ME2708 Economic Growth

Assignment 3
Technology Transfer and DTC

Deadline: May 7, 2018 at 13:15[†]

Instructions

You must solve the first 3 exercises, the rest is left as preparation material for the exam. Grading is according to the **P-F** scale, but demands are high. You are allowed to work in groups of (*maximum*) three persons; individual work is not only acceptable but also encouraged. When you are asked to derive something, you must show *mathematically* how you came with the given answer[1]. Presentations in exercise classes are voluntary.

Something you might appreciate to know is that, according to previous experience, students who do not intensively work on the assignments struggle to pass this course. The nice thing, however, is that this practice handsomely pays off in the written examination.

[†]Submission of solutions may be done either in person at the beginning of the class or by email to luis.perez@indek.kth.se.

[1]Providing only final answers implies failure of the assignment.

1 Technology Diffusion

From the table on countries' income (slide 25, Lecture 1) it is evident that there are huge differences in cross-country per capita incomes between advanced- and LDCs. In this exercise we assume that advanced countries like Sweden advance the technological frontier by devoting resources to R&D and, also, that LDCs like Burundi do simply copy and adopt these technologies with a time lag s. Think of Sweden as:

(S1) Final-goods production: $Y_{Swe}(t) = A_{Swe}(t)(1 - s_R)L_{Swe}(t)$

(S2) Technology (ideas) production: $\dot{A}_{Swe}(t) = \theta L_{A,Swe}(t)^{\lambda} A_{Swe}(t)^{\phi}$

And of Burundi as:

(B1) Final-goods production: $Y_{Bur}(t) = A_{Bur}(t)L_{Bur}(t)$

(B2) Technology level: $\dot{A}_{Bur}(t) = A_{Swe}(t - s)$

Assume that the labor force, L, is constant in Burundi but grows at 1% per year in Sweden[2]. Also assume that the share of the labor force doing research, s_R, is constant. This exercise asks you to:

(i) Show that output per worker in Sweden, $\tilde{y}_{Swe}$, divided by output per worker in Burundi, $\tilde{y}_{Bur}$, can be written as a function of the time lag s and the share of the labor force doing research in Sweden. Put simply, derive the following expression,

$$\frac{\tilde{y}_{Swe}(t)}{\tilde{y}_{Bur}(t)} = (1 - s_R)e^{g_A s}$$

where g_A is the growth rate of output per capita in Sweden.

(ii) From the table on countries' income (mentioned above), per capita income in the Sweden and Burundi are \$44,659 and \$659, respectively. If we assume that s_R is equal to 0.005 and that the growth rate of output per capita in Sweden is 1%, how long must the time lag s be in order to explain the observed difference in output per capita between these two countries?

[2] As unreasonable of an assumption as it might seem, imagine that Burundi is suffering from ebola and other diseases but Sweden is not.

2 Absorptive Capacity and Tech. Transfer

Let the economy be defined by the following equations:

$$Y(t) = K(t)^{\alpha}[h(t)L(t)]^{1-\alpha}, \qquad 0 < \alpha < 1 \tag{1}$$
$$\dot{K}(t) = s_K Y(t) - \delta K(t), \qquad 0 < \delta < 1 \tag{2}$$
$$\dot{h}(t) = \mu e^{\psi u} A(t)^{\gamma} h(t)^{1-\gamma}, , \qquad \mu, \psi, \gamma > 0 \tag{3}$$
$$\dot{A}(t) = A(t) g_A > 0 \tag{4}$$
$$\dot{L}(t) = L(t) n > 0 \tag{5}$$

Equation (1) describes the production of our homogeneous, final good: K denotes capital, h captures the individuals' level of skills and L is the number of people in the workforce. Equation (2) represents the law of motion of capital: s_K is the investment's rate and δ is an exponential rate of depreciation. Equation (3) represents the law of motion of individuals' skills: u is the (constant) time spent on accumulating skills (e.g. you can think of it as the avg. share of years spent in school *wrt* to the population life-expectancy). Equation (4) and (5) represent the motion of technology and population, respectively, with our standard notation. This exercise asks you to:

(i) Construct a graph with $\dot{h}/h$ on the vertical axis and A/h on the horizontal axis. Plot the following two lines in the graph:

$$\frac{\dot{h}}{h} = \mu e^{\psi u} \left[\frac{A}{h}\right]^{\gamma} \qquad \text{and} \qquad \frac{\dot{h}}{h} = g_A$$

(ii) Explain what the two lines mean and also explain the meaning of the intersection point between them.

(iii) Starting from steady state, analyze the short-run and long-run effects of an increase in u on the growth rate of skills in the graph you created in (i).

(iv) Create a new graph and plot the behavior of h/A over time before, during and after the increase in u.

(v) Create a new graph and plot the behavior of $\ln(h)$ over time before, during and after the increase in u.

3 Absorptive Capacity and Trade

Consider the basic framework of Exercise 2. This framework describes North Korea's behavior before the crucial summit after which it decided to open up its borders. The only modification after this summit is that, instead of equation (1), production is better proxied by,

$$Y(t) = K(t)^{\alpha} \left[(h(t) + m(t))L(t)\right]^{1-\alpha}$$

where h is the number of machines that north Koreans have learnt to use by investing time in education and m is the number of machines that they imported from other countries that managed to enforce IPRs all over the world. This exercise asks you to:

(i) Derive the steady-state of the North Korean economy before and after opening up[3].

(ii) Compare the two results derived in (i) and explain which (immediate) effect, if any, trade has.

(iii) Does trade have level effects? And long-run growth effects?[4]

4 Technology Transfer and Club Convergence

Contrast the factors driving convergence in the Schumpeterian and AK models. Describe intuitively how the Schumpeterian approach can explain "club convergence" (Aghion and Howitt's (2009) exercise 1, chapter 7).

[3] *Hint*: Re-arrange the production function in this exercise in such a manner that you have a term capturing the (positive) effect of trade.

[4] Perhaps the answers to some of these questions depend on some critical assumptions we have to make. If this is the case, explain all possibilities and argue for the "most reasonable one".

5 Directed Technical Change and Skill-mismatch

In a famous paper on technology transfer, Acemoglu and Zilibotti (2001) argue that it is difficult to understand the large cross-country income differences because, beside the fact that ideas cross borders very rapidly, cutting-edge technologies can be imported. However, they acknowledge that the machines created and used by technological leaders might not be appropriate for less-developed countries (LDCs).

(i) Name the two most important reasons, according to Acemoglu and Zilibotti, why technologies from one country need not be appropriate for other. If there is more than one factor within each subgroup, creatively explain the mechanism by which they could make technologies inappropriate.

(ii) Why is technical change directed in this framework? And what's the direction of technical change? Is technical change neutral? If not, is there a measure for the "bias" of technical change?

(iii) In Acemoglu and Zilibotti's paper there are two crucial assumptions on which the results hinge. Briefly discuss them and explain how, if relaxed, the results could differ.

Further Exam Prep.

You can find additional exercises in the corresponding Chapter(s) in the main (Jones') textbook of this course.