The IS-LM PC model

1. The medium-run equilibrium is characterised by four conditions:
   Output is equal to potential output $Y = Y_n$.
   The unemployment rate is equal to the natural rate $u = u_n$.
   The real policy interest rate is equal to the natural rate of interest r_n where aggregate demand equals Y_n.
   The expected rate of inflation p^e is equal to the actual rate of inflation p.

a) If the level of expected inflation is formed so p^e equals $p_{(-1)}$, characterise the behaviour of inflation in a medium run equilibrium

b) If the level of expected inflation is $\overline{\pi}$, what is the level of actual inflation in the medium-run equilibrium?

c) Write the IS relation as $Y = C(Y - T) + I(Y, r + x) + G$. Suppose r_n is 2%. If x increases from 3 to 5%, how must the central bank change r_n to maintain the existing medium run equilibrium? Explain in words.

d) Suppose G increases. How must the central bank change r_n to maintain the existing medium-run equilibrium? Explain in words.

e) Suppose T decreases. How must the central bank change r_n to maintain the existing medium-run equilibrium? Explain in words.

f) In the medium run, a fiscal expansion leads to an increase in the natural rate of interest. Discuss

2. The two paths to the medium-run equilibrium explored in the IS-LM-PC model make two different assumptions about the formation of the level of expected inflation. The approach path assumes the level of expected inflation equals lagged inflation. The level of expected inflation changes over time. The other path assumes the level of expected inflation is anchored to a specific value and never changes. The economy is in medium-run equilibrium where actual and expected inflation equals 2% in period t.

a) Suppose there is an increase in consumer confidence in period t + 1. How does the IS curve shift? Assume that the central bank does not change the real policy rate. How will the short-run equilibrium in period t + 1 compare with the equilibrium in period t?

b) Consider the period t + 2 equilibrium under the assumption that $\pi^e_{t+2} = \pi_{t+1}$. If the central bank leaves the real policy rate unchanged, how does actual inflation in period t + 2 compare with inflation in period t + 1? How must the central bank change the nominal policy rate to keep the real policy rate unchanged? Continue to period t + 3. Making the same assumption about the level of expected inflation and the real policy rate, how does actual inflation in period t + 3 compare with inflation in period t + 2?

c) Consider the period t + 2 equilibrium making the assumption that $\pi^e_{t+2} = \overline{\pi}$. If the central bank leaves the real policy rate unchanged, how does actual inflation in period t + 2 compare with inflation in period t + 1? How must the central bank change the nominal policy rate to keep the real policy rate unchanged? Continue to period t + 3. Making the same assumption about the level of expected inflation

and the real policy rate, how does actual inflation in period t + 3 compare with inflation in period t + 2?

d) Compare the inflation and output outcomes in part (b) with that in part (c).

e) Which scenario, part (b) or part (c), do you think is more realistic? Discuss.

f) Suppose in period t + 4, the central bank decides to raise the real policy rate high enough to return the economy immediately to potential output and the period t rate of inflation. Explain the difference between central bank policies using the two assumptions about expected inflation in part (b) and part (c).

3. A shock to aggregate supply will also have different outcomes when there are different assumptions about the formation of the level of expected inflation. As in Problem 2, one path assumes that the level of expected inflation equals lagged inflation. The level of expected inflation changes over time. The second path assumes the level of expected inflation is anchored to a specific value and never changes. Begin with medium-run equilibrium.

a) Suppose there is a permanent increase in oil price in period t + 1. How does the PC curve shift? Assume that the central bank does not change the real policy rate. How will the short-run equilibrium in period t + 1 compare with the equilibrium in period t? What happens to output? What happens to inflation?

b) Consider the period t + 2 equilibrium under the assumption that $\pi^e_{t+2} = \pi_{t+1}$. If the central bank leaves the real policy rate unchanged, how does actual inflation in period t + 2 compare with inflation in period t + 1? Continue to period t + 3. Making the same assumption about the level of expected inflation and the real policy rate, how does actual inflation in period t + 3 compare with inflation in period t + 2?

c) Consider the period t + 2 equilibrium under the assumption that $\pi^e_{t+2} = \bar{\pi}$. If the central bank leaves the real policy rate unchanged, how does actual inflation in period t + 2 compare with inflation in period t + 1? Continue to period t + 3. Making the same assumption about the level of expected inflation and the real policy rate, how does actual inflation in period t + 3 compare with inflation in period t + 2.

d) Compare the inflation and output outcomes in part (b) with that in part (c).

e) In period t + 4, the central bank decides to change the real policy rate to return the economy as quickly as possible to potential output and to the inflation rate of period t. Under which path for the formation of expected inflation is the nominal policy rate of interest higher in period t + 4: the path from (b) or the path from (c)? Explain why, when inflation expectations are anchored as in part (c), the central bank can change the policy rate immediately to reach the new level of potential output and the period t level of inflation in period t + 4. Make the argument that it is not possible for the central bank immediately to hit both the new level of potential output and the period t level of inflation in period t + 4 when expected inflation is equal to its lagged value.

4. Okun's law is written as:
$$u - u_{(-1)} = -0.4(g_y - 3\%)$$

a) What is the sign of $u - u_{(-1)}$ in a recession? What is the sign of $u - u_{(-1)}$ in a recovery?

b) Explain where the 3% number comes from.

c) Explain why the coefficient on the term $(g_y - 3\%)$ is -0.4 and not -1.

d) Suppose the number of immigrants per year allowed to enter the United States is sharply increased. How would Okun's law change?

5. Suppose the economy operates at the zero lower bound for the nominal policy rate; there is a large government deficit. The economy is operating at the potential output in period t. A newly elected government vows to cut spending and reduce the deficit in period t + 1, period t + 2 and subsequent.

a) Show the effects of the policy on output in period t + 1.
b) Show the effects of the policy on the change in inflation in period t + 1.
c) If expected inflation depends on past inflation, what happens to the real policy rate in period t + 2? How will this affect output in period t + 3?
d) How does the zero lower bound on nominal interest rates make fiscal consolidation more difficult?

6. Consider the data in the table and answer the questions:

The nominal interest rate, inflation and the real interest rate, 1929–1933

Year	Unemployment rate (%)	output growth rate (%)	one-year nominal interest rate i (%)	Inflation rate (%)	One-year interest rate r(%)
1929	3.20	-9.8	5.30	0.00	5.30
1930	8.70	-7.6	4.40	-2.50	6.90
1931	15.90	-14.7	3.10	-9.20	12.30
1932	23.60	-1.8	4.00	-10.80	14.80
1933	24.90	9.10	2.60	-5.20	7.80

a) Do you believe that output had returned to its potential level in 1933?
b) Which years suggest a deflation spiral?
c) Make the argument that if the expected level of inflation had remained anchored at the actual value of inflation in 1929, the Great Depression would have been less severe.
d) Make the argument that a substantial fiscal stimulus in 1930 would have made the Great Depression less severe
e) Calculate real interest rates in each year, assuming that the expected level of inflation is last year's inflation rate. The rate of inflation in 1928 was -1.7%. Do the changes in real interest rates explain the data on real output growth and unemployment better than when you assume the expected rate of inflation is the current year's rate of inflation?
f) Calculate Okun's law coefficient for each year from 1930 to 1933. To do so, assume potential output is not growing. Speculate why firms did not take on additional workers in 1933 even though output growth was 9.1%. (Hint: If potential output is not growing, Okun's law is $u - u_{(-1)} = -a g_Y$.)

ADDITIONAL QUESTIONS:
Label each of the following statements is true, false or uncertain. Explain briefly.

1. The IS curve shifts up with an increase in G, an increase in T and an increase in x.
2. If $(u - u_n)$ is greater than zero, then $(Y - Y_n)$ is greater than zero.

3. If ($u - u_n$) is equal to zero, the output is at the potential.
4. If ($u - u_n$) is less than zero, the output gap is negative.
5. If the output gap is positive, inflation is higher than expected inflation.
6. Okun's law says that if output growth increases by one percentage point, the rate of unemployment drops by one percentage point.
7. At the natural unemployment rate, inflation is neither rising nor falling.
8. In a medium-run equilibrium, the rate of inflation is stable.
9. The central bank can always act to keep output equal to potential output.
10. It is easier for the central bank to keep output at potential output if inflation expectations are anchored.
11. A significant increase in oil price increases the natural rate of unemployment.