Process of convergence in the EU

Computer laboratories – materials

Academic year: winter semester: 2019-2020

**Part 1**

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*Parts of the instruction of Lab: 1 is partly based on the materials for instructors from: David N. Weil (2013) Economic Growth, Pearson International Edition.*

**LAB 1**

**Some Basic Growth Facts**

In this lab, you will document cross-country differences in income and growth rates to help motivate the study of growth..

Exercise 1

The data is available in an Excel spreadsheet: “LabData\_PWT9.0\_Weil\_2018” on the course web page. Information about the data sources are provided in a separate document.

1. Calculate the GDP per capita for all countries in the data set based of the information on GDP and population.
2. Calculate the average level of real GDP per capita in the first and last year of analysis for all the countries in the data set. What is the minimum per capita income? What is the maximum? How has the distribution of income changed over time?
3. Calculate the growth rate of real per capita income over the time period 1970 to 2014. What is the average growth rate for all the countries in your data? What is the minimum growth rate? What is the maximum growth rate?
4. The same analysis conduct for the subset of the EU countries
5. Sort the data by the growth rates you calculated in number 3. Identify the 10 fastest growing and the 10 slowest growing countries. Do the fast growers have anything in common? Do the slow growers? Do these lists suggest potential ideas for investigation of the determinants of growth?

Exercise 2

Download data from Eurostat for GDP per capita for Poland for the last decade. [Database: database by themes: Economy and finance, Prices, Purchasing power parities (PPPs), Purchasing power parities (PPPs), price level indices and real expenditures for ESA 2010 aggregates (prc\_ppp\_ind), variable: Real expenditure per capita (in PPS\_EU28).]

1. Calculate the annual average growth for the period 2009 - 2018
2. Using the growth rate calculated in part 1 (assuming that in future the Polish economy will have the same annual average growth), calculate what will Polish real income per capita be in 2050

**LAB 2**

**Production function in the Solow Model**

In this lab we will explore the properties of production function. Production function describes the maximum output that can be produced from inputs of capital (K) and labour (L): **Y = f(K,L)**

The Solow model is based on a simplified production function that has the properties of constant returns to scale and diminishing return (to a factor). The Cobb-Douglas production function has this properties.

$$Y=K^{α}L^{1-α}$$

where: $0<α<1$

1. Constant returns to scale: if you multiply both K and L by some constant, Z, then Y will increase by that same constant, Z.

Using Excel file fill the below table and answer the questions, assume that $α$ = 0.25

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Z | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| K | 4 |  |  |  |  |  |  |  |  |  |  |
| L | 64 |  |  |  |  |  |  |  |  |  |  |
| Y |  |  |  |  |  |  |  |  |  |  |  |
| Y/L |  |  |  |  |  |  |  |  |  |  |  |

a) When Z doubles then Y …….. and Y/L

b) When Z changes from 1 to 10 what happens to Y and Y/L?

c) Does changing the number of workers and machines by the same ratio affect the output per worker?

d) Does changing the capital per worker (K/L) affect output per worker?

1. Diminishing returns (to a factor).

|  |  |  |
| --- | --- | --- |
| **K/L** | **Y/L** | **MPK** |
| 0 |  |  |
| 0.1 |  |  |
| 0.2 |  |  |
| 0.3 |  |  |
| 0.4 |  |  |
| 0.5 |  |  |
| 0.6 |  |  |
| 0.7 |  |  |
| 0.8 |  |  |
| 0.9 |  |  |
| 1 |  |  |
| 1.1 |  |  |
| 1.2 |  |  |
| 1.3 |  |  |
| 1.4 |  |  |
| 1.5 |  |  |
| 1.6 |  |  |
| 1.7 |  |  |
| 1.8 |  |  |
| 1.9 |  |  |
| 2 |  |  |

1. As K/L increases, that means we're adding MORE machines per each worker, because of the diminishing marginal productivity of capital, output per worker increases but at ……………. rate.
2. Do not confuse Decreasing Returns (to scale) with Diminishing returns (to a factor). What are the differences?
3. Explore the properties of production function using the below tools:

Cobb-Douglas production function (3D view): <http://www.eurmacro.eu/tutor/a-c10.html>

Cobb-Douglas partial production function (3D🡪2D): <http://www.eurmacro.eu/tutor/cobb-douglas.html>

1. What is capital’s share of output $\left(\frac{rK}{Y}\right)$ and labour’s share of output $\left(\frac{wL}{Y}\right)$ ?

Using the data from Penn World Table 9.0 (Feenstra, Robert C., Robert Inklaar and Marcel P. Timmer (2015), The Next Generation of the Penn World Table, *American Economic Review*, 105(10), 3150-3182, available for download at [www.ggdc.net/pwt](http://www.ggdc.net/pwt))

1. Calculate the minimum, maximum and average value of share of labour?
2. Is the share of labour constant over time?

**LAB 3**

**The Solow growth model**

In this lab we will simulate the Solow growth model, we will derive output per worker, capital per worker at steady states and graph the Solow diagram.

1. The Solow model for beginners

There is an assumption of autonomous savings = 50 USD, the initial capital equals 300 USD and depreciation rate = 0.1. Fill the table below and find capital at steady state. Make a graph of depreciation line and Savings showing the capital at steady state.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Time | K | S | D | $$ΔK$$ |
| 1 | 300 | 50 |  |  |
| 2 |  | 50 |  |  |
| … |  |  |  |  |
|  |  |  |  |  |

**2.** In a country a production function is , the fraction of output invested is equal to 0.25, the depreciation rate is = 0.05.

a. What are the steady state levels of capital per worker, k, and output per worker, y?

b. In year 1 the level of k is 16. Show how capital and output change over time.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Year | capitalk | output | investment | depreciation | Change in capital stock |
| 1 | 16 | 4 | 1 | 0.8 | 0.2 |
| 2 | 16.2 |  |  |  |  |
| 3 |  |  |  |  |  |
| 4 |  |  |  |  |  |
| 5 |  |  |  |  |  |
| 6 |  |  |  |  |  |
| 7 |  |  |  |  |  |
| 8 |  |  |  |  |  |

c. Calculate the growth rate of output between years 1 and 2

d. Calculate the growth rate of output between years 7 and 8

e. Comparing the answers from parts c and d, what can you conclude about the speed of output growth as a country approaches its steady state?

**3.** Use the below tools to explore the properties of the Solow model

1. Solow model – Basic version (Y): <http://www.eurmacro.eu/tutor/solow.html>
2. Solow model –per worker version (y=Y/L): <http://www.eurmacro.eu/tutor/solowpc.html>
3. Two-country Solow model: <http://www.eurmacro.eu/tutor/solow2country.html>

**4.** In the light of the Solow model describe the implications of

1. a rise in the savings rate
2. a rise in a population growth
3. a dramatic drop in capital stock due to war damage
4. a war killing half of the population
5. a volcanic eruption destroying half of the land

For each case draw a detailed Solow diagram explaining the changes in steady state levels of production.

**LAB 4**

***Real* beta and sigma convergence – introduction**

In this lab, you will calculate beta and sigma convergence. How the real convergence can be defined? How to measure real convergence?

**Exercise 1**

The data is available in an Excel spreadsheet: “LabData\_PWT9.0\_Weil\_2018” on the course web page. Information about the data sources are provided in a separate document.

1. Sigma convergence
2. Calculate the coefficient of variation of GDP per capita for the whole sample of countries in the analysed period of time: 1970-2014. Can we observe sigma convergence? Check the robustness of the finding using other measures of dispersion.
3. Repeat the exercise for the subsample of European economies.
4. Beta convergence
5. Make a scatter plot showing the correlation between the log of GDP per capita in 1970 (x – axis) and the average annual growth rate over the period 1970 - 2014 (y-axis) Is there evidence of a systematic relationship between initial income and subsequent speed of growth? Explain a theoretical hypothesis that would be consistent with this evidence.
6. Estimate the equation describing the trend line obtained from the scatter plot. Comment.
7. Repeat the exercise for the subsample of European economies.
8. Repeat the exercise for the period of time 2000 - 2014

**Exercise 2**

Check the sigma and absolute beta convergence between EU28 countries for the period 1995 – 2017

Download data from Eurostat for GDP per capita of each of EU28 countries – see Exercise 2 from Lab 1.

1. Calculate the annual average growth for each of the country
2. Make a scatter plot showing the correlation between the ln(GDP pc) in 1995 : x axis, and the growth rate (y – axis)
3. Sigma convergence: for every year calculate the coefficient of variation for group of countries and check its trend

**LAB 5**

**Absolute and conditional convergence in Solow model**

In this lab we are going to analyze absolute and conditional convergence in Solow model. According to Solow model the further below its steady state the country is, the faster it will grow

1. Absolute convergence

If two countries have the same rate of investment, depreciation rate, then the country with lower income will grow faster. Use the excel file (convergence.xls, sheet “absolute convergence”) to

* Calculate the capital and output at the steady state of country A and B
* Calculate the capital and output of country A and B till the 50th period
* Draw the graph showing the dynamics of output of country A and B
* Draw the graph showing the output A and B as a percentage of poor country’s income
1. Conditional convergence

If two countries have different rate of investment, then they will have different steady states

Use the excel file (convergence.xls, sheet “conditional convergence”) to

* Calculate the capital and output at the steady state of country A and B
* Calculate the capital and output of country A and B till the 50th period
* Draw the graph showing the dynamics of output of country A and B
* Draw the graph showing the output A and B as a percentage of poor country’s income