

Professor Christiano  
Economics 311, Winter 2005  
Suggested answers for second midterm

1. Shorter questions.

- (a) Describe carefully the distinction between an exogenous variable and an endogenous variable.

An exogenous variable is one whose value is determined outside of the model. An endogenous variable is one whose value is determined by the model.

- (b) Explain the impact on the natural rate of unemployment of an increase in competition among firms. Make your argument using graphs, and supply intuition as well.

We capture an increase in competition among firms by a reduction in  $\mu$ . The natural rate of unemployment is the level of unemployment that occurs in the medium run, when  $P = P^e$ . In this case, the bargaining equation and the price setting equation together determine the unemployment rate (no other relations are needed):

$$1 = (1 + \mu) F(u, z).$$

The value of  $u$  that solves this equation is the natural rate of unemployment,  $u_n$ . You can see this as a graph with the real wage,  $W/P$ , on the vertical axis and  $u$  on the horizontal axis. The price setting equation is a horizontal line at  $1/(1 + \mu)$ . The bargaining equation is a down-sloped line. The intersection defines  $u_n$ . An increase in competition implies that  $1/(1 + \mu)$  rises. That is, given their costs of production, firms now set a lower price. For workers, this means a higher real wage,  $W/P$ . Since this means more ‘successful’ bargaining outcomes for the workers, the level of unemployment where the bargaining equation is satisfied is lower. With a lower unemployment rate, the bargaining power of workers is greater, consistent with these better outcomes. Thus, the natural rate of unemployment is lower when there is increased competition among firms.

- (c) Suppose there is a shock to  $\bar{I}$ . What is the impact, in the medium run, on the composition of demand between consumption, investment, and government spending? Explain.

The shock to  $\bar{I}$  has no impact on output in the medium run. This is because in the medium run output is equal to its natural rate, and this is not influenced by  $\bar{I}$ . Since output does not change in the medium run, consumption does not either. Also, since  $G$  is an exogenous variable and we did not change it, that variable also does not change. It follows from this reasoning that in the medium run,  $I$  does not change in response to a change in  $\bar{I}$ . So, there is no change in the composition of demand in the medium run in response to a shock in  $\bar{I}$ .

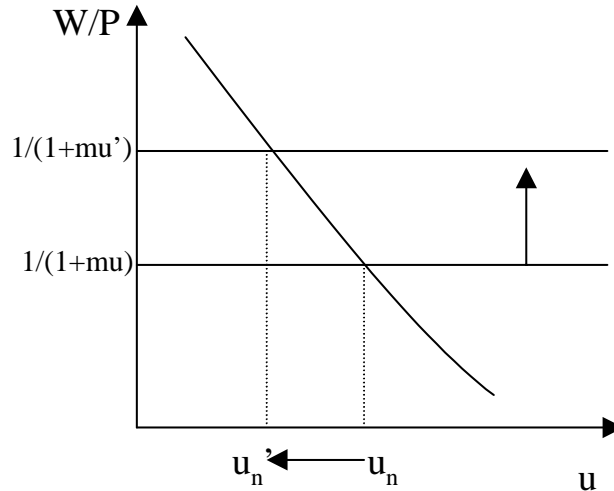


Figure 1:

- (d) Describe 3 different exogenous shocks that could cause  $P$  and  $Y$  to move in opposite directions. Briefly explain, using  $AD-AS$  diagram. Shifts in the  $AS$  curve cause the economy to move along the downward-sloped  $AD$  curve. Thus, these shocks make  $P$  and  $Y$  move in opposite directions. Shocks that move the  $AS$  curve include changes in laws that affect the bargaining power of workers, changes in unemployment insurance provisions, changes in the competitiveness of firms.
- (e) Describe 3 different exogenous shocks that could cause  $P$  and  $Y$  to move in the same direction. Briefly explain, using  $AD-AS$  diagram. Shifts in the  $AD$  curve cause the economy to move along the  $AS$  curve. As a result, such shocks make  $P$  and  $Y$  move in the same direction. Examples of such shocks include disturbances to  $\bar{I}$ ,  $c_0$ ,  $\bar{G}$ .
- (f) Suppose there is a change in the labor force, say due to sudden immigration. What does this do to the natural rate of unemployment and to the natural rate of output? Explain.

In the medium run,  $P = P^e$ . In this case the equations that describe the labor market (the labor market identity, the bargaining equation, the price setting equation and the production function) are enough to pin down the unemployment rate and the level of output. These equations are:

$$\begin{aligned} 1 &= (1 + \mu) F(u_n, z) \\ u_n &= 1 - Y_n / (aL). \end{aligned}$$

Note that  $u_n$  is determined by the first equation. So, the second

equation takes the  $u_n$  implied by the first equation and uses it as input to determine  $Y_n$  in the second equation. An increase in  $L$ , because it does not appear in the first equation, cannot affect  $u_n$ . As a result,  $Y_n/(aL)$  does not change with a change in  $L$ . We conclude that  $Y_n$  moves equiproportionally with  $L$ .

- (g) Provide an intuitive explanation of why the expected price level and the actual price level coincide in the medium run.

People can be wrong in their assessment of something in their environment for a short period of time. However, over a longer period of time they see what's going on.

- (h) Explain why it is that if labor productivity,  $a$ , rises but output does not increase right away, then the unemployment rate rises.

This can be seen by combining the labor market identity with the production function:

$$u = 1 - Y/(aL).$$

If  $a$  goes up but  $Y$  does not change, the unemployment rate must rise. That is, if fewer people are needed to produce a given amount of output, then if output does not change employment must drop with a rise in productivity, and the unemployment rate will rise.

- (i) Suppose a country's output drops for a decade. Where should you look for the cause, on the demand side (i.e., inside the AD curve) or on the supply side (i.e., inside the AS curve)? Explain.

Shocks on the AD side of the economy only have an impact on output in the short run. This is easily less than a decade. (In class I said it was a period from 1 to 3 years). Shocks on the AS side, which affect the natural rate of output would have a much longer impact on  $Y$ .

2. Suppose  $P^e$  jumps from  $P_1^e$  to  $P_2^e$ ,  $P_2^e > P_1^e$ , and remains at  $P_2^e$  in the short run (say that  $P_2^e$  is 10% above  $P_1^e$ ). The medium run dynamics are as before: as the short run turns into the medium run,  $P^e$  adjusts down if in the short run equilibrium it is above the actual price level;  $P^e$  adjusts up if in the short run it is below the actual price level; and  $P^e$  does not change if in the short run it is equal to the actual price level.

- (a) Suppose  $\bar{P}$  is the price level in the short run equilibrium after the jump in  $P^e$ . Is  $\bar{P}$  bigger than, smaller than or equal to  $P_2^e$ ? Explain your answer carefully.

At  $Y = Y_n$ , the AS curve shifts up by exactly the amount of the rise in  $P^e$ . First, recall that the equation for the AS curve (obtained by combining the price-setting equation, the bargaining equation and the production function) is,

$$P = P^e(1 + \mu)F(1 - Y/(aL), z).$$

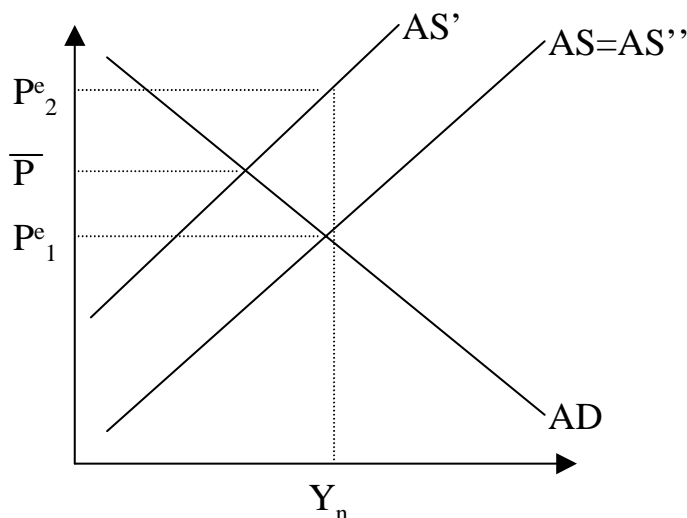


Figure 2:

Second, recall that at  $Y = Y_n$ , the terms to the right of  $P^e$  in the above expression are equal to one. When  $Y = Y_n$ ,  $P = P^e$ , so therefore  $1 = (1 + \mu)F(1 - Y/(aL), z)$ . Furthermore, the AD curve is downward-sloping. A simple graph of the AD-AS curves, drawn to reflect the two observations just discussed, shows that the rise in  $P$  in short run equilibrium must be less than the rise in  $P^e$ . Note: In the absence of any other shock, the AS curve will return to its original position in the medium run.

- (b) Suppose that when  $P^e$  jumps, the Fed simultaneously increases the money supply. Explain, using diagram(s), by how much the Fed has to increase the money supply so that unemployment and output remain precisely at their natural rates in the short run equilibrium. In this case:
- i. how do the new short run and new medium run equilibria compare? Explain
  - ii. how do the old and new medium run equilibria compare in terms of  $W, u, Y, i, M/P, C, I$ ? Explain.

To answer this question it is useful to observe that a 10% jump in the money supply raises the AD curve in the vertical direction by 10%. To see why, note that if  $i, Y, I, G, C$  are such that the goods market and financial market equations are satisfied for a given  $M$  and  $P$ , then these same  $i, Y, I, G, C$  satisfy the goods and asset market equations if  $M$  and  $P$  change in equal proportions. We conclude that the AD curve shifts up by 10% with a 10% increase in  $M$ . Given the increase

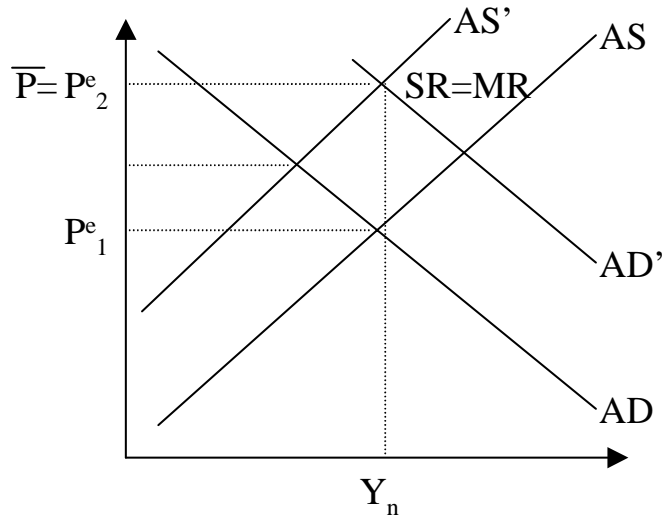


Figure 3:

in the AS curve, such an increase in  $M$  would put the AD curve in a position where it crosses the AS curve at  $Y = Y_n$ . Because  $P = P^e$  in this equilibrium, this short run equilibrium is also a medium run equilibrium.

(i) we conclude that the new short run and new medium run equilibria are identical in every respect.

(ii) we already saw that the increase in  $M$  and  $P$  are the same in percent terms, so that  $M/P$  is unchanged. Because  $W/P = 1/(1 + \mu)$ , and  $\mu$  did not change, we infer that  $W/P$  does not change between the old and new medium run equilibria. This means that  $W$  rose by 10%. We already discussed how  $Y$  does not change, and so  $u$  does not either because nothing in the link between these two variables (involving the labor market identity and production functions) changed. Consumption does not change because its determinants have not changed. Government spending does not change and so with no change in  $C$ ,  $Y$ ,  $G$ , it follows that  $I$  did not change. Since  $I$  does not change, it cannot be that  $i$  changed.

3. Suppose there is a shift up in money demand (i.e., a jump in  $\bar{L}$ ).

(a) What curve does this shift,  $AS$  or  $AD$ ? Explain the reasons for your answer.

Money demand does not enter the equations that underly the AS curve, so it does not shift. Money demand does appear in the AD curve. To see how it responds, consider the IS-LM diagram, which is

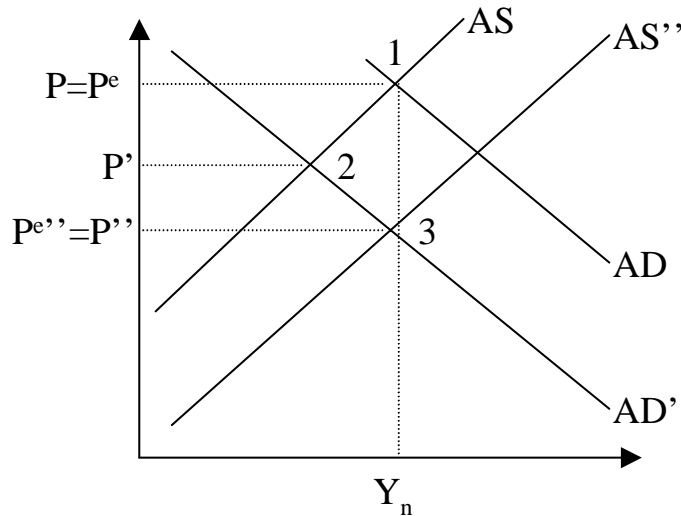


Figure 4:

what is used to construct the AD curve. Note that if you increase  $\bar{L}$ , the LM curve shifts left, and the IS-LM equilibrium occurs at a lower level of output and higher interest rate. This is how much equilibrium output would fall if there were no change in the price level. So, this fall in output is the direction of horizontal shift in the AD curve. That is, the AD curve shifts left by the amount that output falls in the IS-LM model.

- (b) Draw a graph with  $P$  on the vertical axis and  $Y$  on the horizontal. Where is the short run equilibrium? Where is the medium run equilibrium? Indicate the initial equilibrium by the number '1' in your diagram. Indicate the short and medium run equilibria after the shock by the numbers '2' and '3', respectively.

Shift the AD curve left. The intersection of the new AD curve and the old AS curve is point 2. The intersection of the new AD curve and the vertical line above  $Y = Y_n$  is point 3.

- (c) What happens to unemployment, output, employment, the interest rate, consumption, investment, the wage rate and the price level between equilibria 1, 2, 3? Explain the reason for your answer.

At point 2, output is lower. Because the IS curve is downward sloping, the lower equilibrium output requires a higher interest rate. To see this, note that when  $Y = Z$ , aggregate demand, then:

$$Y = \frac{1}{1 - c_1 - q} [c_0 - c_1 T + \bar{I} - bi + \bar{G}]$$

The IS curve is the combinations of  $Y$  and  $i$  that satisfy the above equation. Note that if  $Y$  is lower then  $i$  must be higher. The fact that output is lower also implies that consumption and employment are lower. Unemployment is therefore obviously higher. Investment is definitely lower. The higher  $i$  makes it lower, and the lower  $Y$  does too. At point 2 the price level is lower because the wage rate is lower, and this in turn is a consequence of the bargaining equation and the fact that  $u$  is higher.

At point 3, output is back at its natural rate. So, unemployment must be too. Because output is at its old level, the interest rate must be too (that's implied by the IS curve). Since the interest rate is at its old level, then the price level must have fallen by precisely the amount necessary to produce a rise in  $M/P$  that is sufficient to accommodate the rise in  $\bar{L}$  at the old  $Y, i$ . Since output and the interest rate are back at their old levels, investment must be too. Same for consumption. Since the real wage is  $1/(1 + \mu)$ , that is unchanged at point 3. Thus, the wage rate falls by the same percent as the price level.

- (d) Provide a brief narrative, describing in journalistic terms what happens to the economy in the wake of the jump in money demand.

The rise in money demand impacts on the financial markets, where people try to sell bonds to get more cash. The attempt to sell bonds drives their price down and the interest rate up. The rise in the interest rate affects the goods market, because it causes a fall in investment. This leads to a rise in unanticipated inventories. Firms respond by cutting back on orders, and production slows down. The fall in output is associated with a drop in employment. These effects on output and employment impact on financial markets and the labor market. In the financial market there is a reduction in money demand, so that the rise in the interest rate is ultimately not as sharp as implied by the initial rise in money demand. In the labor market the drop in employment produces a rise in unemployment. This weakens the bargaining power of workers who then receive a lower wage. This is what happens in the short run (i.e., in the time leading to point 2). Then, when people notice that the price level has fallen,  $P^e$  drops and the actual price level falls even further. This produces a fall in the interest rate, which leads to a rise in investment and an expansion in output as firms order more goods. The process ultimately stops in the medium run when output is back at its natural rate.

4. Suppose there is a cut in taxes,  $T$ .

- (a) What is the impact of this shock on the AD curve? Explain the reasons for your answer.

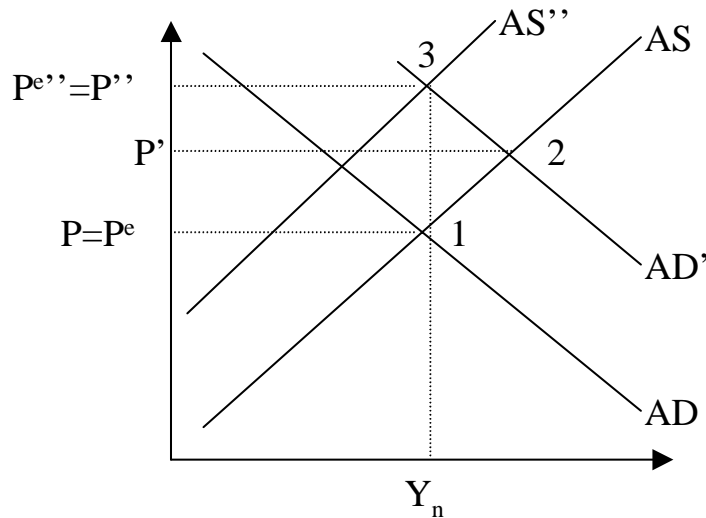


Figure 5:

The AD curve shifts right by the amount that output increases in the IS-LM model.

- (b) Repeat questions 3 (b) (c), but do not discuss the impact on investment.

With the right-shift in the AD curve and the fact that in the short run AS does not shift, short run equilibrium  $P$  and  $Y$  are higher (i.e., this is so at point 2). Consumption is higher at point 2 because of the structure of the consumption function. Employment is higher because output is higher. Unemployment is lower because  $N$  is higher. This is why the nominal wage rate,  $W$ , is higher at 2, and  $P$  is higher. Point 3 occurs at the intersection of the new AD curve and a vertical line above  $Y_n$ , the old equilibrium level of output. The AS curve intersects the new AD curve at that point. The price level is higher at point 3 than at 2, and so is  $P^e$ . Nothing has happened to output, unemployment because nothing has happened to the equations that determine these in the medium run. Consumption is higher because, though  $Y$  is the same,  $T$  is lower. Since  $G$  is unchanged (it is exogenous) and  $C$  is higher, it must be that  $I$  is lower. This means that  $i$  must be higher in the new medium run equilibrium. The rise in  $C$  in the medium run exactly crowds out investment.

- (c) What version of our model has the property that, in the short run, the cut in  $T$  generates a rise in investment. More specifically, discuss a parameter(s) and under what conditions on this parameter(s) might generate a rise in investment.



If  $q$  is sufficiently large, then the rise in output at point 2 implies that investment is higher there.

- (d) What is the impact, in the medium run, of the shock on the composition of output between consumption, investment and government consumption? Explain.

In the medium run, as noted in 3 (b), investment must be lower by the amount that consumption increases.