- Why are some countries so rich and others so poor?

- Which are the determinants of economic growth? Do countries converge in the long-run to the same level of income?

- Which are the determinants of technical progress?

- What creates growth miracles in some countries?

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Lesson 1: main stylized facts in empirical works

- (1) There are huge **differences** in per capita income across economies

- (2) Countries grow at **different rates**

- (3) Growth rates **vary over time**

- (4) Comparing a country to others reveals that its relative per capita income can **change** over time

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Lesson 1: main stylized facts in empirical works

- (5) the average growth rate of output per person has been positive and relatively **constant** over time in US,

- (6) Growth in output and growth in the volume of international trade are closely related,

- (7) Both skilled and unskilled workers tend to **migrate** from poor to rich countries or regions.

Lesson 2:

- The baseline economic growth model: The Solow Model (1956)

- Aim find the main causes explaining long-run economic growth of countries

- Robert Solow is an American Neo-Keynesian economist (MIT) that was awarded the Nobel Prize in 1987 for his important contributions to theories of economic growth.

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Lesson 2:

- Solow, R., 1956"A contribution to the theory of economic growth", Quarterly Journal of Economics, vol. 70, pp. 65-94

- Basic version of the Solow growth model without technological progress countries

- Main assumptions: perfect competition

- Main predictions

- Which empirical facts can be explained?

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Lesson 3:

- Comparative statics of the basic Solow model

- Analyze the response of the model to changes in parameters
    - (1) The effects of a change in the population on economic growth

    - (2) The effects of a change in investment (savings) on economic growth

- (1) and (2) have **temporary** effects on the growth rates and **permanent** effects on the long run levels of production .

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Lesson 3:

- Extensions of the simple version of the Solow growth model

- A version of the model with **technological progress**

    - incorporate productivity improvements.

    - Exogenous technological progress

Lesson 4:

- **Comparative statics of Solow model with exogenous technological progress**

- Analyze the response of the model to changes in parameters
    - (1) The effects of a change in the population on economic growth

    - (2) The effects of a change in investment (savings) on economic growth

- **Results are similar to the model without technological progress**

- (1) and (2) have **temporary** effects on the growth rates and **permanent** effects on the long run levels

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Lesson 4:

- **Evaluating the Solow model**

- How the Solow model answers key questions of economic growth and development?
    - (1) Why some countries are so rich and other so poor?
    - (2) Why economies exhibit sustained growth in the Solow model?
    - (3) How does the Solow model account for differences in growth rates across countries?

- Empirical evidence corroborates some of the predictions of the Solow model

Lesson 4:

- How can we measure technological progress?

- **Computing and estimating Multi-factor Productivity**

    - The Solow residual

    - A black box.

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Lesson 5:

- **Extensions of the Solow model: Human Capital**

- Mankiw, Romer, and Weil (1992) "A contribution to the Empirics of Economic Growth", Quarterly Journal of Economics
    - Assess how good is the fit with the data of the predictions of the Solow model with technological progress

    - They augment the model with the human capital and show that this version improves the fit

    - By recognizing that labor in different economies may have different levels of education (skills)

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Lesson 5:

- Some countries grow more quickly than others. Why?
- One explanation: convergence.

  - Catch-up phenomenon: poor countries tend to grow faster than rich countries

  - Does the gap between poor and rich countries is getting closer?

  - Causes of convergence.

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Lesson 6:

- Endogenous growth

- Economics of ideas

- AK model

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Lesson 6: Endogenous growth theories:

- Aim: explaining the differences in income per capita across countries and the exponential growth observed in the last two centuries, and showing how policies interventions can affect growth

- Models in which we can have positive long-run growth

- Models in which policy interventions can permanently affect the growth rates of the economies

Lesson 7: The Romer Model

- Romer (1990), "Endogenous Technological Change"

- We will study the version by Jones (1995) and discuss the differences with Romer (1990)

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- **Lesson 7: The Romer Model**

- The model describes advanced economies

- **Endogenous Growth: technological change is endogenous**

- **Technological progress is the addition of new varieties of goods to those available in the economy**

- E.g: Laptop computers are a new type of good compared to desktop computers and smartphones are new compared to laptops

- Product innovation is a specific activity motivated by profits

- Market structure: imperfect competition

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- **Lesson 7: The Romer Model**

- In this model technological change takes the form of a larger variety of intermediate products

- **The model is composed of three sectors:**

    - (1) A sector producing final goods

    - (2) An intermediate goods sector

    - (3) A research sector

Lesson 8: Schumpeterian model

- An alternative way to model endogenous technological progress:

- **Creative destruction**: is to allow innovations to replace existing intermediate good with a more productive (or better quality) goods

- The innovation can be **uncertain** (a probability of being able to find an innovation)

- This alternative approach is based on Schumpeter's (1939, 1942) original idea (see Aghion and Howitt, 1988 and Grossman and Helpman (1991))

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Lesson 8: Schumpeterian model

- **Creative destruction**:

- Economic growth required the continual **obsolescence of old techniques**

- when new ones were invented

- Improving productivity at each step

Lesson 8: Schumpeterian model

- Schumpeterian growth changes the mechanical details of growth, but not the general conclusions
    - The long-run trend growth rate depends on population growth

- One advantage of the Schumpeterian model is that it explicitly allows us to think about **firm dynamics, or the creation and destruction of firms over time.**

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Lesson 9

- The role of population

- Other determinants of economic growth:

- Social infrastructure

- Institutions: policy implications

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Lesson 10

- International Trade and Economic Growth

- Does trade liberalization can foster economic growth/ productivity?

- Export activity and productivity: cause or determinant?

Introduction to the production function

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Introduction to the production function

- Y is the real aggregate output at a given time

- K is the stock of capital used in the production process

- L is the employment used in the production process (often, in some models, this does not differ from population)

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Production function: reflects the economy's level of technology Real output,

Y, is produced according to a function like this

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

- **Eq. (1) shows how much output (Y) the economy can produce from K units of capital and L units of labor**

- Very often, we use a very specific function, $F()$, called the Cobb-Douglas.

$$Y = K^{\alpha} L^{1-\alpha} \tag{2}$$

- Returns to scale

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Returns to scale

- Returns to scale describe the change in output relative to a change in the inputs

- Suppose $Y_1 = F(K_1, L_1)$

- Scale the inputs by the same factor z, such that:

- $zK_1 = K_2$ and $zL_1 = L_2$

- What happens to Y_2?

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What happens to Y_2?

- **Increasing returns to scale** if $Y_2 > zY$

- **Decreasing returns to scale** if $Y_2 < zY$

- **Constant returns to scale** if $Y_2 = zY$

- Let's maintain the constant returns to scale as the basic hypothesis, such that:

- $zY = F(zK, zL)$

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Per capita production function

- Given the hypothesis of constant returns to scale,

- all variables can be expressed in per capita terms (we multiply by the factor $1/L$):

$$Y/L = F(K/L, L/L), F(K/L, 1) \qquad (3)$$

- Defining $k = K/L$ and $y = Y/L$, we can rewrite as:
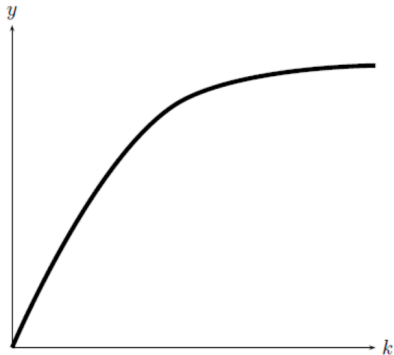
$$y = f(k) \qquad (4)$$

- where $f(k)$ represents $F(k, 1)$

Per capita production function

The production function f(k) is assumed to satisfy:

- $f(0) = 0 \rightarrow$ Without capital per worker there is no production

- $f'_k > 0$ and $f''_k < 0$

    - When k rises, output per worker rises ($f'_k > 0$)
    - but the size of the increase falls as k increases ($f''_k < 0$)
    - Capital per worker has a diminishing marginal product

Per capita production function

Assume perfect competition

Marginal products of factors of production

Assume perfect competition

- There are many firms, all producing the same **homogeneous output**

- Firms enter and exit freely (**no fixed entry costs**)

- They all produce using a similar production function (**same technology**)

- They are all **price-takers** for the use of labor and capital

Marginal products of factors of production

Define:

- w is the wage of a worker (price of labor)

- r is the market rate for renting capital

- For the representative firm:

$$MPL = F'_L = w > 0 \tag{5}$$

$$MPK = F'_K = r > 0 \tag{6}$$

- which just say that the firm sets the **marginal product of a factor equal to its marginal cost**.

Capital's and labor's shares of income

- If each factor is remunerated according to its marginal product,

- the total remuneration accruing to the factors exhausts output

- **Euler's theorem:**

  - If a function $g = f(x, z)$ has constant returns to scale

  - then $g = x f'_x(x, z) + z f'_z(x, z)$

- Thus, $Y = F'_K K + F'_L L = rK + wL$

Cobb-Douglas production function and CRS

- It is often useful to work with a Cobb-Douglas production function, such as:

$$F(K, L) = Y = AK^\alpha L^{1-\alpha} \tag{7}$$

- where A can be thought as measuring productivity

- α and $(1-\alpha)$ are capital's and labor's income shares (α between 0 and 1)

- This production function has the properties of constant returns to scale (CRS):

$$F(zK, zL) = A((zK)^\alpha)((zL)^{1-\alpha}) = Az^{\alpha+1-\alpha}K^\alpha L^{1-\alpha} = z(AK^\alpha L^{1-\alpha}) = zF(K, L) \tag{8}$$

Cobb-Douglas production function and CRS

$$F(K, L) = Y = AK^{\alpha}L^{1-\alpha} \tag{9}$$

- In per capita terms: (dividing by L both sides)

$$Y/L = A(K/L)^{\alpha}(L/L)^{1-\alpha} \tag{10}$$

$$Y/L = Ak^{\alpha} \tag{11}$$

Recall our production function:

$$F(K, L) = Y = AK^{\alpha}L^{1-\alpha} \tag{12}$$

- The marginal product of capital (MPK) is derivative of output with respect to capital:

$$MPK = F'_K = \alpha A(K)^{\alpha-1}(L)^{1-\alpha} > 0 \tag{13}$$

- Diminishing marginal products:

$$F''_K = (\alpha - 1)\alpha A(K)^{\alpha-2}(L)^{1-\alpha} < 0 \tag{14}$$

MPK and MPL in a Cobb-Douglas production function

Recall our production function:

$$F(K, L) = Y = AK^{\alpha}L^{1-\alpha} \tag{15}$$

- Similarly, the marginal product of labor (MPL):

$$MPL = F'_L = (1 - \alpha)A(K)^{\alpha}(L)^{-\alpha} > 0 \tag{16}$$

- Diminishing marginal products:

$$F''_L = (-\alpha)(1 - \alpha)A(K)^{\alpha}(L)^{-\alpha-1} < 0 \tag{17}$$

MPK and MPL in a Cobb-Douglas production function

Recall our production function:

$$F(K, L) = Y = AK^{\alpha}L^{1-\alpha} \tag{18}$$

- The capital's share of income in a Cobb-Douglas is:

$$\frac{MPKxK}{Y} = \frac{\alpha A(K)^{\alpha-1}(L)^{1-\alpha}xK}{AK^{\alpha}L^{1-\alpha}} = \alpha \tag{19}$$

- The labor's share of income in a Cobb-Douglas is:

$$\frac{MPLxL}{Y} = \frac{(1-\alpha)A(K)^{\alpha}(L)^{-\alpha}xL}{AK^{\alpha}L^{1-\alpha}} = 1-\alpha \tag{20}$$