Review Problems: Innovation and Growth
Prof. Lutz Hendricks. February 16, 2010

Jones, Macroeconomics, problems 6.1-6.8.

1 Basics

1. What is meant by the non-rivalry of ideas?
   (a) Give examples of rival and non-rival goods.
   (b) If Roche holds a patent on a drug, does that make it a rival good?
2. Explain how non-rivalry lead to increasing returns to scale and scale effects.
3. Explain why increasing returns to scale are incompatible with perfect competition. Why does this destroy the presumption that market equilibria are efficient?
4. What is meant by scale effects? Explain why they arise.
5. Define "balanced growth path."

1.1 Answers: Basics

1. See slides
2. See slides
3. Increasing returns means falling average costs, so that marginal cost $<$ average cost. Perfect competition requires pricing goods at marginal cost. With increasing returns, firms would incur losses. If goods are not priced at marginal cost, this is inefficient. Example: the marginal cost of a drug may be only \$1. It may the worth \$100 to the patient, but the firm may price it at \$200.
4. See slides.
5. An equilibrium path along which all variables grow at constant rates.

2 Romer Model

1. Why is there sustained growth in the Romer model, but not in the Solow model?
2. Derive the balanced growth rate of ideas in the Romer model.
3. Suppose there is a one-time increase in the productivity of research ($\bar{z}$). Describe the effect on the level and the growth rate of technology (A).
4. Show the effects of changes in $\ell, \bar{N}, A_0$ in the Romer model.
5. The government uses patent protection and R&D subsidies to foster growth. Could such policies overshoot their targets and actually reduce output and consumption, even in the long-run?

2.1 Answer: Romer model

1. Romer: constant returns to A in the production of A. Solow: diminishing returns to K in the production of K.

Of course, the Romer model with diminishing returns grows, if there is population growth. This is due to the non-rivalry of ideas.

So there are four cases: rival / non-rival $\times$ constant returns / diminishing returns. All of them have sustained growth (with population growth), except for the Solow case (diminishing returns / rival).

2. We did this in class.

3. Increase in $\bar{z}$: faster growth $\left(g = \bar{z}\ell\bar{N}\right)$. No change in y at impact.

4. We did that in class.

5. The short answer is: of course. Suppose we set the fraction of labor working in R&D to 1. Then output is zero.

3 Romer Model with Diminishing Returns

Consider the Romer model with $\Delta A_t = A_t^{\rho}\bar{z}\ell N_t$, $N_t = (1+n)^t$ and $\rho < 1$.

1. Derive the balanced growth rate.

2. Intuitively, why does the balanced growth rate rise with n?

3. [Harder] What is the effect of a permanent increase in ℓ on the time path of A_t? Set $n = 0$. Hint: use the law of motion for A_t to plot $\Delta A_t/A_t = g(A_t)$ against A_t.