14.02 Principles of Macroeconomics
Problem Set 4
Solutions
Fall 2004

Part I. True/False/Uncertain
Justify your answer with a short argument.

1. High unemployment implies that the labor market is sclerotic.

   Uncertain. *The unemployment rate reflects two very different realities. It may well point to a stagnant unemployment pool – a sclerotic market with few separations and few hires. However, it may also reflect an active labor market, with many separations and many hires and with many workers entering and exiting unemployment. (See page 115.)*

2. Patty lives in the US, and her salary at Widgets-R-Us is $25,000 per year. Suppose she is offered to move to France to work at a Widgets-R-Us franchise in Paris. Her new salary would be $35,000. Assume over the course of her move inflation in both countries will be zero, and Patty will not incur any moving costs or any other costs associated with going to France. Assume also that the two jobs she will be doing are completely identical. Patty should move, because she is going to get a higher salary.

   Uncertain. *People care about real wages, not nominal wages. What matters is not Patty's salary in dollars, but how much she can buy with what she earns in each country. This is determined by the price level. If the price level in France is sufficiently higher than that in the US, Patty should stay. Note also that what matters is the expected price level. Even though this problem assumes that inflation will be zero over the course of Patty's transition to France, it is not known whether it will be zero thereafter. If Patty expects the price level to increase more in the US relative to France in the future, she should go to France, even if the actual price level in France today is high relative to the US price level.*

3. When output is below the natural level of output, the actual price level is lower than the expected price level.

   True. *The actual price level equals the expected price level when output is equal to the natural level of output. (See page 138.) Because the AS curve is upward-sloping, if output is below its natural level, the actual price level is lower than expected. See diagram:*
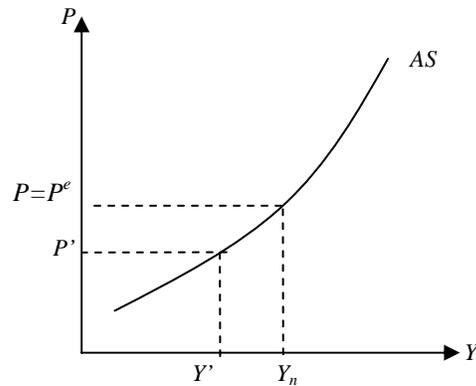
4. Suppose there is a decrease in the price level from P to P'. Given the stock of nominal money, M, this leads to an increase in the real money stock, M/P, which shifts the LM curve down. This implies that the AD curve shifts to the right.

   False. *The first part of the statement is true: the decrease in the price level results in an increase of the real money stock, which leads to a decrease in the interest rate. (The LM shifts down and to the right, while the IS does not shift.) The decrease in the interest rate leads to an increase in the demand for goods and an increase in output (Y to Y'). Thus, because there is no shifts in the IS curve, the AD curve does not shift. All we are doing here is moving along the AD curve.*
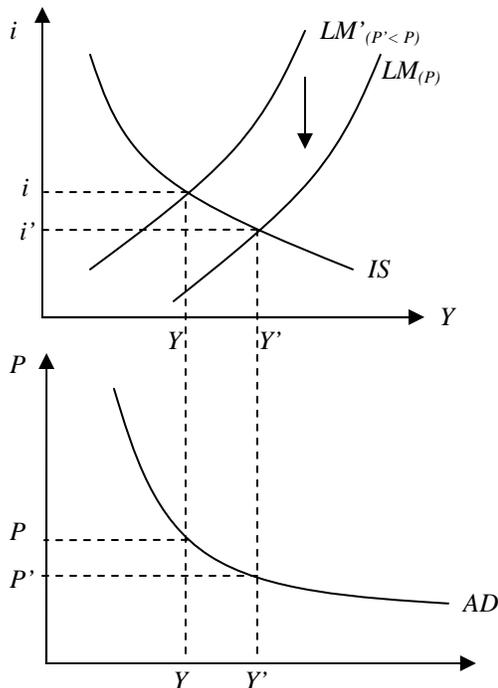
5. In terms of changing output, monetary policy is relatively more effective when the AS curve is relatively flat, while fiscal policy is more effective when the AS curve is relatively steep.

   False. *Monetary and fiscal policies affect the AD curve, <u>not</u> the AS curve. Monetary and fiscal policies are <u>both</u> more effective in changing output when the AS curve is flatter and*

less effective when the AS curve is steeper. In the extreme case, when the AS curve is vertical, neither policy has any effect on output (the only effect of monetary and fiscal policy in this case is a change in the price level).

6. The neutrality of money means that monetary policy cannot affect output.

   False. *It is true that in the medium run, the increase in nominal money is reflected entirely in a proportional increase in the price level, and therefore the increase in nominal money has no effect on output or on the interest rate. However, the neutrality of money in the medium run does not mean that monetary policy cannot or should not be used to affect output: a monetary expansion can, for instance, help the economy move out of a recession and return faster to the natural level of output. In fact, in the short run, an increase in the money supply leads to an increase in output, an increase in the price level, and a decrease in the interest rate. What the term implies is that monetary policy cannot sustain higher output forever. (See page 147.)*

Part II. Aggregate Demand and Aggregate Supply

In the first quiz, you have found that the IS relation is given by $Y = \dfrac{c_0 + b_0 + \overline{G}}{1 - c_1(1-t)} - \dfrac{b_1}{1 - c_1(1-t)} i$

And the LM relation is given by $i = \dfrac{1}{m_2}(m_0 - \dfrac{M^s}{P} + m_1 Y)$ in the Republic of Keynesia.

Let $\dfrac{1}{1 - c_1(1-t)} = \lambda$ for simplicity.

1. Derive the expression for aggregate demand using the above equations. Is the AD curve upward- or downward-sloping?

   To derive the AD curve, we can substitute in for i into the IS equation from the LM equation.

   $$Y = \lambda(c_0 + b_0 + \overline{G}) - \frac{\lambda b_1}{m_2}(m_0 - \frac{M^s}{P} + m_1 Y)$$

   $$Y + \frac{\lambda b_1 m_1}{m_2} Y = \lambda(c_0 + b_0 + \overline{G}) - \frac{\lambda b_1}{m_2}(m_0 - \frac{M^s}{P})$$

   $$Y(\frac{m_2 + \lambda b_1 m_1}{m_2}) = \lambda(c_0 + b_0 + \overline{G}) - \frac{\lambda b_1}{m_2}(m_0 - \frac{M^s}{P})$$

   $$Y = \frac{m_2 \lambda}{m_2 + \lambda b_1 m_1}(c_0 + b_0 + \overline{G}) - \frac{\lambda b_1}{m_2 + \lambda b_1 m_1}(m_0 - \frac{M^s}{P})$$

   The AD curve is downward-sloping in the (Y,P) space.

   $$\frac{\partial Y}{\partial P} = -\frac{\lambda b_1 M^s}{m_2 + \lambda b_1 m_1}(-1)(-\frac{1}{P^2}) < 0$$

   Intuitively, for an increase in the price level, there is a decrease in the real money stock, which leads to an increase in the interest rate. The increase in the interest rate causes a decrease in the demand for goods, which leads to a decrease in output. This implies that the

relation between output and price is negative, which is exactly what the AD curve captures. (See page 139.)

2. Show (mathematically) that output, Y, is an increasing function of the real money stock, M/P, and an increasing function of government spending, $\overline{G}$.

$$\frac{\partial Y}{\partial (M^s/P)} = \frac{\lambda b_1 M^s}{m_2 + \lambda b_1 m_1} > 0 \rightarrow \text{Output is an increasing function of the real money stock}$$

(When the real money stock decreases, the interest rate increases in order to clear the financial market. Since the interest rate increases, investment and output decrease.)

$$\frac{\partial Y}{\partial \overline{G}} = \frac{m_2 \lambda}{m_2 + \lambda b_1 m_1} > 0 \rightarrow \text{Output is an increasing function of government spending}$$

3. Let:
$c_0 = 200$ $m_0 = 400$ $\overline{G} = 100$
$c_1 = 0.5$ $m_1 = 1$ $t = 0$
$b_0 = 300$ $m_2 = 0.8$ $Y_n = 550$
$b_1 = 0.4$ $M^S = 200$

Derive the AD equation using these figures. (All figures are in millions of US dollars.)

$$\lambda = \frac{1}{1 - c_1(1 - t)} = 2$$

$$Y = \frac{(0.8)(2)}{0.8 + (2)(0.4)(1)}(200 + 300 + 100) - \frac{(0.4)(2)}{0.8 + (2)(0.4)(1)}(400 - \frac{200}{P})$$

$$Y = 400 + \frac{100}{P} \text{ (or } P = \frac{100}{Y - 400}\text{).}$$

4. Suppose the aggregate supply takes the following form: $P = (1.5)P^e + (1/50)(Y - Y_n)$ and P=1. Assume we are in the short-run for now. What is the equilibrium output, Y*? What is the expected price level, P^e? Draw the AS-AD diagram.

$Y^* = 500$
$1 = (1.5)P^e + (1/50)(500 - 550)$
$P^e = 1.3\overline{3}$

Note that there was a typo in the expression for the AS curve here. If the AS curve is $P = (1.5)P^e + (1/50)(Y - Y_n)$***, the actual price level does not equal the expected price level when Y equals Y_n. The AS curve should have been*** $P = P^e + (1/50)(Y - Y_n)$***. Then, in the above calculation,*** $P^e = 2$***, and when Y=Y_n, P=P^e=1. (If you used the AS as it is given to you, you will get full credit.)***
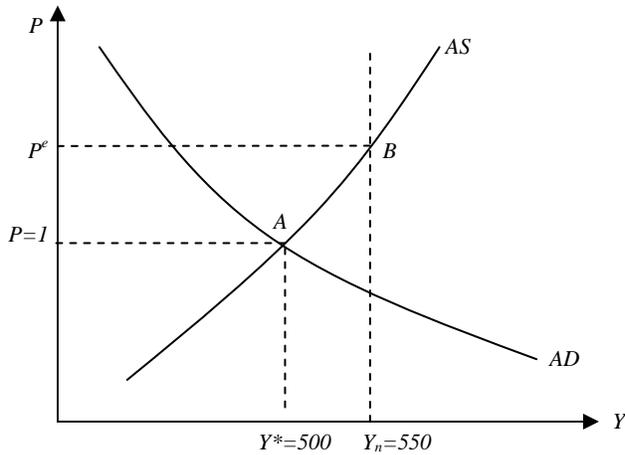
The short-run equilibrium in this economy is at point A, where AS and AD intersect. At this point, the goods market, the financial market, and the labor market are all in equilibrium. If the equilibrium level of output equaled the natural level of output (and if the actual price level equaled the expected price level), the equilibrium would be at point B. Note that the equilibrium level of output is actually below the natural level of output in this economy (at point A).

5. The Keynesian government is up for reelection soon, and so it wants to achieve the natural level of output. (We are still in the short run.) Propose two different policy options that would do the job. For each policy option, draw the IS-LM and the AS-AD diagrams, and show how the first translates into the second. Calculate by how much the government must increase/decrease government spending to achieve the natural level of output.

Policy Option 1: Expansionary Fiscal Policy
   If the government increases spending, the IS curve shifts right. Because price increases, the LM curve shifts up, and the interest rate increases even further. As a result of the fiscal expansion, the AD curve shifts out, and output increases to its natural level. The equilibrium is now at point B, where the actual price level equals the expected price level.
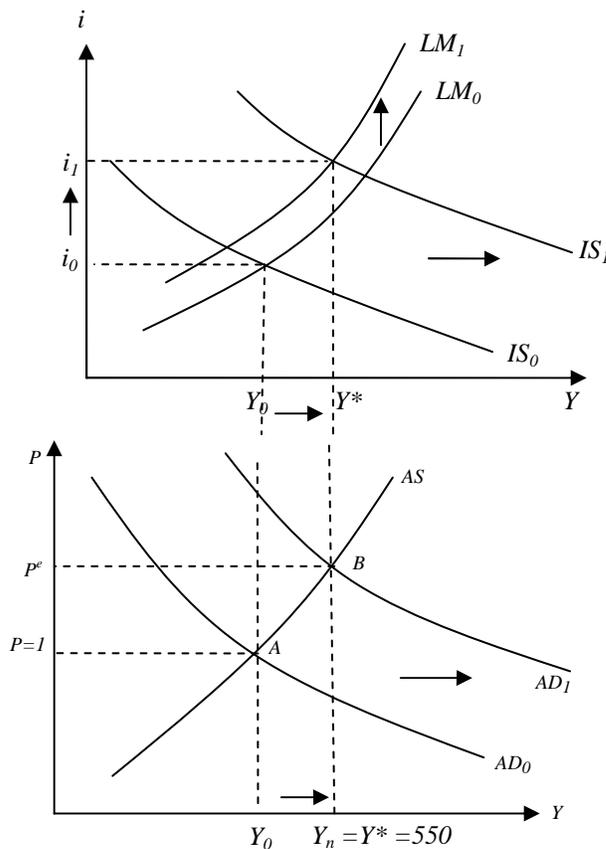
We know that at point B, $P^e = 4/3$ and the natural level of output we want to achieve is 550.
Plugging into the AD equation:
550 = (200+300+100+ΔG)-200+100/(4/3)
ΔG = -50+200-75
ΔG = 75
Government spending must increase by 75 million to close the gap.

Again, if we use the proper expression for the AS here, we would have the following:
550 = (200+300+100+ΔG)-200+100/2
**ΔG = -50+200-50**
ΔG = 100
Government spending must increase by 100 million to close the gap.

Policy Option 2: Expansionary Monetary Policy
If the central bank increases the money supply, the LM curve shifts down from LM_0 to LM_1.
But because the price has increased, the LM shifts back up from LM_1 to LM_2. As a result of
the monetary expansion, the AD curve shifts out, and output increases to its natural level.
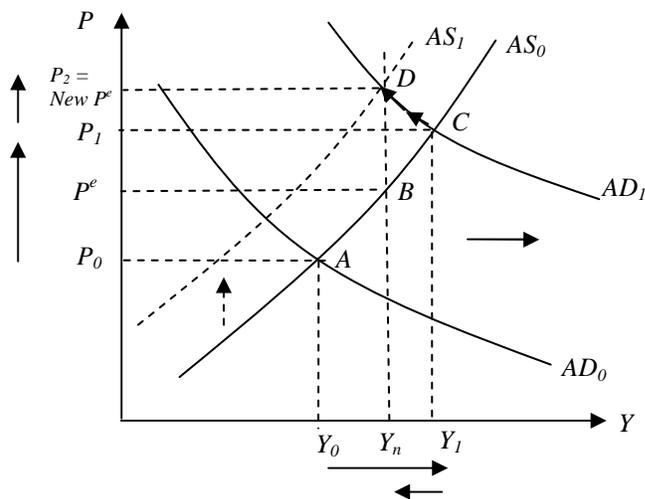The equilibrium is at point B, where the actual price level equals the expected price level.
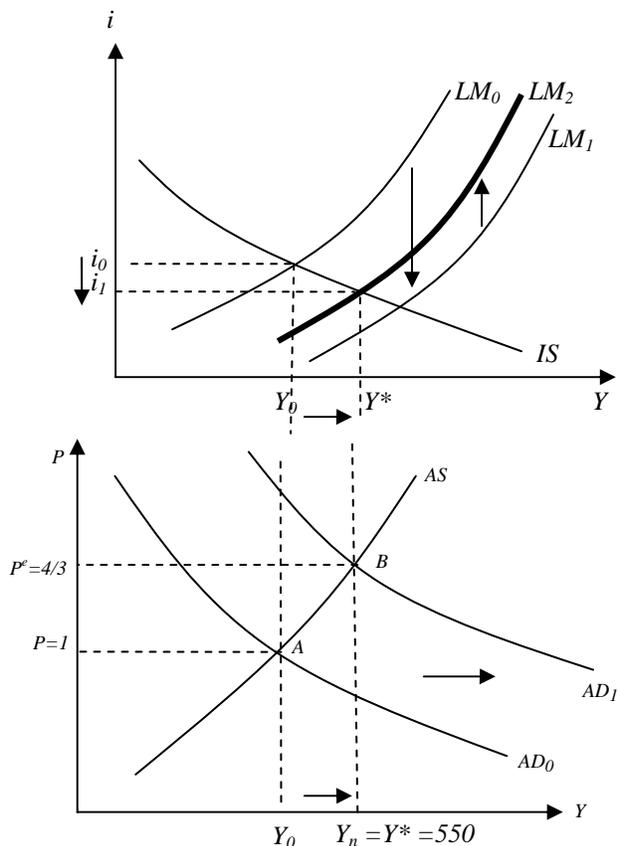
Note that the only difference between the two policies is in their effect on the interest rate.
Expansionary fiscal policy increases the interest rates, while expansionary monetary policy
decreases it. (This difference is seen in the IS-LM diagrams – the AS-AD diagrams are
identical for the two policy options.)

6. The Keynesian government decides not to listen to you, and raises government spending by more than would be required to achieve the natural level of output. Its argument is that higher output is better. The voters apparently think so too, and the government gets reelected. What happens as time passes and we get to the "medium run"? (You do not have to do any calculations, just draw diagrams and give some intuition.)
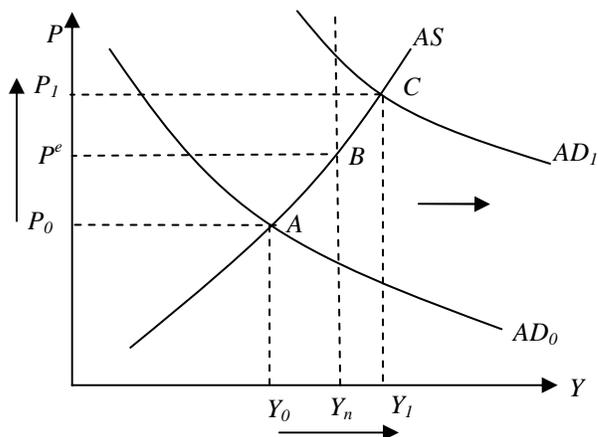
When government spending increases by more than would be required to achieve the natural level of output, equilibrium output rises above the natural level of output (from Y_0 to Y_1). In the short-run, equilibrium goes from point A to point C. The actual price level is above the expected price level. So, the benefit of the fiscal expansion is that output has increased by more (instead of going from Y_0 to Y_n, it went from Y_0 to Y_1). On the flip side, the price level has also increased by more.

What happens in the medium run? As output exceeds the natural level of output at point C, the price level is higher than wage setters expected. They revise their expectations, causing the AS curve to shift up over time. Since agents expect higher prices in the future, nominal
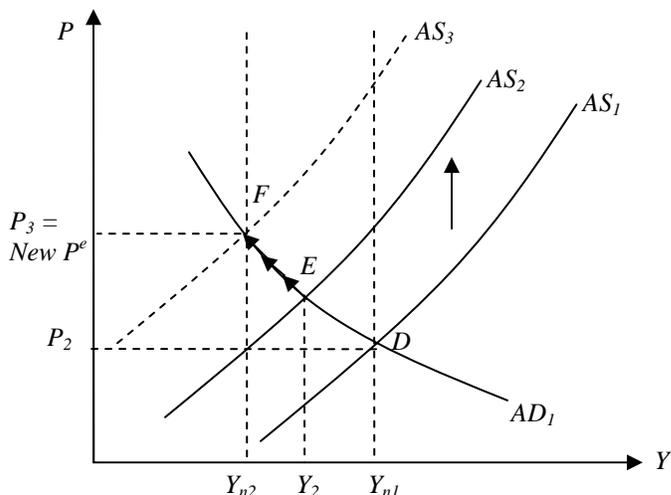

wages rise, which causes an increase in the actual price level. This higher price level leads to a decrease in the real money stock. When the real money stock decreases, the interest rate rises, such that there is equilibrium in the money market. This results in a decrease in output. This process continues until we go back to the natural level of output (until we are at point D). So, the increase in output over the natural level was only temporary. The only thing that the Keynesian government has accomplished is an even further

increase in the price level. If it listened to us, the price level would have remained at P^e. (Note that in the medium run, output would have gone from Y_0 to Y_n even if the government did not enact any expansionary policy. In this medium-run model, the only thing the government can do is prevent the price level from rising even further.) (See pages 143-146.)

7. Suppose the world price of oil increases. Use a diagram to show what will happen in the Republic of Keynesia, starting with the new medium run equilibrium you found in part 6.

In this analysis, we will assume that the AD curve does not shift, as in the book (page 155). In the short run, the AS curve shifts up and the economy moves from point D to point E (remember that we are starting at point D, picking up from where we left off in part 6). Output decreases from Y_{n1} to Y_2. The increase in the price of oil leads firms to increase their price which decreases demand and output.

What happens over time? While output has decreased, the natural level of output has decreased even more (see pages 153-154) (Y_2 is still above Y_{n2}). Thus, the AS curve continues to shift up. (The fact that the actual price, P, is rising changes the expected price level, P^e, which in turn changes P and so on. That is why the AS is shifting up and to the left and that is why the natural level of output has decreased from Y_{n1} to Y_{n2}.) The final equilibrium is at point F. We can conclude that bad macroeconomic policies adopted by the Keynesian government, coupled with the worldwide increase in the price of oil, led to a decrease in output and a dramatic increase in the price level in the Republic of Keynesia (a phenomenon that is typically referred to as <u>stagflation</u>).

Part III. The Phillips Curve

Suppose the Phillips curve is given by $\pi_t = \pi_t^e + 0.2 - 5u_t$ where $\pi_t^e = \theta\pi_{t-1}$

1. What is the natural rate of unemployment in this economy?

The natural rate of unemployment is defined as the rate of unemployment when the actual price equals the expected price, $P_t = P_t^e$, or alternatively, $\pi_t = \pi_t^e$.
Therefore, we have $0 = 0.2 - 5u_n$.
So, $u_n = 4\%$.

2. For now assume that $\theta = 0$. (What does that mean?) Suppose that the government decides to lower unemployment to 3% and keep it there forever. What is the rate of inflation for t=100? Is this realistic? Why?

Since $\theta = 0$, $\pi_t^e = 0$. (This means that agents in the economy ignore past inflation and assume that this year's price level is roughly the same as last year's price level. This is a reasonable assumption as long as inflation is low and not very persistent. (See page 167.))

$\pi_t = 0.2 - 5(0.03) \rightarrow \pi_t = 0.05$

So, if unemployment is kept at 3% forever, inflation will be 5% forever. In particular, it will be 5% in t=100. This is not a very realistic model. Inflation expectations are zero in every period, but actual inflation is 5%. This means that every period people underestimate the rate of inflation. It would be more realistic if expectations changed, depending on what the actual inflation rate is.

3. Assume that only for the first three periods (t=1, t=2, and t=3) people form their expectations using θ=0. After the third period, from t=4 on, they start using θ=1 forever. Also, the government still wants to keep unemployment at 3%. What is the rate of inflation for t = 4, 5, and 6? What is the expected rate of inflation for t=4, 5, and 6? Is this setup more realistic? Why?

$\pi_t - \pi_{t-1}$ =0.2 – 5(0.03)=0.05 (Inflation goes up every period by 5%.)
π_3 =0.05
π_4 = 0.1 ➔ $\pi_4{}^e$=0.05
π_5 =0.15 ➔ $\pi_5{}^e$=0.1
π_6 =0.2 ➔ $\pi_6{}^e$=0.15
This is a more realistic setup, because expectations adapt to inflation behavior. For example, in period 4, people expect inflation to be 0.05, but it is actually 0.1. So, for the next period, people adjust their expectations to be 0.1. However, inflation expectations are always lagging behind actual inflation, and people are still constantly underestimating inflation.