ECO2143 Macroeconomic Theory II
First mid-term examination: March 7th, 2011
University of Ottawa
Professor: Louis Hotte
Time allotted: 1h 20min

Attention: *Not all questionnaires are the same. This is questionnaire* ***A****. On the answer sheet, you must indicate the letter of your questionnaire with the course's number as follows:* ***ECO2143A****. You must answer according to* ***the material seen in this course****. Read all answer choices before choosing your answer.* GOOD LUCK!

QUESTIONNAIRE A

I. MULTIPLE CHOICE QUESTIONS (4 points each)

1. Assume two countries (1 and 2) have the same values of A (a constant productivity level) and γ (investment as percentage of output). Country 1 has a depreciation rate $\delta = 0.05$ and population growth $n = 0.025$. Country 2 has a depreciation rate $\delta = 0.06$ and population growth $n = 0.03$. Noting these differences, what can be said about their relative steady state levels?
   (a) Country 1 has a lower steady state stock of capital per capita.
   (b) Country 2 has a higher steady state level of income per capita.
   (c) There is no difference in their steady state levels of income and capital per capita.
   (d) The growth rates of income per capita at both countries' steady states are equal.
   (e) Not enough information is given to come to any conclusions about relative steady states.

2. Suppose that there are two countries, Abysus and Chimerica, that differ in both their rates of investment and their population growth. In Abysus, investment is 6% of GDP and population grows at 4% per year. In Chimerica, investment is 20% of GDP and population grows at 2% per year. Further assume that both countries have the same constant level of productivity (A), that capital's share of national income (α) is 1/3 and that their depreciation rates (δ) are both 5%. Using this information, what is the ratio of the two countries' steady-state levels of income per capita (y_a^{ss}/y_c^{ss})?
   (a) 0.48
   (b) 1.52
   (c) 0.76
   (d) 0.38
   (e) 1.47

3. Which of the following statements best describes the importance of the relationship between income and health?
   (a) Better health leads to higher income.
   (b) There is no causal relationship between health and income.
   (c) Higher income leads to better health.
   (d) Better health leads to higher income and higher income leads to better health.
   (e) There is no correlation between health and income.

4. Regarding productivity between two countries, A and B, which statement is true?
   (a) If Country A has a higher level of accumulated factors than Country B, it will have a lower level of productivity.
   (b) If Country B has the same level of accumulated factors as Country A, both countries will have the same level of productivity.
   (c) If Country B has a higher level output per worker and more accumulated factors than Country A, it necessarily has a higher level of productivity.
   (d) If Country A and Country B have the same level of accumulated factors but Country A has a lower level of output per worker, then Country A has a higher level of productivity than Country B.
   (e) None of the above statements are correct.

5. Assume that an economy can be represented by the Solow model with labour augmenting technological progress. The national production function is $Y = K^{\alpha}(eL)^{1-\alpha}$. Suppose that the investment rate is $\gamma = 8\%$, the depreciation rate is $\delta = 5\%$, the growth rate of the labour force is $n = 2\%$, and the growth rate of technological progress is $\hat{e} = 2\%$. What will be the long run steady-state growth rate of output per worker?
   (a) 2%
   (b) 4.15%
   (c) 2.44%
   (d) 4%
   (e) 0

6. Which of the following statements regarding the long-run steady-state growth rate of aggregate output $\hat{Y}$ is true?
   (a) It is equal to the growth rate of technological progress growth $\hat{e}$.
   (b) It is equal to the labour force growth rate n plus the growth rate of technological progress $\hat{e}$.
   (c) There is no growth rate of long-run aggregate output $\hat{Y}$ because of "Decreasing Returns to Capital".
   (d) The long-run steady-state growth rate of aggregate output is equal to zero.
   (e) None of the above is correct since it depends on whether we start above or below the country specific steady-state.

7. Suppose that in a certain country, one-fifth of the females die in infancy; two-fifths die at age 30; and two-fifths live to age 60. Furthermore, women bear one child at age 22, one child at age 26, one child at age 29, and one child at age 32. Where one-half of all children born are girls, what is the net rate of reproduction for this country (NRR)?
   (a) 1.25
   (b) 1.5
   (c) 1.0
   (d) 2.0
   (e) 0.75

   1.4

8. Suppose that returns to education are 13.4% for the first three years of schooling, 10.1% for the next five years, and 6.8% per year for education attained beyond the first 8 years. Knowing this, approximately what fraction of wages is due to human capital for a worker who has 15 years of education?
   (a) 0
   (b) 22%
   (c) 68%
   (d) 78%
   (e) 233%

   73%.

9. In a case study discussed in class which compared the growth experiences of Singapore and Hong Kong since 1960, it was seen that even though both countries had experienced similar output growth rates, productivity growth in Singapore was much lower than in Hong Kong. This led us to make the following observation:
   (a) Singapore's output growth rate will not be able to keep up with Hong Kong's in the long run because of diminishing returns to capital.
   (b) Hong Kong's output growth rate will not be able to keep up with Singapore's in the long run because of diminishing returns to capital.
   (c) Singapore's output growth rate will not be able to keep up with Hong Kong's in the long run because of increasing returns to productivity.
   (d) Hong Kong's output growth rate will not be able to keep up with Singapore's in the long run because of increasing returns to productivity.
   (e) We could not tell which of the two countries would keep on growing fastest.

10. Which of the following is TRUE?
   (a) According to the Malthusian model of population and economic growth, a technological improvement leads to higher standards of living in the long run.
   (b) The Malthusian model of population and economic growth is useful to explain increases in standards of living in the industrialized world over the last 200 years.
   (c) A drop in the mortality rate can lead to lower fertility through the effect of increased incentives to invest in a child's education.
   (d) A drop in the mortality rate can only lead to higher population growth in the long run.
   (e) Better access to contraceptives is the leading explanation for lower population growth in today's developed world.

II. PROBLEM

Answer within the space provided. Your answers must be accompanied with clear explanations. Graphs and equations without explanations will not get you far.

Technological progress and economic growth (60 points)
Suppose that the national output of an economy is given by the following function:

$$Y = AK^{\alpha}L^{1-\alpha} = K^{\alpha}(eL)^{1-\alpha}$$

where the variables are as defined in class and $e = A^{\frac{1}{1-\alpha}}$. (The time subscripts have been removed for clarity.) The total investment and depreciation levels are given by $I = \gamma Y$ and $D = \delta K$ respectively, with $\gamma \in (0,1)$ and $\delta \in (0,1)$. Population (L) and total factor productivity (A) grow at constant rates n and $\hat{A}$ respectively. Let eL denote the total quantity of "effective workers" available in this economy.

a) (25 points) Derive an expression for the steady-state output per effective worker. At what rate is the output per worker growing in this steady-state?

We first define the following variables in terms of "effective workers":
$y_e = \frac{Y}{eL}$, $k_e \equiv \frac{K}{eL}$, $i_e = \frac{I}{eL}$, $d_e = \frac{D}{eL}$
Since $\Delta K = I - D$, we have $\Delta k_e = i_e - d_e$
$\Rightarrow \Delta k_e = \gamma k_e^{\alpha} - (\delta + n + \hat{e}) k_e$
In steady-state: $\Delta k_e = 0 \Rightarrow \gamma k_e^{\alpha} = (\delta + n + \hat{e}) k_e$
$\Rightarrow k_e^{SS} = \left(\frac{\gamma}{\delta + n + \hat{e}}\right)^{\frac{1}{1-\alpha}} \Rightarrow \boxed{y_e^{SS} = \left(\frac{\gamma}{\delta + n + \hat{e}}\right)^{\frac{\alpha}{1-\alpha}}}$ ← This is the SS output per effective worker.
$\left(NB\ y_e = \frac{Y}{eL} = k_e^{\alpha}\right)$
Since output per worker $= y = \frac{Y}{L}$,
we have $y_e = y/e \Rightarrow \hat{y}_e = \hat{y} - \hat{e}$. In steady-state, $\hat{y}_e = 0 \Rightarrow \hat{y} = \hat{e}$. Output per worker is growing at rate $\hat{e} = \frac{1}{1-\alpha}\hat{A}$.

b) (10 points) Explain briefly (in words only) how it is possible that output per worker be growing at a faster rate than $\hat{A}$.

We found above that output per worker is growing at rate

$\frac{1}{1-\alpha}\hat{A} > \hat{A}$. This growth rate is larger than the total factor productivity growth rate because as TFP increases, so does the accumulation of capital per worker (k).

c) (25 points) Suppose that in 1950, productivity growth jumps from $\hat{e}_1$ to $\hat{e}_2$, with $\hat{e}_1 < \hat{e}_2$. Assuming that the economy was in steady-state before 1950, show and explain graphically how the output per worker will change over time after 1950.

An increase in $\hat{e}$ moves the economy towards a new steady-state, i.e. from $y_{e_1}^{ss}$ to $y_{e_2}^{ss}$.

In the long run, $y_{e_2}^{ss}$ being constant, we have $\hat{y}_2 = \hat{e}_2$.

Output per worker will be growing at a faster rate than before 1950.