Written Exam for the M.Sc. in Economics - Fall 2015

Macroeconomics III
Final Exam

February 8, 2016

3-hour closed book exam

Please note that the language for this exam is English.

The points for each question should guide you in allocating time to answering them (they add up to 180, thus proportional to the total time you have for the exam).

1 (20 points) Answer true, false, or uncertain. Justify your answer.

The Calvo model features aggregate price stickiness since, although all firms are in principle able to change their prices, only a fraction of them receive new information in each period, and it is only these firms that change their prices.

2 (20 points) Answer true, false, or uncertain. Justify your answer.

Europe faces a secular process of population aging. This will force countries that have a pay-as-you go social security system to reduce benefits, and thus current workers should be given incentives to save more for their retirement privately.

3 (20 points) Answer true, false, or uncertain. Justify your answer.

If the government announces that next year a distortionary capital income tax will be introduced, consumers will respond immediately by increasing consumption.

4 (60 points) Consider an economy where households maximize the following intertemporal utility:

$$U = \int_0^\infty \left[\ln c_t + v(m_t)\right] e^{-\rho t} dt$$

where c is per capita consumption in the household, ρ is a time discount factor, m are real money balances per capita, and there is no population growth. Function v represents

the value of money balances for the household. Use the following functional relation for $v(\cdot)$:

$$v(m) = \ln m - \gamma m$$

where the term γm captures the utility costs of handling money (either because of the physical cost of holding money, or the costs of doing bank transactions). In this economy there are two types of money, both in fixed supply, and perfect substitutes to each other. There is paper currency, H, and bank deposits, D, such that $M = H + D$.

Assume that there are many identical competitive firms that hire labor and capital to produce the consumption good with a CRS technology. Firms maximize the following profit function:

$$\pi^F(K_t, L_t) = K_t^\alpha L_t^{1-\alpha} - w_t L_t - r_t K_t,$$

where K_t and L_t denote the quantities of capital and labor employed by the firm. Assume $0 < \alpha < 1$. There is no capital depreciation. Competition will imply that capital and labor are paid their marginal productivities, r, and w respectively, given by:

$$r_t = \alpha k_t^{\alpha-1}, \qquad\qquad w_t = (1-\alpha)k_t^\alpha,$$

where k_t is the capital to labor ratio in the economy at time t.

Households supply labor inelastically. Assume that households can save in capital or money, and that household i's real budget constraint in per capita terms is given by,

$$\dot{a}_t = r_t a_t + w_t + z_t - (c_t + (\pi_t + r_t)m_t)$$

where $a_t \equiv k_t + m_t$ are asset holdings, π_t the rate of inflation, and z are per capita lump sum transfers received from the government (can be negative).

a) Interpret the terms related to real money holdings in the household's dynamic budget constraint. Set up the Hamiltonian, stating which are the control, state and costate variables. Find the FOC that characterize the households' maximization problem, including the transversality condition. Find the equations that characterize the steady state in this monetary economy. Is money superneutral? What is the optimal quantity of money? Explain.

Suppose now that the economy is initially in a steady state and the government decides to instantaneously retire all paper currency from circulation. For this it uses a lump sum tax to collect resources that are given to households in exchange for paper currency. HINT: you can alternatively interpret this as a confiscation of all paper currency holdings.

b) How does this shock affect the dynamic budget constraint, the Hamiltonian, and the first order conditions? What is the effect on the steady state, including the price level? What effects do you expect to see in the transition (give intuition, not math)? Would you expect different effects if the government preannounced this policy a year before its implementation?

Suppose now that the use of paper currency had higher utility costs than bank deposits. Thus, when the government retires paper currency, γ is reduced to $\gamma' < \gamma$.

c) How does the shock affect the dynamic budget constraint, the Hamiltonian, and the first order conditions? What is the effect on the steady state, including the price level? Interpret.

5 (60 points) Consider an economy where aggregate demand satisfies

$$y = m - p$$

where y is output, m is the aggregate amount of money supply, and p is the price level (all lower case variables are in logs). It is assumed that there are shocks to aggregate demand. This is modeled by having m stochastic and its expectation, $E[m]$, known.

In this economy some firms have "flexible" prices, some have "rigid" prices, and some have "rigid-flex" prices, this distinction referring to the information available at the time of price setting. Let p^f denote the price set by a representative flexible price firm, p^r the price set by a representative rigid price firm, and p^{rf} the price set by a representative rigid-flex firm. Fraction α_1 of firms have rigid prices, and fraction α_2 of firms have rigid-flex prices. Flexible price firms set their prices after m is known, rigid price firms set their prices before m is known, and rigid-flex firms initially set their prices before m is known, but are able to change them if $(m - E(m))^2 > \sigma^2$ where σ^2 is the volatility of m.

Firms respond to an increase in aggregate demand by producing more, and in that case would have to pay higher wages to induce workers to work more. Since firms have some monopoly power in setting prices, they pass the increase in costs (the higher wages) into prices. Thus the desired relative price, $p_i^* - p$, set by firm i if there were no uncertainty is given by:

$$p_i^* - p = \phi y = \phi(m - p)$$

where ϕ measures the degree of real rigidity in the economy (how responsive prices are to aggregate demand). With uncertainty we assume that price setting follows:

$$\begin{aligned} p^f &= E[p_i^*|m] = (1-\phi)p + \phi m \\ p^r &= E[p_i^*] = (1-\phi)E[p] + \phi E[m] \\ p^{rf} &= \begin{cases} E[p_i^*] & \text{if } (m - E(m))^2 \leq \sigma^2 \\ E[p_i^*|m] & \text{if } (m - E(m))^2 > \sigma^2 \end{cases} \end{aligned}$$

where expectations are rational (i.e. subject to information known when setting prices, and knowing how other producers set prices). The price level satisfies $p = \alpha_1 p^r + \alpha_2 p^{rf} (1 - \alpha_1 - \alpha_2) p^f$.

a) Find p^f in terms of p^r, m, $E[m]$, and the parameters of the model (ϕ, α_1, α_2, and σ^2). Find p^r in terms of $E[m]$ and the parameters of the model.

b) Do anticipated changes in m (i.e. changes known at the time rigid price firms set their prices) affect y? Why or why not? Do unanticipated changes in m affect y? Why or why not?

c) Show that the marginal response of output to an unanticipated change in m, is larger for small shocks (i.e. when $(m - E(m))^2 \leq \sigma^2$). Interpret. Does output become more or less responsive to an unanticipated change in m when there is an increase in α_2? Interpret.