# Homework #5 - *Answers*
## Macro Policy Analysis
## Due Mar 25

1.  Using the IS-LM model for a closed economy and the Mundell-Fleming model for an open economy (always in the short run, with a fixed price level), derive and compare the effects of a tax cut for the three regimes of

    CE: A **C**losed **E**conomy
    FE: A small open economy with a **F**loating **E**xchange rate
    PE: A small open economy with a **P**egged **E**xchange rate

    Consider the effects of a given tax cut on

    i.   GDP ($Y$)
    ii.  the interest rate ($r$)
    iii. the level of demand for money ($L$), and
    iv.  the level of consumption ($C$).

    Derive, for each of these, both the direction of the effect on the variable and how it compares in size to the effects under the other two regimes.

    To do all this, follow the steps listed on the next several pages.

a. On the axes below, draw and label the appropriate diagram for showing the effects of a tax cut in a **closed economy**. Then record, below that, the direction (+, − , 0, ?) of the changes in each of the variables listed above, together with reasons for these changes. ("From the diagram" is an acceptable reason, if appropriate.)
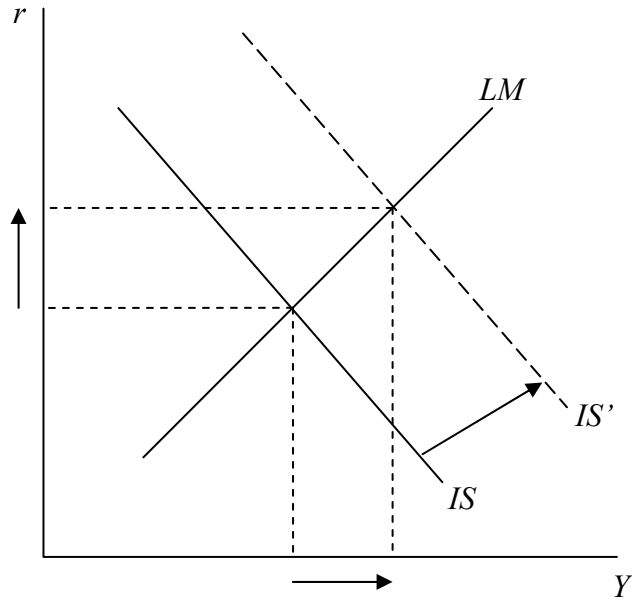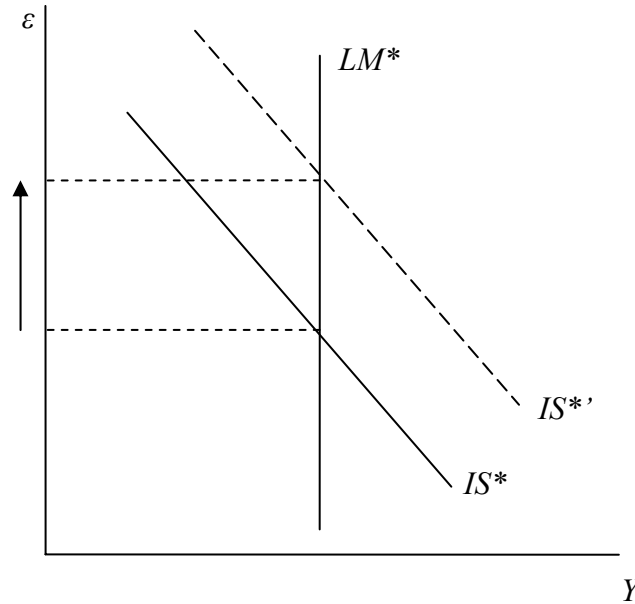


Y _____ + _____ Why? *From the diagram.*

r _____ + _____ Why? *From the diagram.*

L _____ 0 _____ Why? *L=M and ΔM=0*

C _____ + _____ Why? *C=C(Y-T) and ΔY>0 while ΔT<0*

b.  Draw and label the appropriate diagram for showing the effects of a tax cut in a **small open economy with a floating exchange rate**. Then record, below that, the direction (+,– , 0, ?) of the changes in each of the variables listed above, together with reasons for these changes.



Y        _____0_____        Why?        *From the diagram.*

r        _____0_____        Why?        *r=r\*.*

L        _____0_____        Why?        *L=M and ΔM=0*

C        _____+_____        Why?        *C=C(Y-T) and ΔY=0 while ΔT<0*

c.  Draw and label the appropriate diagram for showing the effects of a tax cut in a
    **small open economy with a pegged exchange rate**. Then record, below that, the
    direction (+,– , 0, ?) of the changes in each of the variables listed above, together
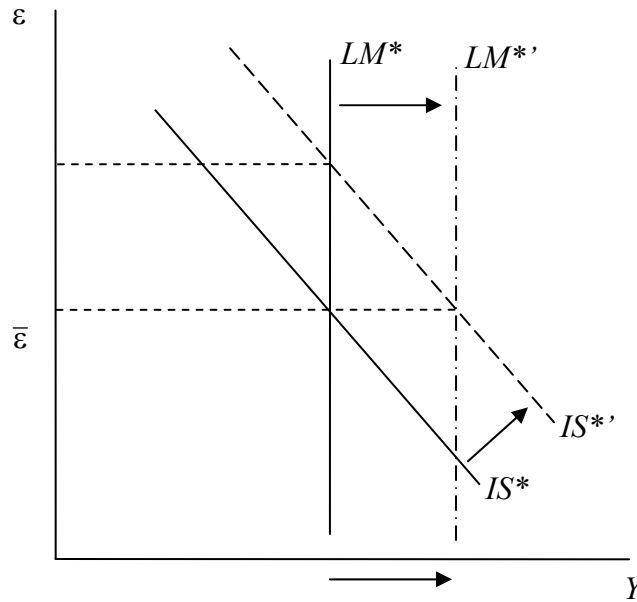    with reasons for these changes.



Y  _____+_____  Why?   *From the diagram.*

r  _____0_____  Why?   *r=r\*.*

L  _____+_____  Why?   *L=M and ΔM>0*

C  _____+_____  Why?   *C=C(Y-T) and ΔY>0 while ΔT<0*

d.  Starting with the IS-LM equilibrium shown below, show how the IS and LM
    curves are shifted by the time you get to a new equilibrium in **all three** of the
    cases above. That is, identify the final IS and LM curves for each of the cases,
    labeling them $IS_{CE}$ and $LM_{CE}$ for the closed economy case, $IS_{FE}$ and $LM_{FE}$ for the
    floating exchange rate case, and $IS_{PE}$ and $LM_{PE}$ for the pegged exchange rate case.
    Then use these curves to identify, in the same figure, the equilibrium
    combinations of $Y$ and $r$ for each case, marking them CE, FE, and PE
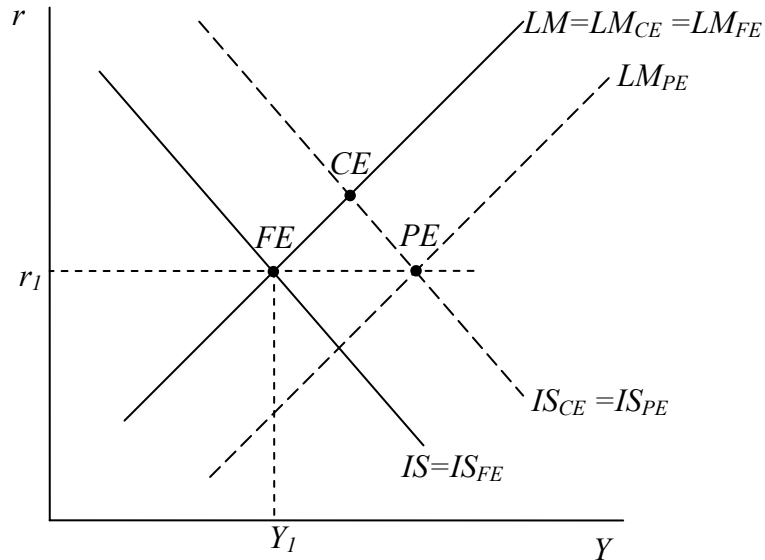


respectively.

e.  For each of the variables that you examined in parts a-c, indicate how the changes
    compare, to each other and to zero, across the three regimes. For example, if it
    were the case that variable $X$ increases the most in a closed economy, next most
    with a pegged rate, and not at all with a floating rate, then you would write:

$$\Delta X_{CE} > \Delta X_{PE} > \Delta X_{FE} = 0$$

If $X$ changes by the same amount in two regimes, use "="instead of ">" or "<".

| Ranked changes in $Y$ | $\Delta Y_{PE} > \Delta Y_{CE} > \Delta Y_{FE} = 0$ |
|---|---|
| Ranked changes in $r$ | $\Delta r_{CE} > \Delta r_{FE} = \Delta r_{PE} = 0$ |
| Ranked changes in $L$ | $\Delta L_{PE} > \Delta L_{CE} = \Delta L_{FE} = 0$ |
| Ranked changes in $C$ | $\Delta C_{PE} > \Delta C_{CE} > \Delta C_{FE} > 0$ |

2. You are advisor to the government of a small open economy with a floating exchange rate. The government has control over both monetary and fiscal policies, and it has come to you for advice on how to achieve one of the following objectives in the short run (it is up for reelection next year and does not care about the long run). What do you tell it in each case?

   a. Reduce unemployment    *Expand the money supply (fiscal policy won't work because of the floating exchange rate).*

   b. Cause its currency to appreciate.    *Either contract the money supply or expand fiscal policy.*

   c. Lower its interest rate.    *Forget it. This is a small country, and that's not possible.*

   d. Raise GDP **and** appreciate the currency.    *Use expansionary monetary and fiscal policies together, being careful that the fiscal expansion is sufficiently large.*

   e. Prevent a rise in the world interest rate from causing any change in domestic income.    *A rise in the world interest rate will raise domestic income if not met by any policy change at all (since with unchanged money supply, a rise in r will require a rise also in Y to keep money demand equal to supply). Therefore, to prevent this from happening, the monetary authorities must reduce the money supply (to the new level demanded when r rises to r\*).*

3.  Use the sticky-wage model of the short-run aggregate supply curve to work out the effects of the following changes on that curve:

    a.  An increase in the target real wage, $\omega$ .

        *Ans:  The equation that we derived for the sticky-wage model was*

        $$Y = F\left[ L^d\left( \omega \frac{P^e}{P} \right) \right]$$

        *From this, an increase in $\omega$ for any given value of P will increase the real wage paid, reduce quantity of labor demanded, and reduce output. Thus the SRAS curve shifts to the left.*

    b.  An improvement in technology that increases both the marginal and the average product of labor by 5%.

        *Ans: Using the same equation as in part (a), this technological improvement causes both an increase in labor demand for any real wage, and an increase in output for any level of employment. Therefore, for any given P, it causes an increase in labor demand and an even larger increase in output, shifting the SRAS curve to the right.*

4. The following equations represent more or less the same aggregate supply and demand model that you examined numerically in Homework #2.

| | | |
|---|---|---|
| LRAS: | $\overline{Y} = 100$ | (1) |
| AD: | $Y_t = 100 + X_t + M_t - P_t$ | (2) |
| SRAS: | $P_t = P_t^e + a(Y_t - \overline{Y})$ | (3) |
| Expectations: | $P_t^e = P_{t-1} + \pi_t^e$ | (4a) |
| | $\pi_t^e = P_{t-1} - P_{t-2}$ | (4b) |
| Monetary growth: | $M_t = M_{t-1} + m_t$ | (5) |
| Policy Rule I: | $m_t = \overline{m}$ | (6a) |
| Policy Rule II: | $m_t = m_{t-1} + b(\hat{Y} - Y_{t-1})$ | (6b) |

The main differences are that this model now includes an upward sloping SRAS curve, a role for expectations about prices and inflation, and two possible rules for monetary policy in terms of the rate of growth of the money supply, rather than just its level. (If you want these equations to make the most sense, think of $M$, $P$, $P^e$, and perhaps even $Y$, as being the logarithms of the respective variables.) Note that the simple expectations mechanism just sets an expected rate of inflation equal to last period's observed rate of inflation, and then uses that expected rate of inflation to set the current expected price level.

Policy Rule I sets a constant rate of monetary growth for all periods, a rate that could be zero. Policy Rule II sets a more active policy response based on a target level of income, $\hat{Y}$, which could be equal to $\overline{Y}$ but doesn't need to be. Whatever the target is, under this rule the monetary policy makers increase money growth when income is below the target and reduce it when it is above.

a. Before solving the model numerically (which you will do below), use your knowledge of the AD-AS model and the Phillips Curve to describe how you expect this economy to behave if, starting from a long-run equilibrium with constant prices, the monetary authorities now begin to increase the money supply at a constant positive rate from then on. You need not draw any diagrams for this, but you are welcome to.

*Ans: The increased rate of monetary expansion will at first cause the AD curve to shift to the right and expand income. This will raise the price level, causing expected inflation to rise above zero. As time goes on, both actual and expected inflation will rise to the rate of monetary expansion, and income will return to its long-run level, $\overline{Y}$.*

b.  In part (c) below you will be solving this model numerically. In order to do that,
    since the model includes two equations – (2) and (3) – that must be solved
    simultaneously, you will first need to find that solution analytically. In the space
    below, use equations (2) and (3) above to derive the following:

$$Y_t = \frac{1}{1+a}\left(100 + X_t + M_t - P_t^e + a\bar{Y}\right) \tag{2'}$$

$$P_t = \frac{1}{1+a}P_t^e + \frac{a}{1+a}\left(100 + X_t + M_t - \bar{Y}\right) \tag{3'}$$

*Ans:  Substitute (3) into (2):*

$$Y_t = 100 + X_t + M_t - P_t$$
$$= 100 + X_t + M_t - \left(P_t^e + a(Y_t - \bar{Y})\right)$$
$$= -aY_t + 100 + X_t + M_t - P_t^e + a\bar{Y}$$

*Solve for $Y_t$:*

$$Y_t = \frac{1}{1+a}\left(100 + X_t + M_t - P_t^e + a\bar{Y}\right)$$

*Substitute this into (3):*

$$P_t = P_t^e + a\left[\frac{1}{1+a}\left(100 + X_t + M_t - P_t^e + a\bar{Y}\right) - \bar{Y}\right]$$

$$= \left[1 - \frac{a}{1+a}\right]P_t^e + \frac{a}{1+a}\left(100 + X_t + M_t\right) + \left[\frac{a^2}{1+a} - a\right]\bar{Y}$$

$$= \frac{1}{1+a}P_t^e + \frac{a}{1+a}\left(100 + X_t + M_t - \bar{Y}\right)$$

c.  Using the equations of the model with (2) and (3) replaced by (2') and (3') from
    part (b), calculate the values over time for ten periods of the variables indicated
    in the tables below. Presumably you will want to do this in a spreadsheet. As a
    check that you have entered the equations correctly into the spreadsheet, you
    should first calculate the results without any aggregate demand shocks ($X$=0) and
    without any monetary growth ($m$=0) for all periods. In that case you should find
    that all variables are constant at their initial values.

    In each case, below the tables of results, write a short description of how the
    economy responds in the scenario. (You may want to extend your calculation
    beyond ten periods to help you see where it is going.)

i.) Response to a permanent positive shock to aggregate demand with no change in the money supply:

Parameters: $a = 1.0$

| Period t | X(t) | m(t) | $\pi^e(t)$ | $P^e(t)$ | Y(t) | P(t) | M(t) |
|----------|------|------|------------|----------|------|------|------|
| -2 | 0 | 0 | 0.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| -1 | 0 | 0 | 0.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 0 | 10 | 0 | 0.00 | 100.00 | 105.00 | 105.00 | 100.00 |
| 1 | 10 | 0 | 5.00 | 110.00 | 100.00 | 110.00 | 100.00 |
| 2 | 10 | 0 | 5.00 | 115.00 | 97.50 | 112.50 | 100.00 |
| 3 | 10 | 0 | 2.50 | 115.00 | 97.50 | 112.50 | 100.00 |
| 4 | 10 | 0 | 0.00 | 112.50 | 98.75 | 111.25 | 100.00 |
| 5 | 10 | 0 | -1.25 | 110.00 | 100.00 | 110.00 | 100.00 |
| 6 | 10 | 0 | -1.25 | 108.75 | 100.63 | 109.38 | 100.00 |
| 7 | 10 | 0 | -0.63 | 108.75 | 100.63 | 109.38 | 100.00 |
| 8 | 10 | 0 | 0.00 | 109.38 | 100.31 | 109.69 | 100.00 |
| 9 | 10 | 0 | 0.31 | 110.00 | 100.00 | 110.00 | 100.00 |
| 10 | 10 | 0 | 0.31 | 110.31 | 99.84 | 110.16 | 100.00 |

Describe what happens:

*Ans: The positive shock to aggregate demand causes a temporary increase in real income and a rise in prices. Prices continue to rise, however, as expectations of prices are also adjusted upwards, and this reduces real income eventually back to its original level. Both the actual and expected price levels remain permanently higher, in order to reduce aggregate demand down to its long run level equal to the natural rate of output. The adjustment to the long run equilibrium involves a small amount of cyclical fluctuation around it.*

ii.) Response to a permanent increase in the rate of growth of the money supply:

Parameters:    $a = 1.0$

| Period t | X(t) | m(t) | $\pi^e(t)$ | $P^e(t)$ | Y(t) | P(t) | M(t) |
|----------|------|------|------------|----------|--------|--------|--------|
| -2 | 0 | 0 | 0.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| -1 | 0 | 0 | 0.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 0 | 0 | 10 | *0.00* | *100.00* | *105.00* | *105.00* | *110.00* |
| 1 | 0 | 10 | *5.00* | *110.00* | *105.00* | *115.00* | *120.00* |
| 2 | 0 | 10 | *10.00* | *125.00* | *102.50* | *127.50* | *130.00* |
| 3 | 0 | 10 | *12.50* | *140.00* | *100.00* | *140.00* | *140.00* |
| 4 | 0 | 10 | *12.50* | *152.50* | *98.75* | *151.25* | *150.00* |
| 5 | 0 | 10 | *11.25* | *162.50* | *98.75* | *161.25* | *160.00* |
| 6 | 0 | 10 | *10.00* | *171.25* | *99.38* | *170.63* | *170.00* |
| 7 | 0 | 10 | *9.38* | *180.00* | *100.00* | *180.00* | *180.00* |
| 8 | 0 | 10 | *9.38* | *189.38* | *100.31* | *189.69* | *190.00* |
| 9 | 0 | 10 | *9.69* | *199.38* | *100.31* | *199.69* | *200.00* |
| 10 | 0 | 10 | *10.00* | *209.69* | *100.16* | *209.84* | *210.00* |

Describe what happens:

*Ans:  The increased money supply initially causes output to rise and prices to rise beyond their expected level. Over time, however, expectations of inflation recognize the inflation that is occurring and begin to cause the actual price level to equal only what is expected. This reduces output back toward its natural level. In the long run, output falls to its natural level, while actual and expected prices (and the money supply) continue to grow indefinitely at a constant rate.*

iii.) Monetary authorities attempt to stabilize the economy in response to a permanent positive shock to aggregate demand (use (6b)):

Parameters:  $a = 1.0$
$b = 2.0$
$\hat{Y} = \bar{Y} = 100$

| Period t | X(t) | m(t) | $\pi^e$(t) | $P^e$(t) | Y(t) | P(t) | M(t) |
|---|---|---|---|---|---|---|---|
| -2 | 0 | 0 | 0.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| -1 | 0 | 0 | 0.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 0 | 10 | 0.00 | 0.00 | 100.00 | 105.00 | 105.00 | 100.00 |
| 1 | 10 | -10.00 | 5.00 | 110.00 | 95.00 | 105.00 | 90.00 |
| 2 | 10 | 0.00 | 0.00 | 105.00 | 97.50 | 102.50 | 90.00 |
| 3 | 10 | 5.00 | -2.50 | 100.00 | 102.50 | 102.50 | 95.00 |
| 4 | 10 | 0.00 | 0.00 | 102.50 | 101.25 | 103.75 | 95.00 |
| 5 | 10 | -2.50 | 1.25 | 105.00 | 98.75 | 103.75 | 92.50 |
| 6 | 10 | 0.00 | 0.00 | 103.75 | 99.38 | 103.13 | 92.50 |
| 7 | 10 | 1.25 | -0.63 | 102.50 | 100.63 | 103.13 | 93.75 |
| 8 | 10 | 0.00 | 0.00 | 103.13 | 100.31 | 103.44 | 93.75 |
| 9 | 10 | -0.63 | 0.31 | 103.75 | 99.69 | 103.44 | 93.13 |
| 10 | 10 | 0.00 | 0.00 | 103.44 | 99.84 | 103.28 | 93.13 |

Describe what happens:

*Ans:  Compared to part (i), where the same shock was met with a constant money supply, this policy causes a more rapid return to the natural level of output and less inflation. But while the price level now avoids overshooting its long run level, real output spends somewhat more time in recession. Also, the fluctuations in real output are more rapid.*

iv.) Starting in period 0, monetary authorities attempt to maintain a level of real
output above its natural rate (use (6b)):

Parameters:   $a = 1.0$
              $b = 2.0$
              $\hat{Y} = 110 > \overline{Y}$

| Period t | X(t) | m(t) | $\pi^e(t)$ | $P^e(t)$ | Y(t) | P(t) | M(t) |
|---|---|---|---|---|---|---|---|
| -2 | 0 | 0 | 0.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| -1 | 0 | 0 | 0.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 0 | 0 | 20.00 | 0.00 | 100.00 | 110.00 | 110.00 | 120.00 |
| 1 | 0 | 20.00 | 10.00 | 120.00 | 110.00 | 130.00 | 140.00 |
| 2 | 0 | 20.00 | 20.00 | 150.00 | 105.00 | 155.00 | 160.00 |
| 3 | 0 | 30.00 | 25.00 | 180.00 | 105.00 | 185.00 | 190.00 |
| 4 | 0 | 40.00 | 30.00 | 215.00 | 107.50 | 222.50 | 230.00 |
| 5 | 0 | 45.00 | 37.50 | 260.00 | 107.50 | 267.50 | 275.00 |
| 6 | 0 | 50.00 | 45.00 | 312.50 | 106.25 | 318.75 | 325.00 |
| 7 | 0 | 57.50 | 51.25 | 370.00 | 106.25 | 376.25 | 382.50 |
| 8 | 0 | 65.00 | 57.50 | 433.75 | 106.88 | 440.63 | 447.50 |
| 9 | 0 | 71.25 | 64.38 | 505.00 | 106.88 | 511.88 | 518.75 |
| 10 | 0 | 77.50 | 71.25 | 583.13 | 106.56 | 589.69 | 596.25 |

Describe what happens:

*Ans: Inflation accelerates.*