Exam 1. Econ520. Fall 2013

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UNC

Instructions:

- Answer all questions.
- Clearly number your answers. Write legibly.
- Do *not* write your answers on the question sheets.
- *Explain* your answers – do not just state them.
- *Show* your derivations – do not just state the final result.
- Do not refer to any notes or books. You may use a calculator.
- The total time is 75 minutes.
- The total number of points is 100.

1 Methods in Macroeconomics

[25 points] Briefly describe how one can answer cause-effect questions in macroeconomics, such as: How important is schooling for cross-country income differences? (just to give an example)

Consider:

1. controlled experiments,
2. natural experiments,
3. regressions,
4. macroeconomic models.

For each method, *briefly* summarize benefits and drawbacks. Be clear about the limitations of regressions.

2 Solow Model

Recall the key equation of the Solow model: $\dot{k}_t = sk_t^{\alpha} - (n+\delta)\, k_t$. This sets $A_t = 1$ for simplicity.

Questions:

1. [9 points] Plot $g(k)$ against k. Explain the key features of your graph (intercept, slope).
2. [9 points] What does this graph imply for convergence of country income levels?
3. [10 points] What happens to the slope of your graph as α increases?
   What does this mean in words for how the growth rate varies with k?
   What does it imply for how quickly countries converge to the steady state?
4. [7 points] What is the intuition for the result in #3?

3 Solow / Romer Model

Consider a version of the Romer model where A_t is a rival input in the production of goods. Specifically, assume that the production function is given by

$$Y_t = K_t^{\alpha} \left([A_t / L_t] \, L_t \right)^{1-\alpha}$$

What matters for productivity is the amount of knowledge per worker, A_t/L_t, rather than just A_t. Output per worker is then given by $y_t = (A_t/L_t)^{1-\alpha} \, k_t^{\alpha}$.

Otherwise the model equations are unchanged:

$$\dot{k}_t = s y_t - (n + \delta) k_t \tag{1}$$

$$\dot{A}_t = \delta (s_A L_t)^{\lambda} A_t^{\phi} \tag{2}$$

$$n = \dot{L}_t / L_t \tag{3}$$

Questions:

1. [20 points] Show that the *balanced growth* rates are given by $g(y) = g(k) = n \left[\frac{\lambda}{1-\phi} - 1 \right]$.

2. [8 points] In this model, the balanced growth rate of y can be negative, even though there is always innovation $\left(\dot{A}_t > 0 \right)$. Explain in words how this is possible.

3. [12 points] Explain how stronger patent protection affects economic efficiency. What is the main trade-off?
   Give examples of innovations that occur without patent protection.

End of exam.

4 Answers

4.1 Answer: Methods

1. Controlled experiments: Randomly pick two sets of countries. Change schooling in one set (the treatment group), but nothing else. Do nothing to the other set of countries (the control group). Compare outcomes several years later. The good: clearly produces the right answer, if the experiment is correctly carried out. The bad: impossible to implement.

2. Natural experiments: Nature hits some countries with a shock, such as a natural disaster that destroys capital or a country division. The good: similar to controlled experiments. The bad: hard to find examples. One has to be sure that the disaster did not change anything else. For example, WW2 in Germany destroyed capital, but also changed institutions.

3. Regressions: Regress output on schooling and controls. The good: easy. The bad: wrong answer. Regressions do not answer cause-effect questions. There are omitted variable issues. Reverse causality.

4. Models: Build a model, such as the production model we studied. Pick parameters. Vary schooling in the model and see what it predicts for output. The good: can answer just about any question in principle. The bad: need assumptions. Model could be "wrong."

4.2 Answer: Solow Model

1. $g(k) = sk^{\alpha-1} - n - \delta$. The intercept is the steady state capital stock given by $k^{1-\alpha} = s/(n+\delta)$. The slope is negative. This is the principle of transition dynamics. Or one can draw $sk^{\alpha-1}$ and $n+\delta$ against k. Then the curves cross each other at the steady state capital stock.

2. The graph implies that countries grow faster when they are far below the steady state. It does not imply convergence in levels, unless countries share similar parameters s, n, δ, α, and productivity.

3. The graph gets flatter. A good answer needs to show this, not just state it. When you do this, you realize that my language was not very precise. It is not exactly the slope (in the sense of derivative) of the curve that depends on α.
   The best way of showing the result is to write $g(k)$ as a function of k/k_{ss} and then to take the derivative w.r.to k/k_{ss}. One of the practice problems did that. We have $g(k) = s(k/k_{ss})^{\alpha-1} k_{ss}^{\alpha-1} - n - \delta$ with $k_{ss}^{\alpha-1} = (n+\delta)/s$. Therefore $g(k) = (n+\delta)\left([k/k_{ss}]^{\alpha-1} - 1\right)$. Now it is obvious that $dg/d(k/k_{ss}) = (n+\delta)(\alpha-1)(k/k_{ss})^{\alpha-2}$ is increasing in α (for given k/k_{ss}). So higher α gets the slope closer to 0.
   A much easier way is to argue that the elasticity of the "investment" term $k^{\alpha-1}$ with respect to k is $\alpha - 1$. Or one could say: doubling k increases this term by $2^{\alpha-1}$ or $(1/2)^{1-\alpha}$. Higher

α brings this factor closer to 1.
Either way, deviations from the steady state lead to less rapid growth. Convergence takes longer.

4. Intuition: With low α, the marginal product of k rises very fast as k falls. Given savings imply lots of growth.

4.3 Answer: Solow / Romer Model

1. Balanced growth rates: The exactly follows the standard Solow and Romer models.

   (a) $g(k) = sy/k - n - \delta$. Constant $g(k)$ requires constant y/k or $g(y) = g(k)$.

   (b) From the production function: $g(y) = (1-\alpha)\, g(A/L) + \alpha g(k)$. Impose $g(y) = g(k)$ and rearrange to get $g(y) = g(A/L)$.

   (c) The derivation of $g(A)$ is exactly as in the Romer model. Then $g(A) = n\frac{\lambda}{1-\phi}$ and $g(A/L) = g(A) - n$.

2. Innovation ensures that $g(A) > 0$ but not that $g(A) > n$. It is therefore possible that A/L falls on the BGP. Now that A is rival, productivity in making y is determined by A/L , which falls over time.

3. Patents: Stronger patents offer innovators longer lasting monopolies and therefore profits. The rate of innovation increases. The drawback: monopoly prices are above marginal costs. That is not efficient. Patents also create compliance costs (patent searches, lawsuits).
   Examples of innovation without patents: Coca-cola (effectively a monopoly due to secrecy). Google (give away a product to sell a complementary one – advertising). Ebay (network externality gives ebay a near monopoly).

End of answers.