Written Exam at the Department of Economics winter 2017

Economic Growth

Final Exam

June 22, 9-12.

(3-hour closed book exam)

Please note that the language used in your exam paper must correspond to the language for which you registered during exam registration.

This exam question consists of 3 pages in total (this one included)

NB: *If you fall ill during the actual examination at Peter Bangsvej, you must contact an invigilator in order to be registered as having fallen ill. Then you submit a blank exam paper and leave the examination. When you arrive home, you must contact your GP and submit a medical report to the Faculty of Social Sciences no later than seven (7) days from the date of the exam.*

Question A: Shorter questions

1. Please, explain why the replication argument along with the Euler Theorem rules out that private firms fund R&D (or simply investments in "technological ideas") if markets are competitive.

2. Please, explain how Thornton and Thompson ("Learning from experience and learning from others: An exploration of learning and spillovers in wartime shipbuilding". *American Economic Review*) propose to test for the existence of external learning effects by studying shipbuilding during WWII.

3. In a world lacking well established intellectural property rights, where a leader country innovates and a follower country immitates, the extent of R&D may be excessive in the follower country (i.e., from a social planners' perspective). Please explain why.

4. How might the Suez crisis help us understand the impact of trade on growth?

5. Assume output of economy can be described by a Standard Cobb-Douglas production function, $Y = K^\alpha (AL)^{1-\alpha}$, where the notation is standard. Assume, moreover, that growth in A is driven by R&D in a semi-endogenous growth fashion. (i) Provide an equation that allows you to decompose past growth into (a) a contribution from transitional dynamics, and (b) a contribution from steady state growth. (ii) What does the evidence suggest about the relative importance of (a) and (b) for US growth during the last half century?

6. Please, explain why differences in inequality matter to comparative differences in welfare, according to Jones and Klenow ("Beyond GDP? Welfare across countries and time". *American Economic Review*).

Question B: Analytical questions

Consider an economy in the process of development. The economy is closed. Its a one good economy where output can be either consumed or invested. All markets are comptitive, and firms maximize profits. Time is continuous. Households are infinitely lived. There is no population growth and total labor supply is normalized to one. Capital depreciation is ignorned. Utility of the representative household is given by

$$U_0 = \int_t^\infty \frac{c(t)^{1-\theta} - 1}{1-\theta} e^{-\rho t} dt, \theta > 0, \rho > 0.$$

Household wealth accumulates in accordance with

$$\dot{a}(t) = (1 - \tau) r(t) a(t) + (1 - \tau) w(t) - c(t), \quad a(0) \text{ given.}$$

and they are subject to the standard No-Ponzi game condition. a is wealth, r is the real interest rate, w is the real wage, c is consumption and τ is an income tax that is assumed constant through time.

B1. The household problem is to choose a path for consumption $\{c\}_0^\infty$ such that U_0 is maximized given the flow equation and the No-Ponzi game conditions. Show that the optimal path of consumption is given by

$$\frac{\dot{c}(t)}{c(t)} = \frac{1}{\theta} \left((1 - \tau) r(t) - \rho \right).$$

The representative firm i uses the following technology

$$Y_i(t) = K(t)_i^\alpha \left(G(t) L_i \right)^{1-\alpha}$$

where Y_i is output of the representative firm, K_i is capital input, L_i its labor input and G productive government services.

B2. (i) Please, comment on the production function: what is the logic behind G's presence? (ii) Solve the maximization problem of the representative firm, which takes factor prices r and w as given, and proceed to show that the aggregate production function can we written

$$\sum_i Y_i(t) = Y(t) = K(t)^\alpha G(t)^{1-\alpha}.$$

(Hint: Recall that we have assumed $\sum_i L_i = 1$).

B3. Assume that the government balances its budget. This means

$$G(t) = \tau Y(t).$$

(i) Explain why the balanced budget condition can be written in this way. (ii) Given $G = \tau Y$, show that the aggregate production function can be written

$$Y(t) = K(t) \tau^{\frac{\alpha}{1-\alpha}}$$

and thus the real interest rate is given by

$$r = \alpha \tau^{\frac{\alpha}{1-\alpha}}.$$

B4. Explain why the growth rate of per capita income is given by

$$\gamma = \frac{1}{\theta} \left((1 - \tau) \alpha \tau^{\frac{\alpha}{1-\alpha}} - \rho \right).$$

An intuitive argument is sufficient.

B5. Please, discuss the empirical relevance of the model.