

## Problem Set 2

MSU EC 410

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1. Consider a country in which  $Y = 200 K^{2/5} N^{3/5}$ . Assume in this country they save 20% of their income, population grows at 3% per year, and depreciation of capital occurs at 10% per year. Use the Solow model.
  - a. Compare the effectiveness of i) a 50% increase in the savings rate (to 30%), ii) a 67% decline in the population growth rate (to 1%), and iii) a 10% increase in productivity (to 220). That is, for each, give the percent by which it increases long-run average income ( $y^*$ ) and long-run average consumption ( $c^*$ ).
  - b. Give one policy each that could be undertaken to accomplish i)-iii). Which policy has the greatest impact on long-run well-being (assuming each policy has zero costs)?
2. Imagine the following goal of Lenin/Stalin at the beginning of the Soviet regime in Russia: to overtake (i.e. equal) and surpass the world's industrialized economies in terms of GDP per capita. To achieve this goal, the main instrument of control is the fraction of national production that is devoted to building the nation's productive capacity: new machines, factories, transportation equipment, and roads (i.e. investment as a share of GDP). The rest of national production is used for consumer items like clothing and food. The country begins with relatively little capital, being mostly rural and non-industrialized. Assume each of the following:
  - GDP per capita starts in Russia at \$300/year.
  - The world's industrialized economies start with GDP per capita of \$5000/year.
  - Population growth rates are 2% everywhere in the world.
  - All capital depreciates at 8% per year.Assume the basic growth framework of Solow. Further assume  $y = 400k^{1/3}$  in Russia.
  - a. Solve for Soviet long-run GDP per capita ( $y^*$ ) as a function of its savings rate.For parts b.-d., assume long-run GDP per capita equals \$10,000 in the industrialized countries, and that they are saving 10% of income.
  - b. What fraction of national output should be devoted by the Soviet Union to building new capital goods in order to overtake, i.e. **equal**, the industrialized nations' GDP per capita in the long-run? What fraction is left for consumer items?
  - c. What fraction of national output should be devoted by the Soviet Union to building new capital goods in order to surpass, i.e. **double**, the industrialized nations' GDP per capita in the long-run? What fraction is left for consumer items?
  - d. In the long run, what is the ratio of Soviet GDP per capita to GDP per capita in the industrialized countries, and what is the ratio of Soviet consumption per capita to consumption per capita in industrialized countries if the Soviet Union achieves the goal of part b? of part c? (That is, find four ratios.)
  - e. Comparing the outcomes of part d. of this question to the same question answered using the Harrod-Domar model (5e. from problem set 1), which model produces a more optimistic outlook for achieving, by saving and investing at high rates, the Soviet goals of overtaking and

surpassing industrialized countries' living standards? Remember that living standards are best measured by consumption here.

3. a. Use the Solow model to determine the a) instantaneous impact on GDP per capita, b) instantaneous impact on consumption per capita, c) impact on long-run GDP per capita, d) impact on long-run consumption per capita, e) impact on long-run GDP per capita growth rate, and f) impact on long-run GDP growth rate **of a one-time and instantaneous increase in the population  $N_t$** , through wartime refugee immigration, say. Assume the country begins at its steady state value of  $k^*$  before this event occurs. Justify your answer by use of graph and/or equation. [Hint: this should not be considered a change in  $n$ , since the population continues to grow at rate  $n$  after the one-time jump; it should be modeled as a one-time jump in  $N_t$ .]  
b. Graph the path of  $y_t$  and  $c_t$  against time for the event analyzed in part a.  
c. Use the Harrod-Domar model to determine the a) instantaneous impact on GDP per capita, b) instantaneous impact on consumption per capita, c) impact on long-run GDP per capita growth rate, and d) impact on long-run GDP growth rate of a one-time and instantaneous increase in the population  $N$ , through wartime refugee immigration, say. Justify your answer by use of graph and/or equation.  
d. Graph the path of  $y_t$  and  $c_t$  (or  $\ln y_t$  and  $\ln c_t$ , which are typically linear) against time for the event analyzed in part c.
4. *Discuss* whether, to what extent, and why the following are true or false. (Adapted from Ray ch. 3, exercise 8.)
  - a. The Harrod-Domar model predicts that a country's long-run per capita growth rate depends on its rate of savings, whereas the Solow model predicts that it does not.
  - b. According to both the Harrod-Domar and Solow models, if total factor productivity (i.e.  $A$ ) is *higher* in one country than in another, the country with the higher productivity will see faster long-run growth in GDP per capita.
  - c. The Solow model predicts that a change in the population growth rate affects neither the long-run growth rate of GDP nor the long-run growth rate of GDP per capita.
  - d. In the Solow model, output per capita ( $y$ ) goes down as capital per capita ( $k$ ) increases, because of diminishing returns.
  - e. Both the Solow and the Harrod-Domar model point to the inadequacy of GDP per capita (i.e.  $y$ ) as a measure of well-being.