BOSTON COLLEGE
Department of Economics

Macroeconomics Theory Comprehensive Exam
August 31, 2012

Directions: There are four questions to this exam. Please follow the instructions for each question carefully. Write the answer to all questions separately in a bluebook.

Write your Alias and Question Number on the front of each blue book.

Please read the entire exam before writing anything.

Question 1

Set up: Assume growth generated by random sequence of quality improving (vertical) innovations resulting from research activity as in Aghion and Howitt (98).

There are L individuals, each one endowed with 1 unit of labor. The utility is linear in the final good. y is produced using intermediate goods x according to the production function:

$$y = Ax^{\alpha},\ 0 < \alpha < 1$$

Innovations consist of invention of a new variety of intermediate good that replaces the old one and whose use raises A by factor $\gamma > 1$.The final good sector is perfectly competitive but monopoly rents can be earned in producing the new variety of intermediate goods.

The stock of labor can be used to produce intermediate goods, one for one, or in research:

$$L = x + n$$

where n is amount of labor used in research. This is the resource constraint for this economy. When n labor is used in research, innovations arrive randomly with Poisson arrival rate λn, where $\lambda > 0$ is a parameter that reflects productivity of research technology. A firm that innovates successfully has monopoly rents, until it is displaced by the next innovator.

The amount of labor used in research is determined by the arbitrage condition:

$$w_t = \lambda V_{t+1}$$

V_{t+1} is the discounted expected pay-off of (t+1)st innovation. λV_{t+1} is expected pay-off from working in research. w_t is the wage rate from working in the intermediate sector.

V_{t+1} is determined by:

$$rV_{t+1} = \pi_{t+1} - \lambda n_{t+1} V_{t+1}$$

where r is the interest rate and rate of time preference, π_{t+1} is profit obtainable by the (t+1)st intermediate good monopolist,

a) Provide an intuitive interpretation of this equation

b) Consider the intermediate goods producer problem:

$$\pi_t = \max_x [p_t x_t - w_t x_t]$$

where p_t is the price of an intermediate good. Remember that the final good sector is competitive and derive the inverse demand function for the intermediate

good. Use this into the intermediate goods producer problem to derive labor demand (x_t). Show that it is a decreasing function of $\omega_t = w_t/A_t$:

$$x_t = \bar{x}(\omega_t),\ dx/d\omega < 0$$

Show that profits are also a decreasing function of ω_t:

$$\pi_t = A_t\bar{\pi}(\omega_t),\ d\pi/d\omega < 0$$

c) Substituting the optimal x_t and π_t in the arbitrage condition and in the resource constraint obtain the steady state values of ω_t and n_t,. $\hat{\omega}$ and $\hat{n}$. Plot the relevant curves in ω and n space. Derive how the equilibrium of research $\hat{n}$ responds to changes in r, L, γ, and λ. Provide an intuitive explanation for your results.

d) Since the expected growth rate of final output can be shown to be:

$$E(\ln y(\tau+1) - \ln y(\tau)) = \lambda \hat{n} \ln \gamma$$

use this equation and your answer under c) to describe the crucial determinants of growth in this model.

Question 2

Part A

a) Assume no technological progress, no population growth, but positive depreciation (δ). Obtain the Euler equation for consumption, assuming that the central planner maximizes:

$$U = \int_0^{\infty} \exp[-\rho t] \frac{c^{1-\vartheta}}{1-\vartheta} dt$$

where ρ represents the subjective discount rate. The maximization is subject to the resource constraint that can be written as $dk/dt = f(k) - c - k\delta - g$. k denotes the capital labor ratio, c and g are respectively consumption and public spending per head. The production function has the usual neoclassical properties (including, $f'>0, f''<0$). Revenues are obtained through lump sum taxes. Using the planner problem derive the steady state (analytically and graphically) and the dynamics (graphically) for this model.

b) What is the effect of an unanticipated permanent increase in public spending financed by lump sum taxes on the steady state level of k and c? Describe the path of c and k from their initial values to the new steady state (using the phase diagram). How does your answer change if the increase in public spending is unanticipated but temporary? In this last case can you think of any empirical evidence that one can look for to support or refute the predictions of the Ramsey model?

Part B

Assume log income per capita in country i in period t ($\log y_{it}$) depends upon the quality of institutions (R_{it}). In turn institutions depends upon the level of development summarized by log y_{it} and a set of other exogenous variables Z_{it}, so that:

$$\log y_{it} = a + b * R_{it} + \varepsilon_{it}$$
$$R_{it} = c + d * \log y_{it} + f * Z_{it} + \eta_{it}$$

ε_{it} and η_{it} are mean zero error terms, uncorrelated over time and with each other.

a) Describe why using Ordinary Least Squares would not provide you with the right answer about the causal effect of institutions on economic performance (in order to answer derive the reduced form for R).

b) On the basis of your readings, explain how you can obtain a consistent estimate of b, using an instrumental variable procedure.

Question 3

Many economists and policy makers are asking whether world capital flows are "stabilizing" or "de-stabilizing." This question asks you to analyze this issue in a simple environment.

Assume that households maximize the present value of utility subject to a flow budget constraint:

$$\text{Max} \quad E_t \sum_{j=0}^{\infty} \beta^j \left[\frac{C_{t+j}^{1-\sigma}}{1-\sigma} - a \frac{H_{t+j}^{1+\eta}}{1+\eta} \right]$$

s.t.

$$C_t + B_t = W_t H_t + (1 + r_t) B_{t-1} + \Pi_t$$

C is consumption. Π are profits rebated lump-sum to consumers (if any). B is the household's stock of assets and r the rate of return on these assets. The interpretation of B and r will depend on the model, as discussed below. Firms have the production function:

$$Y_t = Z_t H_t .$$

We will contrast the behavior of C and Y in two settings. The first is a standard closed economy, where

$$Y_t = C_t .$$

In the closed economy, $B = 0$ in equilibrium and r_t varies over time. Note the absence of investment. In the open economy, by contrast:

$$Y_t = C_t + NX_t ,$$

where NX denotes net exports. There is only a single type of output in the world, so "trade" really means capital flows. In the open economy, assume that $r_t = r^*$ forever, where r^* is a constant. B will generally not be zero in equilibrium, since these are now assets held against the rest of the world.

A. Suppose there is a permanent positive shock to Z. What happens to Y, C, H and r in the closed economy? What happens in the open economy?

B. Suppose there is a transitory positive shock to Z (Z is high today and will go back to its steady-state value starting next period). What happens to Y, C, H and r in the closed economy? What happens in the open economy?

C. Using your results from Parts A and B, can you say whether the existence of world capital flows (having an open, as opposed to a closed economy) makes Y, C and H more or less volatile? Is your result unambiguous, or does it depend on the type of shock? Explain.

D. The models above omit physical capital as a factor of production, and investment in capital as a form of output. Discuss whether having capital in model would change your results in part C (1) qualitatively, and (2) quantitatively. Does it matter whether there are adjustment costs to changing the capital stock, as in the "q" model of investment? Explain your reasoning!

Question 4

The changing behavior of productivity in the last two US recessions has caused much discussion among macroeconomists. For this question "productivity" means labor productivity, measured as output divided by labor hours. In most post-war business cycles, productivity was procyclical—that is, it went up in booms and down in recessions.

In the last two recessions, particularly the Great Recession that started in 2010, labor productivity actually went up. For example, labor productivity growth was 7 percent in 2001:Q2, the first quarter of the 2001 recession. Labor productivity growth was 5 percent in 2009:Q1 and 7 percent in 2009:Q2, the last two quarters of the 2009 recession. For comparison, the average quarterly growth rate of labor productivity since 1995 is 2.4 percent. (All quarterly growth rates are reported on an annualized basis.)

A. Present a model that is consistent with labor productivity going down during recessions for at least one particular shock—you must specify the shock and explain why it leads labor productivity to fall. Your model should include capital as a factor of production. You should demonstrate that your model is capable of predicting comovement among the main macro variables—that is, in response to the shock(s) in your analysis, *Y, C, H* and *I* should all move in the same direction.

B. Present a model that is consistent with labor productivity going up during recessions for at least one particular shock—you must specify the shock and explain why it leads labor productivity to rise. Your model should include capital as a factor of production. You should demonstrate that your model is capable of predicting comovement among the main macro variables—that is, in response to the shock(s) in your analysis, *Y, C, H* and *I* should all move in the same direction.

   Your model of part B can be substantially similar to your model of part A but with a new shock or a new mechanism, or it can be a completely different model.

C. Using your models of parts A and B, tell a qualitative but rigorous story explaining the changing cyclical behavior of productivity. Make it clear whether your story depends on structural change in the economy (a change in the model) or whether you are assuming that there were different shocks in the two periods.

D. Suggest an empirical test that would help to confirm or reject the story you proposed in part C. Be as specific as you can in explaining what correlation or regression coefficient(s) you would examine, and why these objects are properly identified in your empirical test.

E. Suppose we add the following facts: The 1982 recession is generally agreed to have been due to contractionary policies followed by the Federal Reserve to reduce inflation, and not to any other source. Productivity fell in that recession (absolutely for some quarters and relative to trend for the recession as a whole). Is this new fact consistent with the story that you told in part C? Explain why or why not.