Written Exam for the B.Sc. in Economics summer 2011

Macro A

Reexamination

11. August 2011

(3-hour closed book exam)

All questions, 1.1-1.3 and 2.1-2.8, to be answered.

Please note that the language used in your exam paper must correspond to the language of the title for which you registered during exam registration. I.e. if you registered for the English title of the course, you must write your exam paper in English. Likewise, if you registered for the Danish title of the course or if you registered for the English title which was followed by “eksamen på dansk” in brackets, you must write your exam paper in Danish.

If you are in doubt about which title you registered for, please see the print of your exam registration from the students’ self-service system.

Problem 1: Short questions

(In these problems the focus is on the verbal, intuitive explanations. Formal analysis can, however, be used in the explanations if wanted).

1.1) Explain the concept social infrastructure

1.2) Explain how productive externalities can generate endogenous growth.

1.3) Explain why an increase in the unemployment benefit will not affect the real wage in the general equilibrium model of efficiency wages

Problem 2: **Endogenous growth through Research and Development**

(In this problem formal and computational elements are more important, but verbal, intuitive explanations are still important)

Consider the following model incorporating a research sector creating new ideas:

1) $Y_t = K_t^{\alpha} \cdot (A_t \cdot L_{Yt})^{1-\alpha}$

2) $A_{t+1} - A_t = \rho \cdot L_{At}^{\lambda} \cdot A_t^{\phi}$

3) $L_{At} + L_{Yt} = L_t$

4) $L_{At} = s_R \cdot L_t$

5) $K_{t+1} = K_t \cdot (1-\delta) + s \cdot Y_t$

6) $L_{t+1} = L_t \cdot (1+n)$

The parameters of the model are $\alpha, \rho, \lambda, \phi, s_R, s$ and n. It is assumed that:

$0 < \alpha < 1$, $\rho > 0$, $0 < \lambda \leq 1$, $0 < s_R < 1$, $0 < s < 1$ and $n > -1$.

2.1) Interpret equation 1) - 6). Explain in particular the intuition behind equation 2) and the interpretation of λ and ϕ? How is the non-rival nature of ideas reflected in this model?

In the following it is assumed that: $0 < \phi < 1$ **and** $n > 0$

2.2) Show that (as long as s_R is constant over time) the transition curve for $g_t = \dfrac{A_{t+1} - A_t}{A_t}$ is given by: $g_{t+1} = g_t \cdot (1+n)^{\lambda} \cdot (1+g_t)^{\phi-1}$, and illustrate the transition curve for g_t in a transition diagram.

2.3) Show that the steady state growth rate of A_t is given by:

8) $g_{se} = (1+n)^{\lambda/(1-\phi)} - 1$

Explain why g_{se} depends positively on n and why steady state growth can not be sustained if $n = 0$. Show also that the steady state level of A_t is given by:

9) $A_t^* = \left(\dfrac{\rho \cdot (s_R \cdot L_t)^{\lambda}}{g_{se}} \right)^{\frac{1}{1-\phi}}$, and explain how A_t^* depends on ρ and s_R.

2.4) Show that $\tilde{y}_t = \dfrac{Y_t}{A_t \cdot L_t}$ is given by: $\tilde{y}_t = \tilde{k}_t^{\alpha} \cdot (1 - s_R)^{1-\alpha}$ and that $\tilde{k}_t = \dfrac{K_t}{A_t \cdot L_t}$ evolves according to:

10) $\tilde{k}_{t+1} = \dfrac{1}{(1+g_t)\cdot(1+n)} \cdot \left(\tilde{k}_t \cdot (1-\delta) + s \cdot \tilde{k}_t^{\alpha} \cdot (1-s_R)^{1-\alpha}\right)$

Show also that:

$$\tilde{k}_{t+1} - \tilde{k}_t = \frac{1}{(1+g_t)\cdot(1+n)} \cdot \left(s \cdot \tilde{k}_t^{\alpha} \cdot (1-s_R)^{1-\alpha} - \tilde{k}_t \cdot (\delta + n + g_t + n \cdot g_t)\right)$$

Interpret these equations. Explain how the dynamic evolution of $\tilde{k}_t$ differs from the evolution in the Solow model (with technological growth).

2.5)

Show that:

$$\frac{\tilde{k}_{t+1} - \tilde{k}_t}{\tilde{k}_t} = \frac{1}{(1+g_t)\cdot(1+n)} \cdot \left(s \cdot \tilde{k}_t^{\alpha-1} \cdot (1-s_R)^{1-\alpha} - (\delta + n + g_t + n \cdot g_t)\right)$$

and illustrate this in a diagram with $\tilde{k}_t$ on the horizontal axis (a modified Solow diagram). Show in this diagram the convergence towards steady state in the case where g_t is initially below the steady state value. Explain why convergence tends to be slow in this model (again compared to the Solow model).

2.6)

Define the steady state in this model and show that the steady state values of $k_t = \frac{K_t}{L_t}$ and $y_t = \frac{Y_t}{L_t}$ are given by:

$$k_t^* = \left(\frac{s}{\delta + n + g_{se} + n \cdot g_{se}} \right)^{\frac{1}{1-\alpha}} \cdot (1 - s_R) \cdot \left(\frac{\rho \cdot (s_R \cdot L_t)^{\lambda}}{g_{se}} \right)^{\frac{1}{1-\phi}}$$

$$y_t^* = \left(\frac{s}{\delta + n + g_{se} + n \cdot g_{se}} \right)^{\frac{\alpha}{1-\alpha}} \cdot (1 - s_R) \cdot \left(\frac{\rho \cdot (s_R \cdot L_t)^{\lambda}}{g_{se}} \right)^{\frac{1}{1-\phi}}$$

What is the growth rate of k_t and y_t in steady state? Explain why there are counteracting effects on k_t^* and y_t^* of an increase in s_R. Compare the effects of an increase in s_R with the effects of an increase in L_t.

2.7)

Illustrate the relationship between s_R and y_t^* in a diagram and show that the value of s_R which maximizes y_t^* and k_t^* is given by:

$$s_R^{GR} = \frac{\lambda}{1 - \phi + \lambda}$$

Interpret (*explain* how s_R^{GR} depends on λ and ϕ).

2.8)

Explain the consequences of an increase in n. Consider both the steady state effects and the effects along the transition towards steady state, and illustrate in an appropriate diagram. Discuss whether the steady state effects of an increase in n in this model are plausible.