

### Problem Set 3: Aggregate Demand; Aggregate Supply and Expectations

Answer all the parts of the questions separately giving your reasons for your answer.

1. Consider the IS-LM model:

$$\text{IS equation} : Y = \frac{C_0 + I_0 + G - c_1T}{1 - c_1} - \frac{b}{1 - c_1}r \quad (1)$$

$$\text{LM equation} : \frac{M^S}{P} = m_0 + kY - hr \quad (2)$$

- a) The IS equation represents equilibrium in the goods market. What variable is it thought to determine?
- b) The LM equation represents equilibrium in the money market. What variable is it thought to determine?
- c) Suppose that the Federal Reserve increased the money supply through an open market purchase of bonds. Show how that monetary expansion would impact interest rates and output. [Note: here I am looking for you to tell me the mechanism by which an open market purchase has an impact on the money and goods markets. Use the equations above to help you describe the effect.]
- d) Suppose that the government decides to pursue expansionary fiscal policy by cutting taxes. Describe what happens in the goods and money markets as a result of the fiscal expansion. What is the analytical expression for the tax multiplier from the equations above?

2. Suppose that expectations of inflation are not zero, and instead they play a part.

- a) What is the key link between nominal and real interest rates called? What is the equation which describes this link?
- b) How would you incorporate expectations of inflation in equations (1) & (2) above?
- c) Sketch the new IS-LM curves in *nominal* interest rate - output space, i.e.  $(i, Y)$  space. What do they look like?

- d) Suppose that expectations of inflation increase. What happens to the IS-LM curves in this space?
- e) What happens to nominal interest rates, real interest rates and output in part (d)? What is the name of this effect?

3. Recall that the IS and LM curves give us aggregate demand, AD, curve:

$$Y = \frac{C_0 + I_0 + G - c_1T - \frac{b}{h}m_0 + \frac{bM^S}{hP}}{1 - c_1 + \frac{bk}{h}} \quad (3)$$

where the slope of the AD curve can be shown to be:

$$\frac{\Delta P}{\Delta Y} = -\frac{P^2h(1 - c_1 + \frac{bk}{h})}{bM^S} \quad (4)$$

- a) Draw the AD curve in price-output, (P,Y), space.
- b) What are the key parameters that would influence the slope of the AD curve?
- c) What variables cause a shift of the AD curve? What variables cause a movement along the AD curve?
- d) Suppose there is an increase in G. What happens to the AD curve? Describe your intuition for what happens as well.
- e). Suppose as is question (1d), that the government cuts taxes. Using equation (3), write down the analytical expression for the tax multiplier. How does the expression you wrote here compare to your answer in question (1d)? Which multiplier is bigger?

4. Consider the supply side and in particular the labor market.

- a) What is the firm's objective? Write down this objective function?
- b) What does the Labor Demand schedule represent? What determines how much labor a firm hires, i.e. how does a firm decide how many workers to hire?
- c) What does the Labor Supply schedule represent? What determines how much labor is supplied, i.e. how does a worker decide how much to work?

d) The labor market equilibrium condition requires labor demand to be equal to the supply of labor. Explain why in the long run, the long run aggregate supply is independent of prices?

5. This question is about the sticky wage model. Consider the equations below for aggregate supply in the labor market:

$$Y = F(\bar{K}, L, Z) = Z\bar{K}(200L - \frac{1}{2}L^2) \quad (5)$$

$$L^S = L^* \quad (6)$$

where  $\bar{K}$  is the fixed supply of capital in the long run,  $Z$  represents technology,  $\omega$  represents the **real** wage, and  $Y$  is real GDP. You may assume that  $Z = 1$ .

a) Write out the firm's short run profit function and derive the firm's labor demand function.

b) Consider that the real wage,  $\omega = \frac{W}{P}$  where  $W$  is the nominal wage and  $P$  is the price level. Show that for a given nominal wage, i.e.  $\bar{W}$ , as prices rise, the demand for labor will increase.

c) Show that for a given price,  $\bar{P}$ , a higher nominal wage will lead to a decrease in the demand for labor.

d) Suppose that labor supply is given by equation (6) above. Show that output above is purely a function of the real wage and capital. [Hint: Set labor supply equal to labor demand, and then substitute into the production function in equation (5). You should obtain  $Y = f(w, \bar{K})$ ].

e) Recall that in the sticky wage model,  $\bar{W}$  is fixed in the short run. By substituting  $\omega = \frac{\bar{W}}{P}$ , calculate  $\frac{\partial Y}{\partial P}$ . How is the supply curve sloped in the short run? What is the intuition behind it?

f) Are real wages pro/counter/acyclical in this simple model? Why?

6. Consider the expectations augmented Phillips Curve studied in the lectures.

$$\pi_t = \pi_{t+1}^e + \frac{1}{\alpha}(Y_t - \bar{Y}) + \nu_t$$

- a) How are the Phillips Curve and the Aggregate Supply Curve related?
- b) What is the slope of the Long Run Phillips Curve?
- c) Consider Okun's Law used in the derivation of the Phillips Curve. What does it state? What is the intuition behind it?
- d) What is meant by Rational Expectations? (Note: Here, describe in general what is meant by Rational Expectations, and then give an expression for  $\pi^e = \dots$  )

For the following parts, I am not expecting you to get a numerical result. Just give some intuition for the general levels of the variables and how they compare to  $\pi_{t+1}^e$  and  $\bar{Y}$ .

- e) Suppose that we assume Adaptive Expectations, e.g.  $\pi_{t+1}^e = \pi_{t-1}$ . How would you expect (on average) inflation to be related to  $\pi_{t+1}^e$ ? What would output (on average) be at?
- f) Now suppose we assume Rational Expectations. How would you expect (on average) inflation to be related to  $\pi_{t+1}^e$ ? What would output (on average) be at?