ECO2143 Macroeconomic Theory II
First mid-term examination: February 1st, 2010
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)

ATTENTION: To simplify, whenever convenient, today's rich and industrialized countries such as Canada and Western Europe will be referred to as **ICs**, while today's poorer, less-developed countries will be referred to as **LDCs**.

1. Which of the following is generally false?
   (a) Instead of using the market exchange rate, the use of an exchange rate adjusted for purchasing power parity to compare income levels tends to make poor countries look better.
   (b) Instead of using the market exchange rate, the use of an exchange rate adjusted for purchasing power parity to compare income levels tends to make rich countries look even richer.✓
   (c) The use of an exchange rate adjusted for purchasing power parity accounts for the fact that non-tradable goods and services are cheaper in poorer countries.
   (d) The market exchange rate tends to be determined by the law of one price for tradeable goods.

2. Which of the following assertions is *clearly* FALSE.
   a) For Malthus, the only way to improve living standards in the long run is through increased land productivity.✓
   b) Before 1800, humans generally lived at the subsistence level without much differences through time and places.
   c) The Malthus model does a pretty good job at explaining long run per capita economic growth before 1800.
   d) In Ireland, the introduction of the potato crop from the Americas has not contributed to improving the standards of living, as predicted by the Malthus model.

3. A study has estimated the quantity of capital per worker in Mexico to be worth 42 991$(US2000), while that of India is worth 6 270$(US2000). Which property of the national production function allows us to anticipate that an additional unit of capital will have a larger impact on production in India than in Mexico?
   (a) If capital increases, output increases.
   (b) The marginal product of capital is decreasing. ✓
   (c) Constant returns to scale.
   (d) An efficient use of capital.
   (e) capital depreciation.

4. Suppose that physical capital and labor are the only two production factors. The assumption of constant returns to scale implies that
   (a) if the amount of capital doubles but the amount of labor is constant, then total production doubles.
   (b) if the amount of labor doubles but the amount of capital is constant, then total production doubles.
   (c) if the amount of capital doubles but the amount of labor is constant, then total production less than doubles.
   (d) if both the amounts of capital and labor double, then total production doubles. ✓
   (e) if both the amounts of capital and labor double, then total production less than doubles.

5. Over the past 130 years, the average yearly growth rate of income per capita in Canada and the USA has been approximately (give the closest value)
   (a) -1%
   (b) 0%
   (c) 2%✓
   (d) 5%
   (e) 8%

6. Between 1950 and 1980, the rate of growth of output per capita was highest in which of the following countries?
   (a) USA
   (b) UK
   (c) Japan ✓
   (d) Canada

7. Suppose there are two countries that are identical with the following exception: the investment rate in country A is greater than the investment rate in country B. Given this information, in the long run, the Solow model informs us that:
   (a) the capital-labor ratios (k) will be the same in both countries.
   (b) the growth rate of output per capita will be the same in both countries. ✓
   (c) the growth rate of output per capita will be greater in B than in A.
   (d) the growth rate of output per capita will be greater in A than in B.

8. A country is described by the Solow model with $y = k^{1/3}$. The fraction of output invested is 30% and the depreciation rate is 10%. Suppose that $y = 3$ in the present period. Which of the following is true?
   (a) Income per capita will be lower in the next period. ✓
   (b) Income per capita will be higher in the next period.
   (c) Given the parameter values, output $y = 3$ is not possible.
   (d) The Solow model cannot explain changes in income over time.

9. Between 1970 and 2005, China's GDP per capita grew at an average rate of 7.3% per year while in the US, it grew at an average 2.2% per year. In 2005, US GDP per capita was \$36 806 and Chinese GDP per capita was \$5 955. Assuming that the two countries will continue to grow at the same rates, in what year will China overtake the US in terms of GDP per capita?
   (a) 2020
   (b) 2031
   (c) 2042✓
   (d) 2053
   (e) 2064

10. When trying to explain the evolution of income inequalities among the whole world's population over the past 200 years, we can say that
   (a) Inequality has gone down because people are generally richer.
   (b) Inequality has gone up because people are generally poorer.
   (c) Inequality has gone down mostly because of within country differences.
   (d) Inequality has gone up mostly because of between country differences. ✓

II. PROBLEMS

1. Malthus versus Solow (30 points)
For each of the following scenarios, compare the predictions of the Malthusian and Solow models for per-capita incomes in the short and long-run. Use a graphical analysis and be as complete as possible when explaining the predictions and their differences.

a) Parents suddenly prefer to have less kids than before.
b) Climate change leads to lower productivity overall.

2. A productivity increase in the Solow model (30 points)
A country is described by the Solow model with $y = Ak^{\alpha}$, where A is a productivity parameter and $\alpha = 1/3$. The fraction of output invested is 20% and the depreciation rate is 10%.

a) Derive an expression for the long-run income per capita in terms of productivity parameter A. (NB You must derive the expression by explaining the different steps leading to the steady-state.)
b) Discuss the following assertion: If the productivity parameter doubles in size, then the long-run output per capita will also double in size since $y = Ak^{\alpha}$.

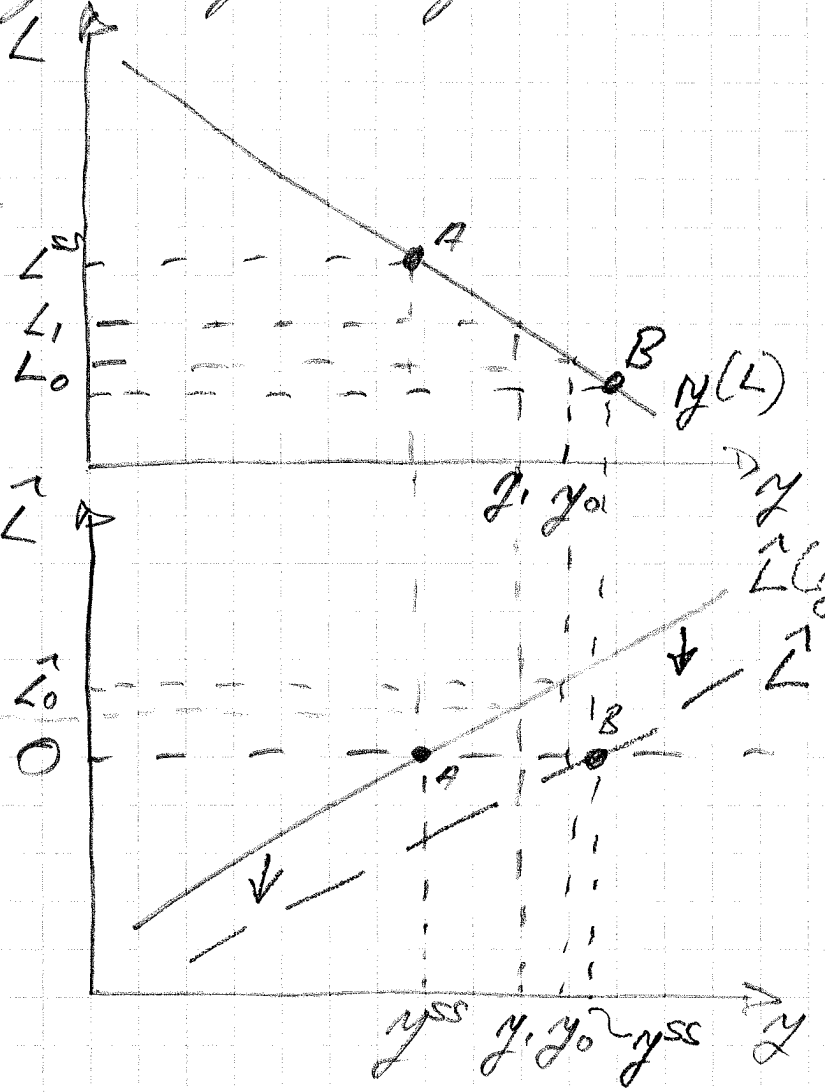
Q.1| Malthus v. Solow

a) Beauty suddenly prefers to have ten children than before.

i) Malthus:

Malthus assumed that ① output decreases with population size and ② population growth increases with output.

Let $L \equiv$ population size
$\dot{L} \equiv$ population growth
$y \equiv$ output per capita



If $y = y_0$ initially, then $\dot{L} > 0$, that is, population size grows.

$\Rightarrow L_1 > L_0$

$\Rightarrow y_1 < y_0$

$\Rightarrow \dot{L}_1 < \dot{L}_0$

$\Rightarrow$ Lower population growth due to lower y.

Eventually, $y = y^{ss}$

$\Rightarrow \dot{L} = 0$

The population stops growing.

If people have less children, then curve $\tilde{L}(y)$ shifts down to, say, $\tilde{L}'(y)$. The only short-term effect is that population starts decreasing. In the long run, the output per capita is higher at point B, and population size is smaller.

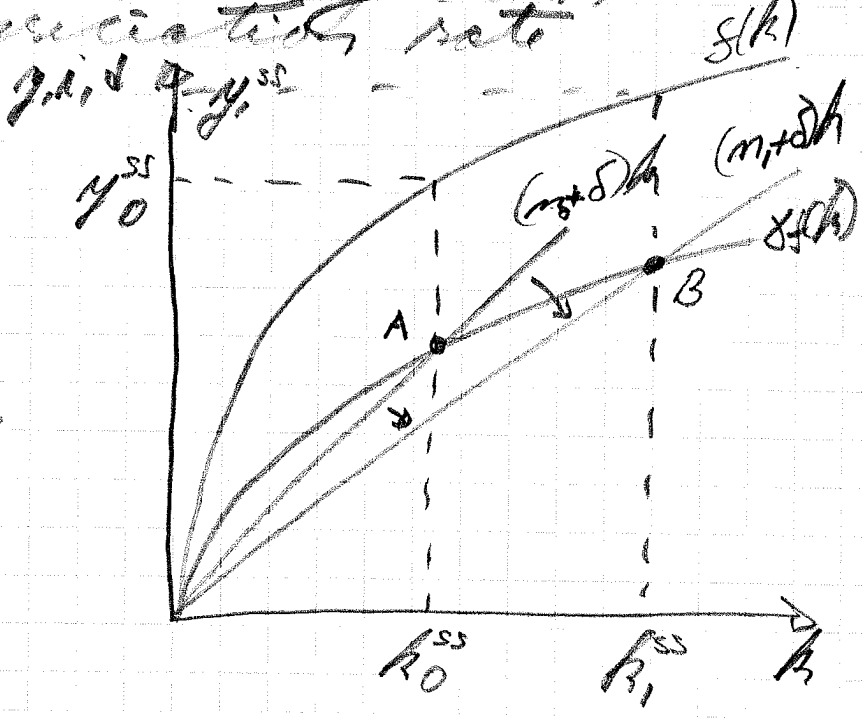
ii) Solow:

In the Solow model, the steady-state is given by the point where investment equals depreciation.

$$\Rightarrow \gamma f(k) = (n+\delta)k$$

where γ is investment rate
k is capital per worker
$f(k)$ is output per worker
n is population growth
δ is depreciation rate

The long-run equilibrium is initially at point A. If people have less children, the depreciation curve rotates down from $(n_0+\delta)k$ to $(n_1+\delta)k$ where $n_0 > n_1$.



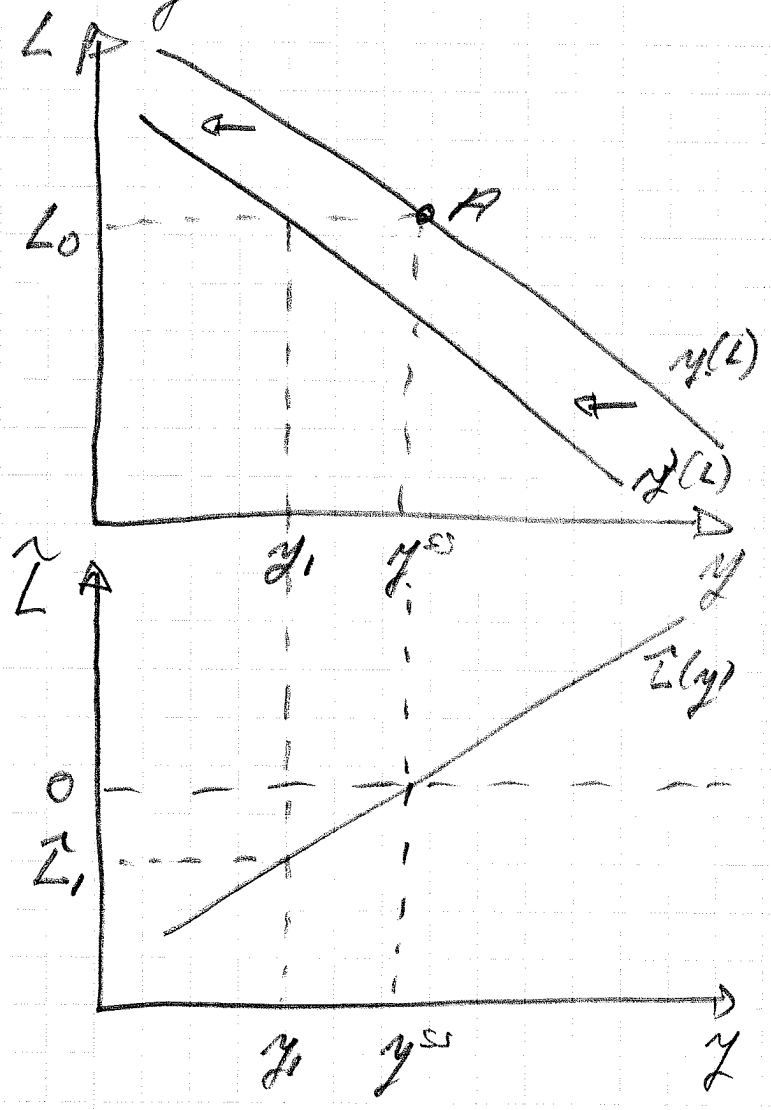
In the short-run, output per capita starts growing along with capital per capita. A long-run equilibrium is reached at point B, with higher output and capital per capita.

Comparing the Malthus model with the Solow model, we see that both lead to higher long-run income following a reduction in the number of children per family. The main difference between the two models is that population stops growing with Malthus due to fixed land size while with Solow, population grows indefinitely while income is made higher through investment.

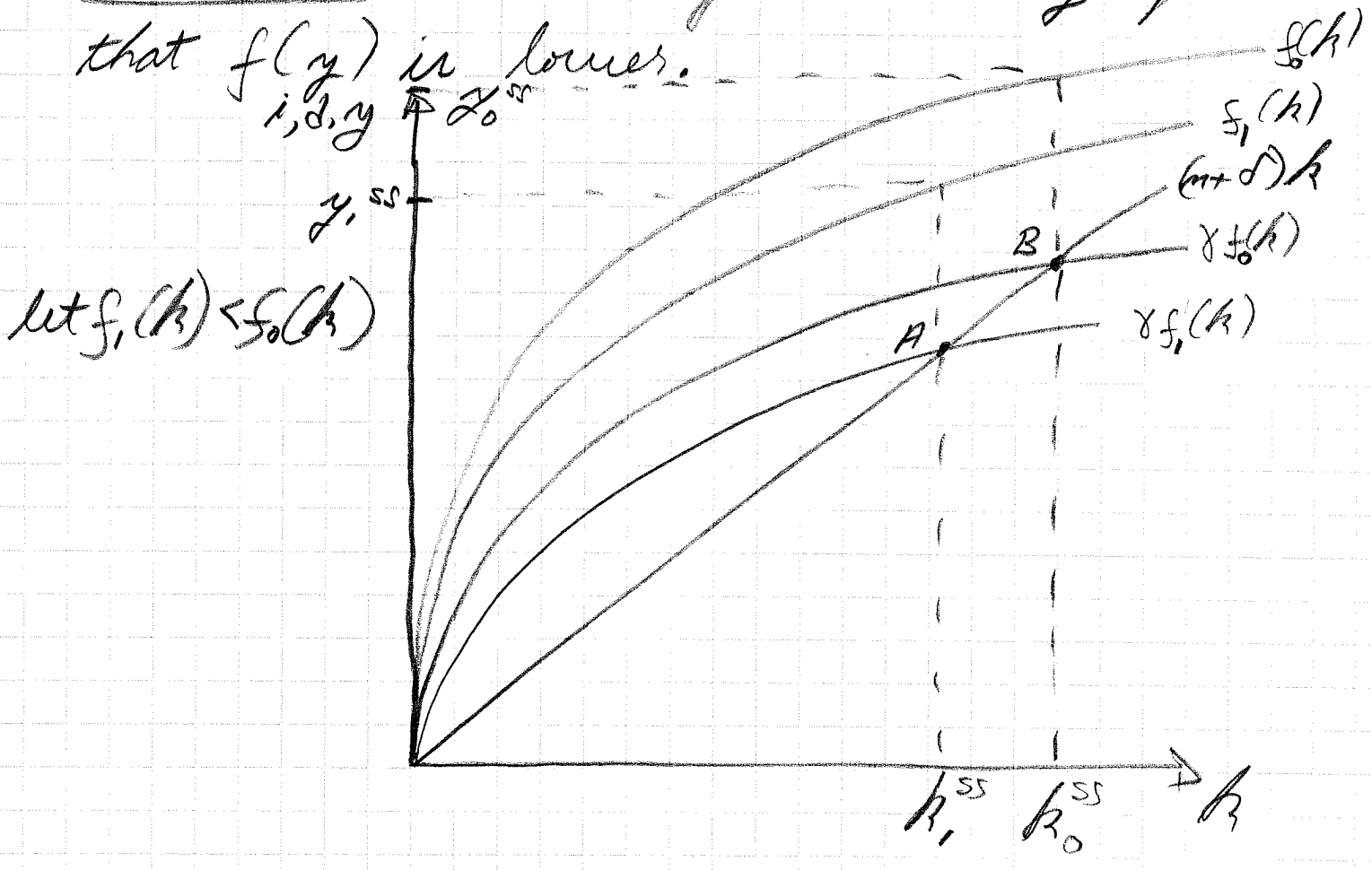
b) Lower productivity:

i) Malthus: in the Malthus model, lower productivity means that less output is produced for any population size L: $g(L)$ shifts left.

If the output curve shifts left from $y(L)$ to $y'(L)$, output drops from y^{ss} to y_1. This causes population size to decrease. With a smaller population, output per capita increases. In the long run, output per capita goes back to y^{ss}.



ii) Solow: a lower productivity implies that $f(y)$ is lower.



A lower productivity leads to a drop in output. This leads to a lower investment level, which means capital per capita to decrease. The long-run output drops from y_0^{SS} to y_1^{SS}. The prediction of the Solow model is thus different from that of Malthus because with Solow, the population size does not "adjust" to the lower productivity.

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#2. A productivity increase in the Solow model

a) $i \equiv$ investment $= \gamma f(k) = \gamma A k^{\alpha}$

$d \equiv$ depreciation $= \delta k$

The long-run per capita level is given by $i = d$

$$\Rightarrow \gamma f(k) = \delta k$$

$$\Rightarrow \gamma A k^{\alpha} = \delta k$$

$$\Rightarrow k^{ss} = \left(\frac{\gamma A}{\delta}\right)^{\frac{1}{1-\alpha}}$$

$$\Rightarrow y^{ss} = A(k^{ss})^{\alpha} = A^{\frac{1}{1-\alpha}}\left(\frac{\gamma}{\delta}\right)^{\frac{\alpha}{1-\alpha}}$$

let $\alpha = 1/3$, $\gamma = 0.2$, $\delta = 0.1$

$$\Rightarrow y^{ss} = \left(\frac{0.2}{0.1}\right)^{1/2} A^{3/2} = \sqrt{2}\, A^{3/2}$$

This is the long-run output per capita as predicted by the Solow model.

b) Let $A_2 = 2A_1$. The ratio of long-run outputs is then

$$\frac{y_2^{ss}}{y_1^{ss}} = \frac{\sqrt{2}}{\sqrt{2}} \frac{(2A_1)^{3/2}}{A_1^{3/2}} = 2^{3/2} \approx 2.8$$

The long-run output is <u>more than</u> twice larger. This is due to the fact that k^{ss} changes with productivity. Indeed, we have:

$$\frac{k_2^{ss}}{k_1^{ss}} = \frac{\left(\frac{\gamma_2 A_1}{\delta}\right)^{\frac{1}{1-\alpha}}}{\left(\frac{\gamma A_1}{\delta}\right)^{\frac{1}{1-\alpha}}} = 2^{\frac{3}{2}} > 2$$

An increase in productivity induces an increase in the steady-state quantity of capital also.

<u>ALTERNATIVE SOLUTION:</u>

a) The investment rate is given by $i = 0.2 A k^{1/3}$.

The depreciation rate is $d = 0.1 k$.

On the long-run, both must be equal, i.e. $i = d$

$$\Rightarrow 0.2 A k^{1/3} = 0.1 k$$

$$\Rightarrow k^{ss} = (2A)^{3/2}$$

Hence, the steady-state output per capita is

$$y^{ss} = A(k^{ss})^{1/3} = A \cdot \left((2A)^{3/2}\right)^{1/3} = A^{3/2}\sqrt{2}$$

b) If $A_2 = 2A_1$, we have

$$\frac{y_2^{ss}}{y_1^{ss}} = \frac{(2A_1)^{3/2}\sqrt{2}}{A_1^{3/2}\sqrt{2}} = 2^{3/2} \approx 2.8$$

a doubling of productivity causes the output to increase by more than a factor of 2.

This is because an increase in productivity leads to a higher steady-state (long-run) level of capital per capita:

$$\frac{k_2^{ss}}{k_1^{ss}} = \frac{(2 \cdot 2A_1)^{3/2}}{(2A_1)^{3/2}} = 2^{3/2} \approx 2.8.$$