Macroeconomics

Question 6

Essay 1: Compare between the neoclassical and the Schumpeterian theories of convergence.

The neoclassical and the Schumpeterian theories differ both in their analysis of the sources of convergence and in their predictions about cross-country convergence. In the Solow model, convergence is driven by diminishing returns to aggregate capital. An economy accumulates capital as a constant fraction of output is saved and a constant fraction of the capital stock depreciates each period: $\frac{\dot{k}}{k} = sk^{\alpha-1} - (\delta + n)$. As a result of decreasing returns to the capital stock, the net growth rate of capital decreases when a country becomes richer, until it reaches a steady state with constant capital and output per capita (or constant growth in output per capita if there is exogenous technological progress).

The mechanism underlying convergence is different in the Schumpeterian model. In this setup, growth is driven by research and development activities, which improve technology and total factor productivity. The economy comprises a large number of sectors which catch up with the world frontier technology as they innovate, and innovation within each sector is a costly activity with a random probability of success depending on both research expenditure and institutional parameters. The force behind convergence is imitation and technology transfer. Less advanced countries (further away from the frontier) realize a larger productivity gain when they innovate and catch up, which allows them to enjoy higher growth rates as long as they do engage in R&D. All economies converge to a steady state where their relative distance to the frontier is constant and their output growth rate is equal to the world techonology growth rate.

The two models also differ in their predictions about the exact pattern of cross-country convergence. First, both predict conditional convergence, in the sense that countries will reach different steady states if they do not share identical fundamental parameters, but these determinants of steady states are not the same. In the Solow model, convergence is conditional on savings, depreciation and population growth rates. In the Schumpeterian model, convergence is conditional on factors determining the productivity of R&D (education, infrastructures) and monopoly profits (competition policies, patent laws). Second, the neoclassical growth model predicts that all countries experience convergence, while the Schumpeterian model can explain club convergence, whereby a group of countries converges to the frontier growth rate while another group diverges and experiences zero growth. This happens when R&D is not a profitable activity in a subset of countries, due to institutional constraints (e.g. poor protection of intellectual property rights) or low productivity (e.g. dearth of highly educated people).

Grading instructions:
3 points for the source of convergence in the Solow model
3 points for the source of convergence in the Schumpeterian model
3 points for discussing conditional convergence
3 points for discussing club convergence
3 points for the quality of the argument and the ability to link the two models
Partial credit at the grader's own judgement

Essay 2: What do the various growth theories have to say about the determinants of long-run income differences, and how can we empirically show that institutions matter?

Various growth theories emphasize different determinants of long-run differences in income per capita, which fall into three main categories: physical capital, human capital and technology.

Both the neoclassical and the AK growth models put physical capital accumulation at the core of growth and long-run income. In these models, ouput per capita is determined by the stock of capital per capita. In the long-run, in the neoclassical growth model, differences in steady-state income across countries stem from differences in savings rates, as well as depreciation and population growth rates. Countries that save more reach higher levels of steady-state output per capita. In the AK model, in the absence of diminishing returns

to capital, there is no steady state, but the intuition is similar. Countries that save more, and countries with lower depreciation and fertility rates, enjoy persistently higher growth rates of output per capita.

Extensions of the neoclassical growth model point out the role of human capital, on top of physical capital. In the Mankiw-Romer-Weil model, human capital accumulates in a similar fashion to physical capital, so that not only the savings rate in physical capital but also the rate of investment in education and health determine steady-state income differences.

Both the physical capital and the human capital theories leave technology unexplained, and fail to generate long-run growth except in the AK framework at the price of counterfactual predictions about convergence. The Schumpeterian model fills this gap by endogenizing technology differences. It explains long-run differences in GDP per capita across countries by long-run differences in their technological advance, as countries vary in their steady-state proximity to the world productivity frontier.

However, technology itself, as well as the rate of accumulation of physical and human capital, can be considered as outcomes determined by more fundamental factors. In the Schumpeterian model, the determinants of long-run technology are institutions and policies, in particular the enforcement of property rights, and the stock of highly educated people. Savings rates, and even the population growth rate can also be seen as endogenous to institutions, which shape the constraints and incentives faced by agents in the economy. Other possible primary causes of long-run income are geographical and cultural factors.

Testing the hypothesis that institutions do matter for long-run income is an empirical challenge, as a positive correlation between institutional quality and economic prosperity does not translate into a clear causal link: it might just as well be that only rich countries can afford good institutions. The empirical strategy to establish a causal relationship from institutions to income involves finding exogenous sources of institutional variation across countries (instruments) and testing whether they are related to long-run differences in economic performance. A well-known example is the work of Acemoglu, Johnson and Robinson, who focus on the "natural experiment" of European colonization. Arguing that colonizers only established good institutions in areas where they settled in large numbers, the authors use settler mortality as an instrument for protection against expropriation, and find a significant impact on current GDP capita. These results are evidence in favor of the institutional view of the primary causes of development over the pure geographical view.

Grading instructions:
3 points for physical capital in the Solow and AK models
2 points for human capital
3 points for technology or R&D in the Schumpeterian model
3 points for institutions, geography and culture as fundamental causes
4 points for discussing the empirical debate about institutions and economic performance (2 points for mentioning the endogeneity problem, 2 points for an example)
Partial credit based on the quality of the answer

Question 7

a. See figure 1. The household's intertemporal budget constraint is

$$C_0 + \frac{C_1}{1+r} = 100,000$$

$$C_1 = (1+r)(C_0 - 100,000)$$

Grading instructions: 2 points for the shape of the budget line, 3 points for the values of C_0 and C_1 on the axes.

b. The household maximizes a utility function of the form

$$u(C_0) + \delta u(C_1)$$
$$= u(C_0) + \delta u((1+r)(C_0 - 100,000))$$

where $\beta < 1$ is the rate of time preference and $u\left(.\right)$ is in general a concave function. The indifference curves, represented in figure 1, show how many additional dollars of consumption the household must receive in period 1 in order to be willing to sacrifice one dollar of period 0 consumption. First, less current consumption must be offset by more future consumption to keep the household indifferent, so the indifference curves are downward sloping. Second, as C_0 becomes smaller and smaller, each unit of consumption forgone in period 0 requires an increasing number of additional consumption units in period 1. The concavity of the utility function implies that marginal utility of C_0 rises and marginal utility of C_1 falls as current consumption is reduced in favor of future consumption. Hence, indifference curves are convex.

Grading instructions: 1 point for drawing the curves, 2 points for explaining the negative slope, 2 points for explaining the curvature.

c. See figure 2. At the tangency point, the household achieves the highest possible intertemporal utility given its budget constraint. It is also indifferent between consuming or saving its last dollar. At this point, the ratio of marginal utilities in both periods is equal to the rate of time preference times the interest rate:

$$\frac{u'\left(C_0\right)}{u'\left(C_1\right)} = \delta\left(1 + r\right)$$

In particular, if the household's discount rate is equal to the risk-free interest rate, consumption and marginal utilities are equated across periods.

Grading instructions: 1 point for drawing the graph, 2 points for explaining it is the optimal choice, 2 points for the indifference argument. Partial credit at the grader's own judgement.

d. The new budget constraint and the new tangency point T' are represented on figure 3. The new budget constraint is higher, since any level of savings allows for higher future consumption.

Grading instructions: 5 points for drawing correctly the new budget constraint and tangency point, no partial credit.

e. With the indifference curves on figure 3, optimal consumption increases in both periods. There are two effects:

- Income effect: for any given level of savings, the household can afford higher consumption in period 1 than at the previous (lower) interest rate. Thus, the value of its lifetime wealth has increased. This effect allows the household to consume more of all "goods" and tends to increase both C_0 and C_1.

- Substitution effect: the interest rate is the relative price of current vs future consumption: consuming one dollar in the current period costs $\left(1 + r\right)$ dollars of future consumption. As the interest rate rises, current consumption becomes relatively more expensive, which tilts the optimal consumption choice towards more future consumption. This effect tends to reduce C_0 and increase C_1.

Grading instructions: 1 point for the sign of the changes in optimal consumption (note: there are two possible answers for C_0), 2 points for explaining the income effect, 2 points for explaining the substitution effect. Partial credit at the grader's own judgement.

f. From the discussion of question 5, we can immediately see that future consumption C_1 always increases following a rise in the interest rate, while the change in current consumption C_0 is ambiguous. If the income effect dominates (as in figure 3), then C_0 rises as well. If the substitution effect dominates, as in figure 4, C_0 falls instead.

Grading instructions: 2 points for explaining the impact of each of income and substitution effects on C_0, 1 point for concluding that the total effect is ambiguous. Full credit if the student developed the explanation in part (e).

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