

14.02 – Fall 2001 – Problem Set 7 Solutions

Part I: True, False or Uncertain?

1. False. The natural rate of unemployment depends on labor market institutions and market structure. Therefore, policy changes such as a more stringent anti-trust legislation or a more generous Unemployment Insurance program will affect the natural unemployment rate.
2. False. If employment is increasing, but the labor force is increasing even faster, then we can have that the unemployment rate is rising. The statement would be true, however, if we assumed that the size of the labor force is constant.
3. True. All three will shift the Aggregate Demand curve –an increase in M will move the LM, while an increase in either T or G will move the IS, so for any given level of prices we will now have a new level of output as the equilibrium of the goods and financial markets. Hence, since the AD curve will have shifted, the economy will move to a new point along the Aggregate Supply curve.
4. True. All three affect the labor market conditions –an increase in P^e or in z will move the Wage-Setting relation, whereas an increase in the markup μ will shift the Price-Setting relation. As a result, the Aggregate Supply relation between the price level and output will have shifted.
5. False. The correct argument works the other way round, as follows. When the economy is above its natural rate of output, firms must be hiring more workers, so the unemployment rate is below its natural level –in plain English, the labor market is tight. This increases the bargaining power of workers, and hence wages are higher than they would have been otherwise. This creates a pressure to increase prices, since these are set by firms as a markup over wages. Therefore, the price level will be higher than expected. As wage-setters start revising their expectations up, the Aggregate Supply curve shifts up. So much for the labor market and Aggregate Supply –let us now look at the other two markets, represented in the IS-LM framework, and which determine Aggregate Demand. The increase in the price level (inflation) will erode real money balances in the economy (M/P), so the interest rate will need to go up in order to restore equilibrium in the money market. This increase in the interest rate will depress demand for goods and therefore reduce output. In terms of the IS-LM framework, we will see the LM curve shift upwards due to the decline in M/P , thus leading to a higher interest rate and a lower level of output as a result of simultaneous equilibrium in the goods and financial markets. Therefore, we will be moving along the Aggregate Demand curve as the Aggregate Supply shifts up. As that happens, this is, as the price level keeps increasing and the output level is reduced, firms lay off excess workers and the unemployment rate goes up. The aggregate supply curve will

continue to shift up until, in the medium run, output and the unemployment rate are equal to their natural levels. *Note: we were NOT expecting your answer to be this long. I just thought it would be useful to produce more detailed and intuitive solutions so that you could, if you wish, review all the concepts and mechanisms involved in the AD-AS relations...*

Part II: Labor Market Equilibrium. 35 Points

1. If producing an additional unit of output requires $\frac{1}{A}\sqrt{N}$ units of labor, and each unit of labor costs the firm W , then the marginal cost of output is $\frac{1}{A}\sqrt{N} \cdot W$.
2. Price is set above marginal cost by a factor $1 + \mu$, so the Price-Setting relation is: $P = (1 + \mu)\frac{1}{A}\sqrt{N} \cdot W$.

Here, the price is not a constant, independent of the level of employment. There are decreasing returns to labor in this model –as employment increases, the marginal cost of production also goes up (the required increase in labor necessary to produce 1 extra unit of output is larger, the higher the level of production). This forces firms to increase their price, given the wage, as employment increases. This implies that the real wage W/P will go down as N goes up, so we will have a downward-sloping PS relation in the $(W/P, N)$ space, or equivalently, an upward-sloping PS curve in the $(W/P, u)$ space.

–In the textbook, we were assuming constant returns to labor, so the marginal product of labor and therefore the marginal cost of output were always constant in that case, and the PS relation was flat in both spaces.

3. (See Figure 1)
4. (See Figure 1)

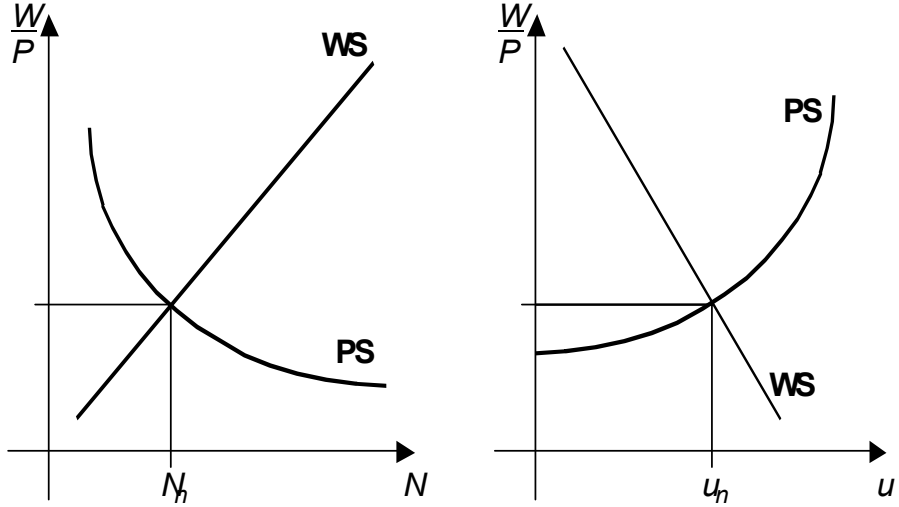


Figure 1: Graphs for Part II, questions 3 and 4.

$$\text{WS: } \frac{W}{P} = \frac{N}{L}z$$

$$\text{PS: } \frac{W}{P} = \frac{A}{1+\mu} \frac{1}{\sqrt{N}}$$

$$\text{WS: } \frac{W}{P} = (1-u)z$$

$$\text{PS: } \frac{W}{P} = \frac{A}{1+\mu} \frac{1}{\sqrt{L(1-u)}}$$

5. By eliminating W/P between the PS and WS equations above, and using the fact that $N = L(1-u)$ (by definition of u), we can derive the equilibrium unemployment rate (u_n , natural rate of unemployment), equilibrium real wage and equilibrium level of output (Y_n , the natural level of output):

$$u_n = 1 - \left(\frac{A}{1+\mu} \right)^{2/3} z^{-2/3} L^{-1/3}$$

$$\frac{W}{P} = (1-u_n)z = \left(\frac{A}{1+\mu} \right)^{2/3} z^{1/3} L^{-1/3}$$

$$Y_n = 2A\sqrt{L(1-u_n)} = 2A^{4/3} \left(\frac{1}{1+\mu} \right)^{1/3} z^{-1/3} L^{1/3}$$

6. If unemployment benefits are reduced, in terms of our model this corresponds to a reduction in z , the variable that captures institutional factors. As a result, real wages will now be lower in equilibrium, the natural rate of unemployment will also be lower, and the natural level of output will be increased.

(Graphically, this would correspond to a downward shift of the WS relation curve).

7. If the market power enjoyed by firms were reduced, this would correspond to a reduction in μ , the markup (of price over cost) that firms charge in this economy. Its effects on the natural rate of unemployment and the natural level of output would be the same as above. Unlike in 5, however, real wages would now increase.

(Graphically, this would correspond to an upward shift of the PS relation curve).

Part III: Aggregate Supply-Aggregate Demand. 45 p.

1. The natural rate of unemployment (and, by implication, the natural level of output) is defined as the unemployment rate (and, by implication, the level of output) that prevails if the price level and the expected price level are equal –which might not be the case in the short run, but should be the case in the medium run. Therefore, we can derive u_n and Y_n as the equilibrium in the labor market when $P = P^e$. In other words, by imposing $P = P^e$ and equating the real wage implied by wage setting to the real wage implied by price setting, we obtain:

$$u_n = u(z; \mu, A) = \left\{ u \text{ such that } F(u, z) = \frac{A}{1 + \mu} \right\}$$

$$Y_n = A(1 - u_n)$$

–or, equivalently :

$$Y_n = Y(z; \mu, A) = \left\{ Y \text{ such that } F\left(1 - \frac{Y}{A}, z\right) = \frac{A}{1 + \mu} \right\}$$

The actual rate of unemployment and the actual level of output will be the result of equilibrium in the labor market at the current level of prices P_t , which may or may not be different to the expected price level P_t^e . This is, we take the nominal wage implied by the wage setting and plug it in the price setting relation, and then use the fact that expectations are formed on the basis of the level of prices in the previous period. Thus, we obtain:

$$u_t = u(z_t, P_{t-1}; \mu, A) = \left\{ u_t \text{ such that } P_t = \frac{(1 + \mu)}{A} P_{t-1} F(u_t, z_t) \right\}$$

$$Y_t = A(1 - u_t)$$

–or equivalently :

$$Y_t = Y(z_t, P_{t-1}; \mu, A) = \left\{ Y_t \text{ such that } P_t = \frac{(1 + \mu)}{A} P_{t-1} F\left(1 - \frac{Y_t}{A}, z_t\right) \right\}$$

The Aggregate Supply is the labor market equilibrium relation between the level of output and the price level, so we have already written it down in order to derive the actual level of output: $P_t = \frac{(1 + \mu)}{A} P_{t-1} F\left(1 - \frac{Y_t}{A}, z_t\right)$. Since we assume that the bargaining power of workers decreases with the

unemployment rate, the function F is decreasing in its first argument, and therefore the Aggregate Supply implies a positive relationship between Y_t and P_t .

2. The Aggregate Demand is the goods and financial markets equilibrium relation between output and the price level. It is derived from the two equations that characterize those equilibria, namely the IS and the LM, which we have been given in this case. Hence, we can represent the AD relation as: $Y_t = Y(\frac{M_t}{P_t}, G_t, T_t)$. For a given G_t , T_t and M_t , an increase in the price level reduces the real money supply, shifts the LM curve up, and reduces output. Therefore, plotting all the possible combinations of Y_t and P_t implied by the IS-LM model produces a negative relation between them.
3. In the short run, the Aggregate Supply relation does not change, while the Aggregate Demand schedule shifts to the right (from AD to AD' in Figure 2): at a given price level, the demand for output is higher as a result of the increased government spending. The economy therefore moves from A to A' , leading to higher output and higher prices.

In the IS-LM framework, the fiscal expansion shifts the IS curve to the right (from IS to IS'). Also, because prices rise in response to the increase in output, the real stock of money decreases ($\frac{M}{P}$ declines because M is fixed), leading to a partially offsetting shift of the LM curve upward (from LM to LM'). The short-run effect of the fiscal expansion is, therefore, to move the economy from A to A' , thus increasing output (from Y_n to Y'), prices (from P_0 to P') and the interest rate (from i_0 to i').

4. After one period, expectations on the price level will be revised. Since the price level was higher in the previous period, expected price level for the next period will be higher as well, thus shifting the Aggregate Supply relation up. While moving towards the long run equilibrium, the AS schedule will keep shifting up (from AS to AS'', eventually), moving the equilibrium point along the AD schedule from A' to A'' , until output again equals its natural rate. (The intuition behind this is as follows: As long as output is above its natural level, unemployment is below its natural rate, wages are set high and prices must exceed the level previously expected, and therefore workers continue to revise their price expectations upward. This means that they will again bargain for higher wages, which results in increasing prices... until output and unemployment have been reduced to their natural levels and thus the workers' bargaining power has gone down enough so that they do no longer demand wages that cause prices to exceed their expectations).

In the IS-LM graph, as long as prices continue to increase, and hence the real money supply is further reduced, the LM curve will keep shifting down (from LM' to LM''). The economy moves up from point A' along IS' and eventually reaches A'' , where output is back to its natural level. The

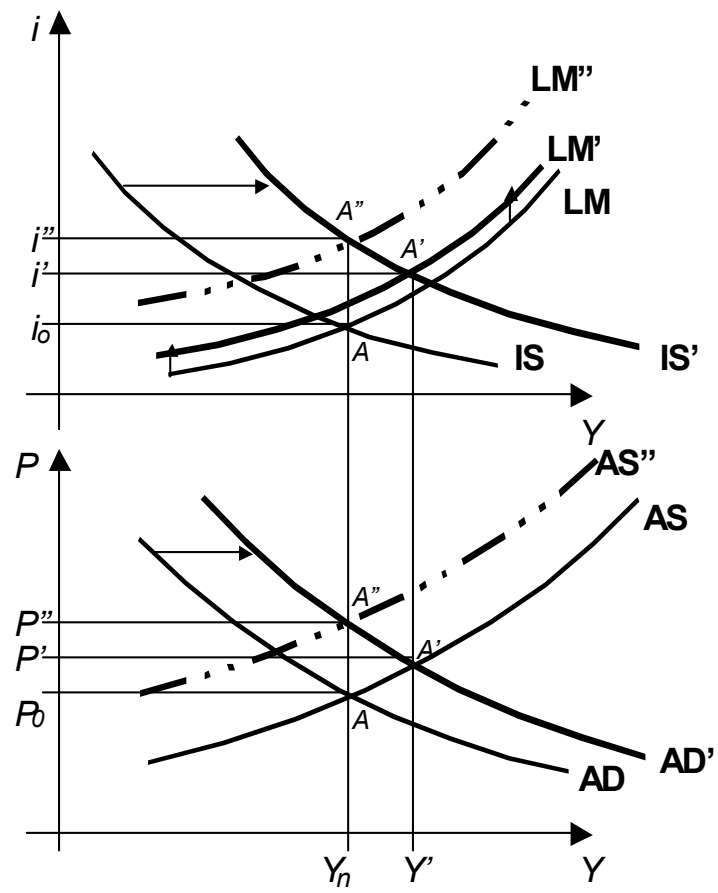


Figure 2: Graph for Part III, questions 3 and 4.

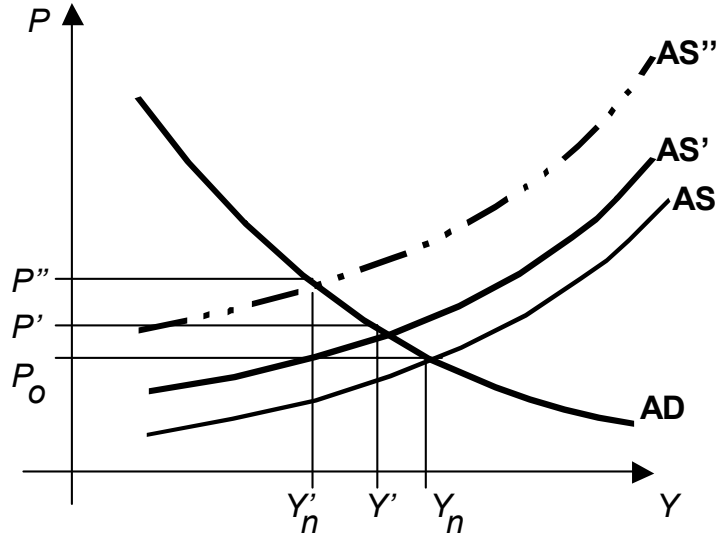


Figure 3: Graph for Part III, question 5.

long-run effect of the fiscal expansion is, then, to increase prices and the interest rate all the way to P'' and i'' , but there is no long-run effect on output. Its composition has changed, however: G is higher (obviously), C is unchanged (since it depends on Y and T , which do not change in the long run) and I has decreased (because Y is the same while i is higher).

5. In the Wage-Setting/Price-Setting graph, the increase in UI causes the WS relation to shift up. The new natural rate of unemployment is above the previous natural rate. –Intuitively, this happens because the higher z means that workers have more bargaining power. However, given the fixed markup μ , firms will set prices so that real wages remain unchanged. Therefore, in equilibrium workers' bargaining position must be reduced by higher unemployment. This gets them to accept the same wage even though z is higher.

The increase in the natural rate of unemployment implies that the natural level of output has fallen (from Y_n to Y'_n in Figure 3). The AS relation shifts up (from AS to AS') in the short-run so that the schedule passes through the new natural level of output (Y'_n) at the previous price level (P_0). This schedule will continue to shift up over time (from AS' to AS''), moving the equilibrium point along the AD curve until output equals the (new) natural level in the long run. The price level will have increased.

6. In the short run, both the AS and AD schedules have shifted up. The short run effect is to increase the price level, since both the higher unemployment benefits and expansionary fiscal policy increase prices. The short run effect on output is ambiguous.

Over time, the AS schedule will continue to shift up as long as output exceeds the new natural level. The crucial thing to note here is that the long-run equilibrium point is at the new natural level of output. Therefore the combination of policies causes a rise in prices and a decrease in output in the long run. This result might appear paradoxical since the fiscal policy was expansionary, but the spending was done in a way to lower the natural level of output, and therefore the long-run response of output makes sense.

(The graphic for this part is a combination of the previous two).