QUIZ 1 - Solutions
14.02 Principles of Macroeconomics
March 3, 2005

I. Answer each as TRUE or FALSE (note - there is no uncertain option), providing a few sentences of explanation for your choice.)

1. The growth rate of real GDP is a better measure of economic growth than the growth rate of nominal GDP.

True. *Economic growth measures the growth in the productive potential in an economy, and the growth rate of nominal GDP is a bad measure since it includes the growth rate of prices as well.*

2. Consider a proportional income tax $T = tY$. Changing the proportional income tax rate t will only affect the autonomous spending, but not the multiplier.

False. *With a proportional income tax, let's say $T = tY$, and the standard consumption function: $C = c_0 + c_1(Y - T)$, the multiplier becomes $\frac{1}{1-c_1(1-t)}$. The autonomous spending is independent of t, ie. $c_0 + I + G$. Thus, changing the proportional income tax rate affects the multiplier, but not the autonomous spending.*

3. In equilibrium in the financial market with the presence of banks, the supply of money is a fraction (< 1) of the supply of high powered money.

False. *The supply of high powered money is a fraction of the supply of money, since the former includes currency and reserves, and the latter currency and deposits (of which reserves are a fraction).*

4. In an open market operation where the central bank increases money supply by buying bonds, the price of bonds will fall.

False. *An increase in the supply of money reduces the interest rate, and therefore increases the price of bonds. Recall that the rate of return of a bond (which promises a fixed payment \$F) is $i = \frac{\$F - \$P_B}{P_B}$.*

5. According to the standard IS-LM framework, if investment becomes more responsive to interest rates, the equilibrium interest rate is also more responsive to a monetary expansion.

False. *The IS curve is flatter if $\frac{\partial I}{\partial i}$ is more negative. So given a change in money supply of size M, the equilibrium interest rate only decreases slightly (shifting the LM curve along a flat IS curve). The equilibrium output, however, becomes more responsive to an increase in money supply.*

6. In the standard labor market model, with constant returns to scale production function and labor as the only input, the real wage can always be determined by the degree of competition among firms and the marginal product of labor.

True. *In the standard labor market model, the equilibrium is determined by equalizing the real wages implied by the wage-setting and price-setting relations. Since the price-setting condition is equal to $\frac{W}{P} = \frac{A}{1+\mu}$, where A is the productivity of labor and μ is the markup, the real wage is always determined by*

the degree of competition in product markets and the marginal product of labor, independent of the factors affecting the wage setting decision.

II. Long question - IS-LM

Suppose the goods market is described as follows :

<u>Goods Market</u>
Goods Demand: $Z = C + I + G$
Consumption: $C = a + b(Y - T)$, where a and b are positive constants
Investment: $I = e - fi$, where e and f are positive constants
Government Exp.: $G = G_0$, where G_0 is a constant
Tax: $T = hY$

Assume $0 < b < 1$; $0 < h < 1$.
1. Derive the IS relation.
Ans:
Aggregate Demand

$$
\begin{aligned}
Z &= C + I + G \\
&= a + b(Y - T) + e - fi + G_0 \\
&= a + b(Y - hY) + e - fi + G_0 \\
&= (a + G_0 + e) + Yb(1 - h) - fi
\end{aligned}
$$

Goods Market Equilibrium

$$Y^* = (a + G_0 + e) + Y^*b(1 - h) - fi$$

$$Y^* = \frac{1}{1 - b(1 - h)}[a + G_0 + e - fi]$$

Equivalently,

$$IS: \quad i = \frac{1}{f}[b(1 - h) - 1]Y^* + \frac{1}{f}(a + G_0 + e)$$

Suppose the money market (with private banks) is described as follows :

Let $\frac{H^s}{P}$ be the supply of real central bank money. The overall real money demand is $\frac{M^d}{P} = uY - vi$.

Assume that people hold a fixed proportion α of their money in currency, and the rest of it in checkable deposits.

Private banks are required to hold θ of their total checkable deposits in reserve.

2. Denote the demand for real central bank money as $\frac{H^d}{P}$. Express $\frac{H^d}{P}$ in terms of parameters (α,θ,u,v) and output (Y), interest rate (i).

Ans:

Demand for currency

$$\frac{CU^d}{P} = \alpha \frac{M^d}{P}$$

Demand for checkable deposits

$$\frac{D^d}{P} = (1 - \alpha) \frac{M^d}{P}$$

Demand for reserves (by private banks)

$$\frac{R^d}{P} = \theta(1 - \alpha) \frac{M^d}{P}$$

Demand for real central bank money

$$
\begin{aligned}
\frac{H^d}{P} &= \frac{CU^d}{P} + \frac{R^d}{P} \\
&= [\alpha + \theta(1 - \alpha)] \frac{M^d}{P} \\
&= [\alpha + \theta(1 - \alpha)](uY - vi)
\end{aligned}
$$

3. Draw the demand and supply for real central bank money in a $(H/P, i)$ space.

Ans: *See figure 1.*

4. Derive the LM relation using the conditions for the central bank money market to be in equilibrium. Does a change in the required reserve ratio affect the sensitivity of output to interest rates along the LM curve?

Ans:

Money Market Equilibrium

$$
\begin{aligned}
\frac{H^s}{P} &= [\alpha + \theta(1 - \alpha)](uY - vi) \\
i &= \frac{u}{v}Y - \frac{H^s}{Pv[\alpha + \theta(1 - \alpha)]}
\end{aligned}
$$

From the LM equation, the slope does not depend on θ, the reserve ratio. Thus, the sensitivity of output to interest rates is independent of θ.

5. After several bank runs, the central bank decides to increase the required reserve ratio from θ to $\theta' > \theta$. How does this policy affect the equilibrium output and interest rate? Show your results graphically in a (Y, i) space. Explain why increasing the required reserve ratio has such an impact on the equilibrium output and interest rate.
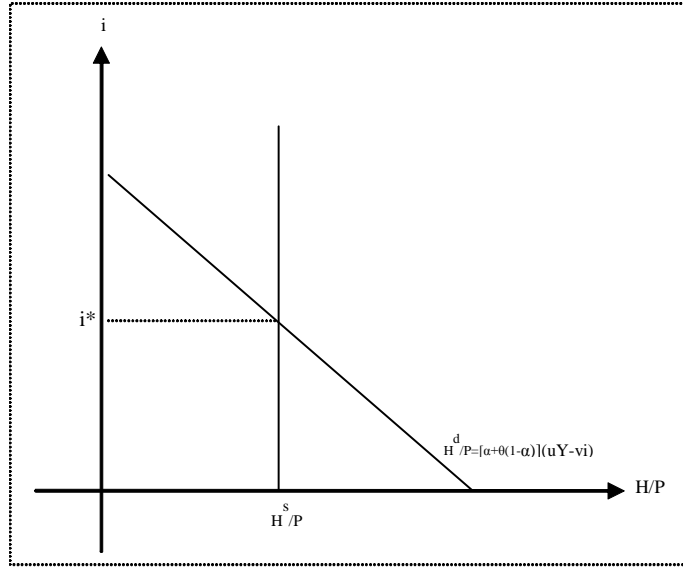
Ans: *See figure 2.*

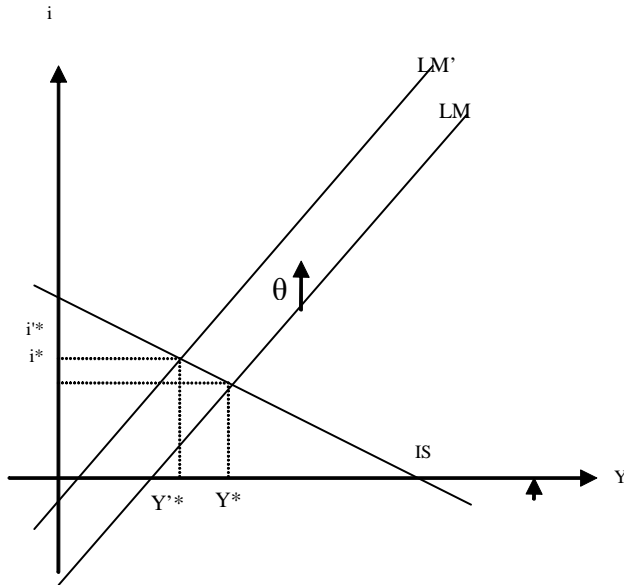Figure 1: for part 3: central bank money supply and demand

Figure 2: part 5: the impact of a higher θ.

The LM curve is shifted up as a result of an increase in θ, leading to a lower equilibrium output and a higher equilibrium interest rate.

Intuition: An increase in the required reserve ratio θ means a smaller demand for bonds (the only financial asset here) by the private banks. For given Y and $\frac{H^s}{P}$, a higher interest rate is needed to clear the (central bank) money market. An increase in i^* decreases investment and thus, the aggregate demand in the goods market. The equilibrium output drops.

6. Suppose now that the government wants to increase output in the short run. Discuss the effectiveness of fiscal versus monetary policy if the overall money demand is very sensitive to interest rates; and investment is very *insensitive* to interest rates. Use a graph in your explanation.

Ans: When money demand is very responsive to interest rates, v is high. The slope of the LM curve, $\frac{u}{v}$, is smaller in absolute value. (ie. the LM curve is flatter)

When investment is very insensitive to interest rates, f is low; and the slope

of the IS curve, $\frac{1}{f}\left(b\left(1-h\right)-1\right)$, is larger in absolute value. (ie. the IS curve is steeper.)

When the central bank increases the supply of central bank money, the LM curve is shifted to the right. i^* decreases a lot while Y^* increases only slightly.

When the government increases government spending, the IS curve is shifted to the right. i^* increases slightly while Y^* increases a lot.

Fiscal expansion is more effective. (ie. a small increase in G leads to a relatively larger increase in Y^*.)

See figures 3 and 4.

7. Suppose now that the government decides to decrease the tax rate h by a half. Does monetary policy become more effective now? Write a few sentences to explain.

Ans: $h \rightarrow \frac{1}{2}h$ means that the slope of the IS curve becomes less steep since $\frac{1}{f}\left[b-\left(bh+1\right)\right] < \frac{1}{f}\left[b-\left(\frac{1}{2}bh+1\right)\right] < 0$. We have shown in part (6) that a steeper IS curve makes monetary policy less effective. A flatter IS curve implies an increase in the effectiveness of monetary policy.

Intuition: the multiplier in the goods market is larger $\frac{1}{1-b\left(1-\frac{1}{2}h\right)} > \frac{1}{1-b(1-h)}$. An increase in money supply decreases the equilibrium interest rate and induces an increase in investment. But such an increase in investment now has a larger impact on output because of the larger multiplier.

III. Long question - The Labor Market
Consider an economy with the following specifics : The wage setting curve is given by $W/P^e = \alpha - \beta u$ (where the constant α denotes any variable whose increase would increase the real wage, and u is the unemployment rate). The production function is $Y = AN$ (where N is employed labor and A is labor productivity), and firms price at a markup of μ over marginal costs.
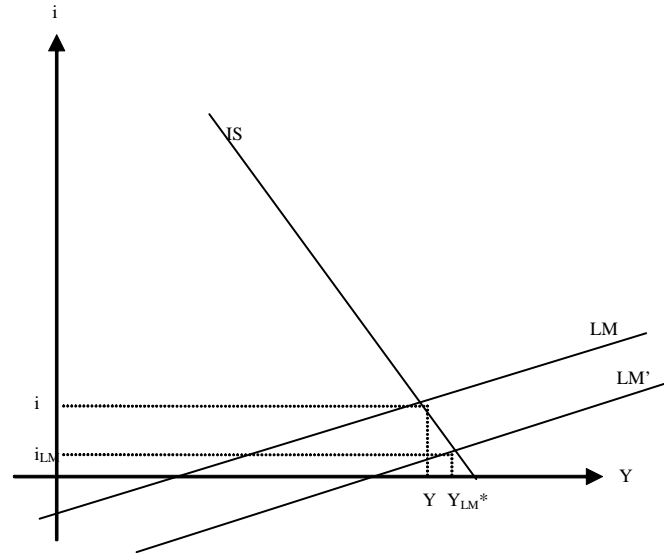
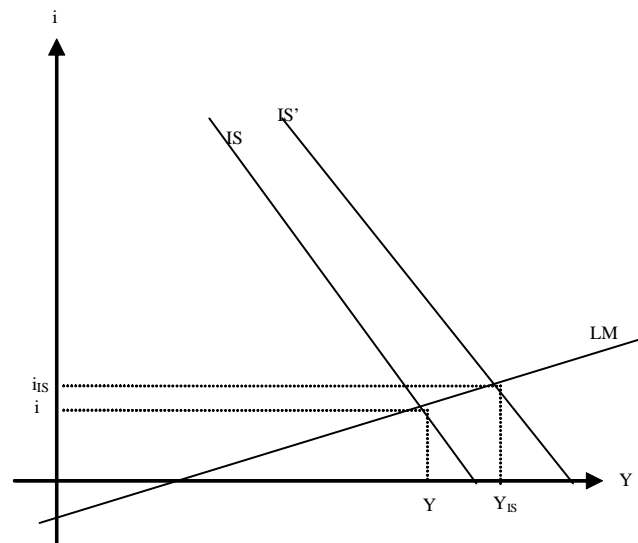Figure 3: for part 6: effectiveness of monetary policy

Figure 4: for part 6: effectiveness of fiscal policy

6

1. Suppose the economy is in labor market equilibrium, with an unemployment rate equal to the natural rate. It has a non-institutional civilian population of 80 million and a number unemployed (they are all looking for a job) equal to 3.2 million. Also consider the following values for the parameters : $\alpha = 1, \beta = 10/3, \mu = 20\%, A = 1$

    (a) Determine the equilibrium rate of unemployment

The wage setting curve is : $W/P^e = 1 - 3.33u$

The price setting curve is : $W/P = 1/(1 + \mu) = 1/1.2$

Setting $P = P^e$ *and equating* W/P *from both equations, we get* $u = 5\%$

    (b) Determine the participation rate

Since $u = 5\%$*, and the number unemployed is 3.2 million, it follows that the labor force is* $3.2 \times 100/5 = 64$ *million*

This means that the participation rate is $64/80 \times 100\% = 80\%$

    (c) Determine the natural level of output

The level of employment is $64 - 3.2 = 60.8$ *million, which translates into* 60.8 *million units of output, according to the production function.*

2. For the case where $Y = AN$, with $A > 1$

    (a) Write down the price setting equation.

The price setting equation is now $W/P = A/(1 + \mu)$*. This is because each worker now produces* $A > 1$ *units of output (instead of 1). Equivalently, producing 1 unit of output requires* $1/A$ *workers. If the nominal wage is W, the nominal cost of producing 1 unit of output is therefore equal to* $(1/A)W = W/A$*. So, the price setting equation is* $P = (1 + \mu)\frac{W}{A}$*.*

    (b) Does the equilibrium real wage increase or decrease (relative to the case where $A = 1$)? Provide some intuition for your answer.

Since the price setting equation pins down the equilibrium real wage, it is clear that the equilibrium real wage is higher when $A > 1$ *than when* $A = 1$*. The reason is that the real wage is increasing in the productivity of labor, and labor is more productive when* $A > 1$

    (c) Does the natural rate of unemployment increase or decrease (relative to the case where $A = 1$)? Provide some intuition for your answer.

The natural rate of unemployment will decrease (the WS curve remains as before, and the PS curve shifts up) relative to the case of $A = 1$*. Intuitively, a lower natural rate of unemployment is just the flip side of a higher real wage. Since the WS curve has not shifted, the only way workers can bargain for a higher real wage is if unemployment decreases, which is exactly what happens when A increases from 1 to some larger number.*

3. For each of the following, describe what happens to the natural rate of unemployment

To answer this question, note that the natural rate of unemployment is given by

$$u_n = \frac{1}{\beta}\left(\alpha - \frac{A}{1+\mu}\right)$$

    (a) An increase in the legislated minimum wage

This would increase the parameter α *and result in a higher* u_n*, since it would increase the bargaining power of workers without increasing their productivity or*

reducing the markup that firms are charging.

(b) A decrease in unemployment benefits

This would decrease the parameter α and result in a lower u_n for reasons exactly analogous to (a)

(c) An increase in anti-trust legislation

This would reduce μ and so reduce u_n, since a decrease in the markup would result in a higher equilibrium real wage (remember that the PS curve pins down the equilibrium real wage), which is consistent along the WS curve only with a lower unemployment rate.

4. Extra credit : Any model which predicts that steady increases in productivity lead to steady decreases in the unemployment rate over time is in contradiction with the facts. There must be something wrong with the model. Discuss.

The wage setting equation in Ch. 6 does not account for productivity increases. The evidence suggests that other things being equal, wages are typically set to reflect the increase in productivity over time. If productivity has been growing at 3% a year on average for some time, then wage contracts will build in a wage increase of 3% a year. This suggests the following extension of our wage-setting equation : $W = P^e A^e F(u, z)$, so that wages now depend on the expected level of productivity. Now the labor market equilibrium condition will require that both price and productivity expectations turn out to be correct, i.e., $P^e = P$ and $A^e = A$. This way of incorporating productivity changes into the wage setting equation delivers an important result. When productivity increases, and if this increase is perfectly anticipated by workers, then both the WS and PS curves will shift up, so that the equilibrium real wage will increase with no change in the natural rate of unemployment. See Ch. 13, Section 13-2 for more detail.