

# Course 8 - Recommended Problems

## Solutions

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### ☆☆ Problem 3, Chapter 9, page 194-195

The two paths to the medium-run equilibrium explored in this chapter make two different assumptions about the formation of the level of expected inflation. One 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. Begin 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 to the equilibrium in period  $t$ ?

The IS curve shifts to the right. Under constant real policy rate, equilibrium output rises. Output is now above potential. We thus move along the PC curve to a higher inflation rate.

- b. Consider the period  $t+2$  equilibrium under the assumption that  $\pi_{t+2}^e = \pi_{t+1}$ . If the central bank leaves the policy rate unchanged, how does actual inflation in period  $t + 2$  compare to 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 to inflation in period  $t + 2$ .

Output is above potential, so  $\pi_{t+2} - \pi_{t+2}^e = \pi_{t+2} - \pi_{t+1} > 0$ : inflation in  $t+2$  is greater than inflation in  $t+1$ . The real policy rate in  $t+2$  is (approximately) given by  $r_{t+2} = i_{t+2} - \pi_{t+2}$ . Since inflation will increase between  $t+1$  and  $t+2$ , the central bank must increase the nominal policy rate to keep  $r_{t+2} = r_{t+1}$ . In period  $t+3$ , the process repeats itself: inflation in  $t+3$  will be higher than inflation in  $t+2$ , so the

central bank will have to raise the nominal policy rate again, in order to keep the real rate unchanged.

- c. **Consider the period  $t+2$  equilibrium making the assumption that  $\pi_{t+2}^e = \bar{\pi}$ . If the central bank leaves the real policy rate unchanged, how does actual inflation in period  $t+2$  compare to 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 to inflation in period  $t+2$ ?**

At the current equilibrium output, the PC diagram tells us that  $\pi_{t+2} - \pi_{t+2}^e = \pi_{t+2} - \bar{\pi} = c > 0$  where  $c$  is the value on the y-axis. That tells us that  $\pi_{t+2} = \bar{\pi} + c$ . But under this expectation regime, this was also true in period  $t+1$ :  $\pi_{t+1} = \bar{\pi} + c$ . So inflation in  $t+1$  and in  $t+2$  are equal. In the anchored expectation regime, being above (below) potential output leads inflation to be above (below)  $\bar{\pi}$  but does not induce any inflation dynamics (as opposed to the lagged inflation regime). Inflation being unchanged, the central bank does not need to change the nominal rate to keep the real rate constant. The same story goes in period  $t+3$ :  $\pi_{t+3} = \pi_{t+2}$  and the central bank does not need to change the nominal rate.

- d. **Compare the inflation and output outcomes in part b to that in part c.**

The difference between the two expectation regimes is crucial. When expected inflation equals lagged inflation, the central bank must increase the nominal rate to keep the real rate constant. However, by doing so, the central does not do enough to drive output back to potential. It simply maintains the medium-run equilibrium (that is, we are not moving in the PC diagram). As a result, inflation keeps increasing.

On the other hand, when expectations are anchored, the outcome is much less dramatic. As mentioned in the previous question, being above potential only leads to inflation being higher than  $\bar{\pi}$  but does not induce inflation dynamics. The economy is running at an inflation rate that may be a little high (compared to the central bank's inflation target) but it is stable at this point.

- e. **Which scenario part b or part c, do you think is more realistic. Discuss.**

These two expectation regimes are rather extreme assumptions. Among other factors, the expectation regime is determined by the trust that economy puts in the central bank's ability to maintain inflation stable. In the lagged inflation regime, the central bank is totally unable to stabilize expectations, suggesting that people do not trust it at all.

This is not very realistic: in hard times, central banks usually take strong measures to restore confidence. In the anchored expectations regime, people do not update their expectations at all. Reconsidering the scenario in question c., this means that they are constantly wrong in forecasting inflation, which is unlikely. In reality, the

expectation regime is likely in between these two extremes.

- 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 to 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.**

In the lagged inflation expectation regime, driving output back to potential will stabilize inflation. Indeed, this will lead to  $\pi_{t+4} - \pi_{t+4}^e = \pi_{t+4} - \pi_{t+3} = 0$ , that is inflation will stop increasing. However, driving output back to potential likely takes a while. Over this time, we are moving along the part of the PC curve above zero: inflation increases. So when we eventually arrive back at potential output, inflation stabilizes at a level higher than the original  $\pi_t$ . In that case, the central bank needs to overshoot a little bit: it will temporarily increase the nominal (hence the real) rate further to drive output slightly below potential (a recession); this will trigger a temporary decrease in inflation, after which the central bank will lower rates for inflation to stabilize around an acceptable value (typically around 2% in the US). Importantly, the central bank must trigger a recession to drive inflation back to its original level.

In the anchored expectation regime, raising the real rate and driving output back to potential simply leads to  $\pi_{t+4} = \bar{\pi}$ . No overshooting is needed. If  $\bar{\pi}$  is an acceptable inflation for the central bank, then that is all it needs to do.

A takeaway from that problem is that the sole fact that people trust the central bank (represented, at its extreme, by the anchored regime) makes the central bank's actions much more efficient and hence its inflation-targeting job much easier. When people do not trust it at all (lagged inflation regime) maintaining inflation is much harder.

## ☆☆ Problem 4, Chapter 9, page 195

**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 Question 3, 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 in medium-run equilibrium where actual and expected inflation equal 2% in period  $t$ .**

- a. **Suppose there is a permanent increase in the price of oil 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 to the equilibrium in period  $t$ ? What happens to output? What happens to inflation?**

A permanent increase in the price of oil will increase inflation  $\pi_{t+1}$ . If this increase is not expected,  $\pi_{t+1}^e$  does not react, so that  $\pi_{t+1} - \pi_{t+1}^e$  goes up. Since this is true whatever the level of output is, this triggers an upward shift of the PC curve. The IS curve is not impacted. Moreover, we assume that the central bank maintains the real policy rate, so the LM curve is unchanged as well. Hence, equilibrium output does not change. Inflation is higher.

- b. **Consider the period  $t+2$  equilibrium under the assumption that  $\pi_{t+2}^e = \pi_{t+1}$ . If the central bank leaves the policy rate unchanged, how does actual inflation in period  $t+2$  compare to 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 to inflation in period  $t+2$ .**

The upward shift in the PC curve established in question 1 implies that *potential* output goes down. Since equilibrium output was unchanged in  $t+1$ , we are now above potential. From then on, the answer to Problem 3 - (b) above applies.

- c. **Consider the period  $t+2$  equilibrium under the assumption that  $\pi_{t+2}^e = \bar{\pi}$ . If the central bank leaves the policy rate unchanged, how does actual inflation in period  $t+2$  compare to 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 to inflation in period  $t+2$ .**

Again, the PC curve shift implies that we are now above potential output. The answer to Problem 3 - (c) applies.

- d. **Compare the inflation and output outcomes in part b to that in part c.**  
Same discussion as in Problem 3 - (d).
- 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 to immediately reach the new level of potential output and the period  $t$  level of inflation in period  $t+4$ . Make the argument that is not possible for the central bank to immediately 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.**

This discussion is due to the overshooting policy needed in the case of lagged inflation expectations: see Problem 3 - (e).

## ☆ Problem 7, Chapter 9, page 195

**Consider the data in the Focus Box, “Deflation in the Great Depression.”**

- a. **Do you believe that output had returned to its potential level in 1933?**

Output was most likely not at potential in 1933. There are several ways to argue for this. First, despite a growth in 1933, output had strongly declined since 1929. It is thus not back at its pre-crisis level. Second, the unemployment rate is still at nearly 25% in 1933! This is definitely above the natural unemployment rate, which means that output is below potential.

- b. **Which years suggest a deflation spiral as described in Figure 9-3?**

Between 1929 and 1932, the rate of inflation (which is actually deflation since it's negative) keeps decreasing. Think about the IS-LM-PC model. This situation suggests that people base their inflation expectations on past inflation levels (at least partially) and that the central bank is not doing enough to maintain the real rate (which we can see in the real rate column). We are thus on the part of the PC curve below the zero horizontal line, where inflation has a decreasing dynamic, and we keep moving further down this PC curve because the central bank fails to lower the nominal rate enough (so the real rate goes up). This situation could happen because the central bank is constrained at the zero lower bound and cannot decrease  $i$  further. However, the data on the nominal rate suggest that the central did not hit the ZLB, since  $i$  remains substantially positive over the whole period.

- 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.**

This is the argument developed in Problem 3 - (d) and (f). Under anchored expectations, being below potential output does not trigger a downward inflation dynamic. Inflation is simply below its medium-run equilibrium level, but does not decrease. If this had been the case during the Great Depression, a large enough reduction in the nominal policy rate would have quickly driven output back to potential and inflation back to its original level. In particular, the delayed response of the Fed (see the Focus Box in the book) would have had less dramatic consequences, because over the time it took to react, inflation would not have fallen as it did.

- d. **Make the argument that a substantial fiscal stimulus in 1930 would have made the Great Depression less severe.**

We can think of a fiscal stimulus as an increase in government spending  $G$ , or as a decrease in aggregate net taxes  $T$ , either through a reduction in taxes or through an increase in transfers. As we have seen in previous chapters, this would have shifted the IS curve to the right. Hence, this would have led to an increase in equilibrium output.

If the stimulus had been substantial enough, this could have driven output back to (or close to) its potential level. According to the PC curve, this would have mitigated the decrease in inflation or could even have stabilized it (even under a lagged inflation expectation regime).

The reason why this policy was not implemented was that some economists and policymakers were concerned with the level of the government deficit at the time. Keynes thought however that no fiscal stimulus would make the situation worse, and make the government deficit potentially greater. Instead, President Hoover decided to listen more to deficit “hawks” and implemented a big tax increase in 1932 (link)

### ☆ Problem 9, Chapter 9, page 196

**This problem considers the case of the Great Depression in the United Kingdom. Answer the following questions based on information found in the table below.**

- a. **Is there evidence of the deflation spiral from 1929 to 1933 in the United Kingdom?**

There is evidence for a deflation spiral over the period 1929-1931, where the inflation rate decreases. It is substantially weaker than in the US though. From 1932 on, inflation starts going back up, which suggests an exit of the spiral.

- b. **Is there evidence of the effect of high real interest rates on output?**

Over 1929-1931, real rates increase (especially in 1930-1931). We see that this is associated with strong declines in output. When the real rate goes back down from 1932 on, output growth becomes positive. These evidence are consistent with the IS-LM model, where rising real rates depress output.

- c. **Is there evidence of a poor choice of the real policy interest rate by the central bank?**

Yes, it would seem like the central bank was actually choosing a policy rate that was too high at that time. In particular, there was a sharp rise of the policy rate between 1930 and 1931, while the country was experiencing recession and instead needed expansionary monetary policy.

However, Britain was still under the Gold Standard at that time, that is largely operating under a fixed exchange rate regime. As we shall see in Chapter 19, this severely constrained its monetary policy choices, as it had to defend the parity of

the pound. In particular, under fixed exchange rates, a country largely gives up its independent monetary policy: its interest rate is equal to that of the countries it is fixing its parity with. But more on this later during the “open economy” topics of the course.

Year	Unemp. Rate (%)	Growth Rate (%)	1Y Nom.(%), $i$	Inflation (%), $\pi$	1Y Real (%), $r$
1929	10.4	3.0	5.0	-0.9	5.9
1930	21.3	-1.0	3.0	-2.8	5.8
1931	22.1	-5.0	6.0	-4.3	10.3
1932	19.9	0.4	2.0	-2.6	4.6
1933	16.7	3.3	2.0	-2.1	4.1