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

Maria Bas

University of Paris 1 Pantheon-Sorbonne

Acknowledges: some slides and figures are taken or adapted from the supplemental ressources to the textbook "Introduction to Economic Growth" by Charles I. Jones and Dietrich Vollrath, Third Edition, Norton W.W. Company Inc.

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

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

Economic Growth

Main reference

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

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.

Organization of the course

- Tutorials: each TD group has 8 sessions of 1h30:
  - TD 1 Mardi 11H A 12H30 SALLE D27 CENTRE CENSIER
  - TD 2 Mardi 16H30 A 18H00 SALLE D25 CENTRE CENSIER
  - TD 3 mercredi 11H00 A 12H30 SALLE D27 CENTRE CENSIER
  - TD 4 mercredi 09H30 A 11H00 SALLE D27 CENTRE CENSIER
  - TD 5 Mardi 9H30 A 11H00 SALLE D27 CENTRE CENSIER

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.

Economic Growth

Lesson 1

- Presentation
- Main Stylized Facts
- Main Questions of Economic Growth

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?
- Which are the determinants of technical progress?
- What creates growth miracles in some countries?

Economic Growth

Lesson 1: main stylized facts in empirical works

- There are huge **differences** in per capita income across economies
- Countries grow at **different rates**
- Growth rates **vary over time**
- Comparing a country to others reveals that its relative per capita income can **change** over time

Economic Growth

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.

Economic Growth

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?

Economic Growth

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 .

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

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.

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)

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

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)

- **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

- **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))

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

Economic Growth

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

Economic Growth

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

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?

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:
- $zY = F(zK, zL)$

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 $1/L$):

$$Y/L = F(K/L, L/L), F(K/L, 1) \tag{3}$$

- Defining $k = K/L$ and $y = Y/L$, we can rewrite as:

$$y = f(k) \tag{4}$$

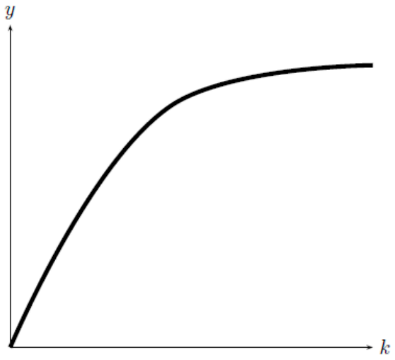
- where $f(k)$ represents $F(k, 1)$

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 $g = xf_x'(x, z) + zf_z'(x, z)$
- 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

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

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

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

$$Y/L = Ak^{\alpha} \quad (11)$$

MPK and MPL in a Cobb-Douglas production function

Recall our production function:

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

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

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

- Diminishing marginal products:

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

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:

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