Assignment #3
Due Monday, March 10th @5:30pm

This third assignment covers theories of endogenous growth and empirical applications of the neoclassical growth model. Your answers to questions 1-4 may be handwritten, but your answers to questions 5-6 should be typed.

1. Golden Rule in the Endogenous Growth Model
Consider the level of per capita income along a balanced growth path given by equation (5.11) in Jones. Find the value of s_R that maximizes output per worker along a balanced growth path. Is it possible for the economy to invest too much in R&D? Explain why or why not.

2. Economic Growth and R&D
(a) Suppose the economy has a population growth rate of 1% per year, and the growth rate of researchers is 3% each year. Assume that the growth rate of technological progress, $\dot{A}/A$, is equal to 2% each year.
(b) Using equation (5.6) from Jones, calculate an estimate for $\lambda/(1-\phi)$.
(c) Using this estimate calculate an estimate for the long-run steady state growth rate of the economy.
(d) Why does your estimate of the long-run steady state growth differ from the 2% growth of *A* observed empirically?
(e) What has happened to the growth rate of labor employed in R&D relative to the general population growth rate? Cite a specific figure or table to support your finding. Does the fact that many developing countries are starting to engage in R&D change this calculation?

3. Neoclassical Model vs. Endogenous Growth Model
This question compares the model parameters in the neoclassical growth model to those in the endogenous growth model presented in Chapter 6 of Jones.
(a) How might one choose a value for γ to be used in empirical analysis? Use this value to discuss how differences in skills affect output per worked in the steady state compared to the neoclassical model.
(b) The endogenous growth model explains differences in the *level* of income across countries by focusing on differences in the savings rate (s_k in Jones) compared to the amount of time an individual spends accumulating skills in lieu of working (u). What is problematic/unappealing about this explanation?
(c) How does the endogenous growth model explain differences in growth rates observed across countries? Contrast this to the neoclassical growth model.

4. Technology Transfer
This problem considers how an economy's openness affects its level of technological sophistication. Here, we consider the short-term and long-run effects of an increase in μ on *h*.
(a) Construct a graph with $\dot{h}/h$ expressed as a function of A/h. Plot the following two lines:

$$\frac{\dot{h}}{h} = \mu e^{\psi u}\left(\frac{A}{h}\right)$$

$$\frac{\dot{h}}{h} = g$$

Note, this is assuming $\gamma = 1$ in equation 5.7 of Jones. Interpret the economic meaning of each of these two lines and discuss the importance of the point where they intersect.
(b) Using the model above, analyze the short-run and long-run effects of an increase in μ on the growth rate of *h*.
(c) Illustrate an impulse response diagram for *h/A* and *h(t)* over time. For *h(t)*, use a log-scale graph.
(d) Discuss the consequences of an increase in openness to technology transfer on an economy's technological sophistication.

The following two questions consider the discussion presented in Romer (1994). Jones takes similar steps in Chapter 3 to demonstrate problems with the neoclassical growth model. The first part of the question will make use of data from the Penn World Tables (1960-2003) for select groups of countries.

5. Empirical Analysis of the Neoclassical Growth Model

(a) Update Figure 1 and Figure 2 from Romer (1994) using the data provided in the workfile. Since you are using more recent data, your figure may look different (Romer's sample ends in 1985).

(b) Run a regression of average growth on the initial level of real GDP relative to the U.S. for two sets of countries: the full sample and OECD countries. What do you find in terms of convergence?

(c) Run a regression of average annual investment share on the initial level of real GDP relative to the U.S. for the OECD countries and the full sample. Compare your findings to those of Romer (1994). [NOTE: Report you regression results from (b) and (c) in one table, following the formatting given in the supplement on presenting regression results].

(d) In the paper, Romer (1994) uses the Philippines to show a fundamental flaw with the neoclassical growth model. Performing a similar analysis using the data in the workfile, what does the model predict the savings rate should be in the U.S. relative to the Philippines and Mexico? Assume the labor share of income is 60% in your analysis. Looking at your Figures 1 and 2, what is the U.S. savings rate relative to these countries? Is this consistent with the model?

6. Origins of Endogenous Growth

(a) According to Romer (1994) why does the neoclassical model fail to predict *growth* rates of countries? How is this related to the convergence controversy?

(b) Romer (1994) discusses three strategies for addressing the problem demonstrated in the previous question. What are they? You should explain each in some detail, citing parameters from the model (you can use Paul Romer's notation for this explanation). According to Romer, why are these approaches unlikely to be successful in addressing the convergence controversy?

(c) In what sense does the incorporation of human capital improve the fit of the neoclassical growth model? Does this modification improve the model's ability to explain differences in the *level* of per capita income across countries? Does it help to improve the model's ability to explain differences in *growth* rates across countries?

(d) Explain the meaning of each of the following terms and explain why each is important for endogenous growth models.

(i) Nonrivalrous goods
(ii) Degree of excludability
(iii) Intellectual property rights
(iv) Fixed costs
(v) Imperfect competition.
(vi) Externalities