I: (50 percent)

Do you agree with the following statements? Explain why or why not.

a:

'An increase in government consumption has no effects on growth as long as the government always runs a balanced budget.'

b:

'Governments should subsidize private research and development activities (R&D) in order to give firms stronger incentives to engage in R&D'.

c:

'The neo-classical growth model predicts that there will be instantaneous convergence between countries with access to international credit.'

II: (50 percent)

Consider an economy where total production, Y, is given by a neo-classical production function

$$Y = F(K, TL) \tag{1}$$

Here K is the aggregate capital-stock, L is the size of the population/workforce, and T is a parameter characterizing the level of technology. Assume that T and L grow exogenously at rates g and n, respectively. Define $\hat{y} \equiv Y/(TL)$ and $\hat{k} \equiv K/(TL)$.

a) Explain, intuitively, why $\hat{k}$ converges to a steady state $\hat{k}^*$ in neo-classical growth models.

—

Let the evolution of $\hat{k}$ over time (t) be approximated by the log-linearization

$$\frac{d\hat{k}(t)/dt}{\hat{k}(t)} = \lambda(\ln \hat{k}^* - \ln \hat{k}(t)) \tag{2}$$

Based on (2), it follows that

$$\frac{d\hat{y}(t)/dt}{\hat{y}(t)} = \lambda(\ln \hat{y}^* - \ln \hat{y}(t)), \tag{3}$$

which in turn implies

$$\frac{\ln \hat{y}(t) - \ln \hat{y}(0)}{t} = b_1 \ln \hat{y}^* - b_2 \ln \hat{y}(0) \tag{4}$$

where $b_1 = b_2 = (1 - e^{-\lambda t})/t$. (You do not need to prove these results).

b) In the framework of a simple Solow-model: Illustrate and explain the relationship (2) graphically. (You do not need to derive the equation algebraically).

c) Explain the difference between i) absolute convergence across economies and ii) conditional convergence across economies.

—

Now let the production function (5) be replaced by

$$Y = F(K, H, TL) = K^\alpha H^\eta (TL)^{1-\alpha-\eta} \tag{5}$$

where H is the aggregate stock of human capital. Assume that K and H are both produced by the same technology as Y, that they depreciate at the common rate δ, and that fixed shares s_k and s_h of total production are used to invest in K and H respectively.

Under these assumptions it can be shown that the steady state value $\hat{y}^*$ satisfies

$$\ln(\hat{y}^*) = \frac{\alpha}{1-\alpha-\eta}\ln(s_k) + \frac{\eta}{1-\alpha-\eta}\ln(s_h) - \frac{\alpha+\eta}{1-\alpha-\eta}\ln(n+g+\delta) \tag{6}$$

and that the log-linearization for the evolution of $\hat{y}$ is

$$\frac{d\hat{y}(t)/dt}{\hat{y}(t)} = (1-\alpha-\eta)(n+g+\delta)(\ln \hat{y}^* - \ln \hat{y}(t)), \tag{7}$$

i.e. as in (3), but with

$$\lambda = (1-\alpha-\eta)(n+g+\delta) \tag{8}$$

(Again: You do not need to prove these results).

d) State a rough estimate of what you consider plausible values for λ? What does this measure say about how quickly economies converge?

e) Show that under the assumptions of the augmented model, equation (4) translates to

$$\begin{aligned}\frac{\ln(y(t)) - \ln(y(0))}{t} &= \frac{(1-e^{-\lambda t})}{t}\frac{\alpha}{1-\alpha-\eta}\ln(s_k) + \frac{(1-e^{-\lambda t})}{t}\frac{\eta}{1-\alpha-\eta}\ln(s_h) \\ &\quad -\frac{(1-e^{-\lambda t})}{t}\frac{\alpha+\eta}{1-\alpha-\eta}\ln(n+g+\delta) - \frac{(1-e^{-\lambda t})}{t}\ln(y(0)) \\ &\quad +\frac{(1-e^{-\lambda t})}{t}\ln T(0) + gt\end{aligned}$$

f) Consider the estimation results reported in Tables IV and V in the appendix on the next page (taken from the study by Mankiw, Romer and Weil 1992). What do these results tell us about the model discussed above? (You may focus on the intermediate sample.)

g) What are the main weaknesses of the analysis leading to the results in Tables IV and V? (Explain briefly, but without going in detail on each point).

h) Discuss briefly other approaches for studying the relationship (4) empirically.

Appendix

Regression results from Mankiw, Romer and Weil (1992)

TABLE IV
TESTS FOR CONDITIONAL CONVERGENCE

Dependent variable: log difference GDP per working-age person 1960–1985

Sample:	Non-oil	Intermediate	OECD
Observations:	98	75	22
CONSTANT	1.93	2.23	2.19
	(0.83)	(0.86)	(1.17)
ln(Y60)	−0.141	−0.228	−0.351
	(0.052)	(0.057)	(0.066)
ln(I/GDP)	0.647	0.644	0.392
	(0.087)	(0.104)	(0.176)
$\ln(n + g + \delta)$	−0.299	−0.464	−0.753
	(0.304)	(0.307)	(0.341)
$\overline{R}^2$	0.38	0.35	0.62
s.e.e.	0.35	0.33	0.15
Implied λ	0.00606	0.0104	0.0173
	(0.00182)	(0.0019)	(0.0019)

Note. Standard errors are in parentheses. Y60 is GDP per working-age person in 1960. The investment and population growth rates are averages for the period 1960–1985. $(g + \delta)$ is assumed to be 0.05.

TABLE V
TESTS FOR CONDITIONAL CONVERGENCE

Dependent variable: log difference GDP per working-age person 1960–1985

Sample:	Non-oil	Intermediate	OECD
Observations:	98	75	22
CONSTANT	3.04	3.69	2.81
	(0.83)	(0.91)	(1.19)
ln(Y60)	−0.289	−0.366	−0.398
	(0.062)	(0.067)	(0.070)
ln(I/GDP)	0.524	0.538	0.335
	(0.087)	(0.102)	(0.174)
$\ln(n + g + \delta)$	−0.505	−0.551	−0.844
	(0.288)	(0.288)	(0.334)
ln(SCHOOL)	0.233	0.271	0.223
	(0.060)	(0.081)	(0.144)
$\overline{R}^2$	0.46	0.43	0.65
s.e.e.	0.33	0.30	0.15
Implied λ	0.0137	0.0182	0.0203
	(0.0019)	(0.0020)	(0.0020)

Note. Standard errors are in parentheses. Y60 is GDP per working-age person in 1960. The investment and population growth rates are averages for the period 1960–1985. $(g + \delta)$ is assumed to be 0.05. SCHOOL is the average percentage of the working-age population in secondary school for the period 1960–1985.