

# Problem Set 8

ECON 30020: Intermediate Macroeconomics

Professor Sims

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**Instructions:** You may work on this problem set in groups of up to four people. Should you choose to do so, please make sure to legibly write each group member's name on the first page of your solutions. This problem set is due in class on Thursday April 12.

1. **The Aggregate Demand Curve:** The equations characterizing the demand side of the New Keynesian model (and the neoclassical model, for that matter) are:

$$C_t = C^d(Y_t - G_t, Y_{t+1} - G_{t+1}, r_t)$$

$$I_t = I^d(r_t, A_{t+1}, f_t, K_t)$$

$$Y_t = C_t + I_t + G_t$$

$$\frac{M_t}{P_t} = M^d(i_t, Y_t)$$

$$r_t = i_t - \pi_{t+1}^e$$

- (a) What are the exogenous variables in these equations and what are the endogenous variables? Please list them.
  - (b) Write down (in words) the definition of the *IS* curve. Which of the equations above are summarized by the *IS* curve?
  - (c) Write down (in words) the definition of the *LM* curve. Which of the equations above are summarized by the *LM* curve?
  - (d) Write down (in words) the definition of the *AD* curve.
  - (e) Suppose that, contrary to our standard assumptions, both consumption and investment are completely insensitive to the real interest rate (i.e.  $\frac{\partial C^d(\cdot)}{\partial r_t} = \frac{\partial I^d(\cdot)}{\partial r_t} = 0$ ). What will the *IS* and *AD* curves look like under these assumptions? How do they look different relative to our standard model?
  - (f) Revert to assuming that consumption and investment are both decreasing in the real interest rate. Instead assume that money demand is insensitive to the nominal interest rate – i.e.  $\frac{\partial M^d(\cdot)}{\partial i_t} = 0$ . What will the *LM* and *AD* curves look like under this assumption? How do they look different relative to our standard model?
2. **Algebra in a Simple Sticky Price Model with no Investment or Government:** Suppose that we have an economy with no investment and no government. Output is produced

using labor only. The price level is completely sticky. Assume the following specific functional forms for the relevant equations of the model:

$$C_t = aY_t + bY_{t+1} - cr_t$$

$$N_t = \theta_t w_t$$

$$Y_t = A_t N_t$$

$$P_t = \bar{P}_t$$

$$Y_t = C_t$$

$$\frac{M_t}{P_t} = -di_t + eY_t$$

$$r_t = i_t - \pi_{t+1}^e$$

The parameters  $a$ ,  $b$ ,  $c$ ,  $d$ , and  $e$  are non-negative constants. The remaining variables have their usual interpretations.

- (a) What are the exogenous variables and what are the endogenous variables? List them.
  - (b) Explain intuitively why we do not have a labor demand curve when the price level is sticky.
  - (c) Algebraically solve for an expression for the *IS* curve.
  - (d) Algebraically solve for an expression for the *LM* curve.
  - (e) Algebraically solve for an expression for the *AD* curve.
  - (f) Combine your algebraic expression for the *AD* curve with the given *AS* curve ( $P_t = \bar{P}_t$ ) to express equilibrium output,  $Y_t$  as a function of exogenous variables only.
  - (g) How is the sensitivity of output to the money supply (i.e.  $\frac{\partial Y_t}{\partial M_t}$ ), impacted by the sensitivity of consumption demand to the real interest rate (as measured by the parameter  $c$ )? Can you provide any intuition for this?
  - (h) Use your previous work to derive expression for how  $Y_t$ ,  $N_t$ , and  $w_t$  are impacted by changes in  $A_t$ . Can you provide any intuition for your answers?
3. **An Interest Rate Peg:** Suppose that we have a partial sticky price model with one twist. The twist is this – the central bank desires to keep the nominal interest rate constant at some specified value,  $i_t = \bar{i}$ , where  $\bar{i}$  is an exogenous target. This means that  $M_t$  becomes an *endogenous* variable rather than exogenous – in the face of exogenous shocks, the central bank must adjust  $M_t$  in such a way as to keep  $i_t = \bar{i}$ . The equations characterizing the model are standard with the exception of this additional equation and the fact that  $M_t$  is now endogenous rather than exogenous.

$$C_t = C^d(Y_t - G_t, Y_{t+1} - G_{t+1}, r_t)$$

$$N_t = N^s(w_t, \theta_t)$$

$$P_t = \bar{P}_t + \gamma(Y_t - Y_t^f)$$

$$I_t = I^d(r_t, A_{t+1}, f_t, K_t)$$

$$Y_t = A_t F(K_t, N_t)$$

$$Y_t = C_t + I_t + G_t$$

$$M_t = P_t M^d(i_t, Y_t)$$

$$r_t = i_t - \pi_{t+1}^e$$

$$i_t = \bar{i}$$

- (a) Briefly discuss how the parameter  $\gamma$  nests both the simple sticky price model and the neoclassical model.
- (b) Given that  $\pi_{t+1}^e$  is taken to be exogenous, show that the nominal interest rate peg translates into a constant target value of the real interest rate.
- (c) Now graphically analyze the model. Suppose that the economy initially begins in an equilibrium and that there is then an exogenous increase in  $f_t$  (i.e. a worsening of financial conditions). How must the money supply change in order to maintain the interest rate peg? Show how the equilibrium changes. Do the endogenous variables change more or less in comparison to the standard version of the model in which there is no interest rate peg and the money supply is instead exogenous?
- (d) Suppose that the central bank's objective is to implement the neoclassical equilibrium – i.e. to use monetary policy to implement  $Y_t = Y_t^f$  as the equilibrium outcome of the sticky price model. If so, based on your previous answers do you think an interest rate peg is a good idea? Explain.