Written exam for the M. Sc. in Economics, Winter 2010/2011

Advanced Macroeconomics 2

Master's Course

January 17, 2011

(3-hours closed book exam)

Please note that the language used in your exam paper must correspond to the language of the title for which you registered during exam registration. I.e. if you registered for the English title of the course, you must write your exam paper in English. Likewise, if you registered for the Danish title of the course or if you registered for the English title which was followed by "eksamen på dansk" in brackets, you must write your exam paper in Danish.

If you are in doubt about which title you registered for, please see the print of your exam registration from the students' self-service system.

The weighting of the problems is:

Problem 1: 45 %, Problem 2: 35 %, Problem 3: 20 %.[1]

[1] The percentage weights should only be regarded as indicative. The final grade will ultimately be based on an assessment of the quality of the answers to the exam questions in their totality.

Problem 1 Consider the following continuous time model which focuses on "very-short run" dynamics of a closed economy:

$$\dot{Y}_t = \lambda(D(Y_t, R_t, \alpha) + G - Y_t), \quad \lambda > 0, \quad 0 < D_Y < 1, \quad D_R < 0, \quad D_\alpha > 0, \tag{1}$$

$$\frac{M_t}{P_t} = L(Y_t, i_t), \qquad L_Y > 0, \; L_i < 0, \tag{2}$$

$$\pi_t = \bar{\pi}, \tag{3}$$

$$R_t = \frac{1}{Q_t}, \tag{4}$$

$$\frac{1 + \dot{Q}_t^e}{Q_t} = r_t, \tag{5}$$

$$r_t = i_t - \pi_t^e, \tag{6}$$

where a dot over a variable denotes the derivative w.r.t. time t, and the superscript e denotes subjective expectations. Further, Y_t = output, Q_t = real price of a consol paying one unit of output per time unit forever, α = index of "level of confidence", G = government spending on goods and services, M_t = money supply, P_t = output price, i_t = nominal short-term interest rate, and $\pi_t \equiv \dot{P}_t/P_t$ = rate of inflation. The tax revenue function is implicit in the demand function D. The variables α, G, and $\bar{\pi}$ are exogenous positive constants. The initial values Y_0, M_0, and P_0 are historically given.

In questions a) - f) we assume that the central bank maintains the real money supply, $m_t \equiv M_t/P_t$, at a constant level by letting the (nominal) money supply grow at a rate equal to the rate of inflation.

a) Briefly interpret the equations (1) - (6) as well as R_t and r_t.

From now on, suppose that expectations are rational and that speculative bubbles do not arise.

b) To characterize the movement of the economy over time, derive from the model a dynamic system in Y_t and R_t. Draw the corresponding phase diagram, assuming that parameters are such that there exists a steady state with a nominal short-term interest rate $\bar{i} > 0$. *Hint:* it may be useful to find an expression for i_t in terms of Y_t and m_t.

c) Illustrate the path that the economy follows for an arbitrary $Y_0 > 0$. Comment.

Suppose that the economy has been in its steady state ("short-run equilibrium") until time $t_0 > 0$.

d) Then an unanticipated shift in the level of confidence to a value $\alpha' < \alpha$ occurs. But after this shift everybody rightly expects the new level of confidence to be maintained for a long time. Illustrate by a phase diagram what happens to Y_t and

R_t over time. Illustrate in another figure the time profiles of Y_t, R_t, i_t, and r_t for $t \geq 0$. Briefly explain in words. *Hint:* the following formula may be helpful:

$$R_t = \frac{1}{Q_t} = \frac{1}{\int_t^\infty e^{-\int_t^s r_\tau d\tau} ds}.$$

e) What is the sign of the slope of the yield curve immediately after the shock? Comment.

Imagine that at time $t_1 > t_0$ the economy has virtually settled down in the new steady state.

f) For simplicity inflation is not endogenous in the model. As a crude representation of the operation ("behind the scene") of a Phillips curve, however, we imagine that at time $t_2 > t_1$ there is a jump down in the inflation rate to the level $\bar{\pi}' < \bar{\pi}$. The central bank instantly lowers $\dot{M}_t/M_t$ to the same level so that the real money supply does not change. Suppose that the market participants rightly expect these new circumstances to last for a long time. Illustrate by a phase diagram what happens to Y_t and R_t over time. Illustrate in another figure the time profiles of Y_t, R_t, i_t, and r_t for $t \geq t_1$. Whether the new steady state level of R exceeds or does not exceed the steady state level before time t_0 is ambiguous. Why?

Imagine that at time $t_3 > t_2$ the economy has virtually settled down in the new steady state. Let the nominal interest rate in this steady state be denoted $\bar{i}''$. Suppose $\bar{i}''$ is practically equal to zero. The fiscal and monetary authorities find the situation unsatisfactory and decide a coordinated fiscal and monetary policy involving a shift of G to $G' > G$ and a continuous adjustment of the money supply through open market operations so as to maintain the short-term nominal interest rate at the target level $i = \bar{i}''$ until the recession is over.

g) Rewrite one of the basic equations of the model so as to indicate how the money supply must move according to the new monetary policy rule.

h) Within the model (with inflation staying at $\bar{\pi}'$ for a relatively long time), is the coordinated fiscal and monetary policy more potent than a conventional expansionary fiscal policy in isolation (that is, with a monetary policy that, as above, maintains the real money supply)? Is it more potent than a conventional expansionary monetary policy in isolation (that is, with a "passive" fiscal policy as above)? Explain your answers.

i) To the extent the stimulation of aggregate demand succeeds in raising economic activity it is likely that (outside the model) inflation also gradually rises towards a more "normal level". Is this feature likely to counteract or support the effectiveness of the coordinated fiscal and monetary policy? Explain.

Problem 2 Consider a small open economy (SOE) facing a real interest rate, r_t, given from the world market for financial capital. There is no cross-country mobility of labor. Under "normal circumstances" the following holds:

- aggregate employment is at the "full employment" level, $N = (1 - \bar{u})L$, where $\bar{u}$ is the NAIRU and L is the aggregate labor supply, a given constant;
- real GDP, Y_t, equals its given trend level, $\bar{Y}_t$, which grows at a constant exogenous rate $g > 0$ due to technical progress;
- $r_t = r$, where r is a constant and $r > g$.

Time is discrete. Further notation is:

$$\begin{aligned} G_t &= \text{real government spending on goods and services in period } t, \\ T_t &= \text{real net tax revenue (= gross tax revenue} - \text{transfer payments) in period } t, \\ GBD_t &= \text{real government budget deficit in period } t, \\ B_t &= \text{real public debt (all short-term) at the start of period } t. \end{aligned}$$

Assume that any government budget deficit is exclusively financed by issuing debt (and any budget surplus by redeeming debt).

a) Write down two equations showing how GBD_t and B_{t+1}, respectively, are determined by variables indexed by t. Also write down an equation indicating how B_{t+1} is related to GBD_t.

Suppose that $B_0 > 0$ and $G_t = \gamma \bar{Y}_t$, $t = 0, 1, \ldots$, where $0 < \gamma < 1$. Define the "net tax burden" as $\tau_t \equiv T_t / Y_t$.

b) Find the minimum sustained net tax burden, $\bar{\tau}$, which is consistent with fiscal sustainability. *Hint:* different approaches are possible; one focuses on the debt-income ratio and uses the fact that a difference equation $x_{t+1} = ax_t + b$, where a and b are constants, $a \neq 1$, has the solution $x_t = (x_0 - x^*)a^t + x^*$, where $x^* = b/(1 - a)$.

c) How does τ depend on r, g, γ, and $b_0 \equiv B_0/Y_0$, respectively?

Now consider an alternative scenario. In period $t = -1$ the SOE is hit by a huge negative demand shock and gets into a substantial recession with Y_{-1} far below $\bar{Y}_{-1}$. In response the government decides an "expansionary fiscal policy" instead of "laissez-faire", where:

- "laissez-faire" means maintaining $G_t = \gamma \bar{Y}_t$, $t = 0, 1, \ldots$;
- "expansionary fiscal policy" entails a discretionary increase in G of size ΔG, beginning in period 0 and maintained during the slump to stimulate economic activity, that is, $G_t = \gamma \bar{Y}_t + \Delta G$, where ΔG is a positive constant.

Let the tax and transfer rules in the economy imply that net tax revenue in period 0 is given by the function $T = T(Y)$; thus, $T_0 = T(Y_0)$. Assume that under the current slump conditions marginal net tax revenue is $T'(Y) = 0.50$ whereas the spending multiplier is $\partial Y/\partial G = 1.5$.

d) For a given $\Delta G > 0$, find expressions for the approximate effect of the expansionary fiscal policy on GBD_0 and B_1, respectively, in comparison with laissez-faire?

e) For a given r_1, and assuming that both $\partial Y/\partial G$ and $T'(Y)$ are approximately the same in period 1 as in period 0, find an expression for the approximate effect of the expansionary fiscal policy on B_2 in comparison with laissez-faire?

Suppose the slump is over in period 2 and onwards. Suppose further that compared with the expansionary fiscal policy, laissez-faire during the slump would have implied not only higher unemployment, but also more people experiencing *long-term* unemployment. As a result some workers would have become de-qualified and in effect be driven out of the effective labor force. Let the loss in "full employment" output from period 2 and onwards implied by laissez-faire be ΔY per period, where ΔY is a positive constant.[2] Finally, let the ensuing loss in net tax revenue be $\tau \cdot \Delta Y$ per period, where τ is a positive constant (possibly close to $\bar{\tau}$ from b)).

f) With $r_t = r_2$, $t = 2, 3, \ldots$, and given ΔG and τ, find an expression for the value of ΔY required for the expansionary fiscal policy to "pay for itself" in period 2 and onwards in the sense that the averted loss in net tax revenue exactly offsets the extra interest payments?

g) Given $\tau = 0.30$, $r_1 = 0.02$, and $r_2 = 0.03$, answer again f). Comment.

Problem 3 *Short questions*

a) Both the Barro OLG model with bequests and the Blanchard OLG model assume perfectly competitive markets. Yet the two models give opposite answers to the question of Ricardian equivalence. What is meant by Ricardian equivalence and what is the basic reason that the two models give opposite answers?

b) "Taking all three Slutsky effects into account, in the Blanchard OLG model, as formulated in our syllabus, the total effect of a rise in the real interest rate is always a lowering of current consumption." True or false? Why?

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[2] It is possible that ΔY is more or less constant for a long time because two offsetting effects are operative. Because of technical progress the loss of output per lost worker is growing over time. On the other hand the pool of long-term unemployed generated by the slump will over time be a decreasing share of the labor force due to exits by the old and entrance by young people in the labor force.