14.02 Principles of Macroeconomics

Problem Set 2

Fall 2017

1 Question 1: Money Demand (Lecture 4)

Suppose there are only two assets in the economy, money and bonds. We assume the people's money demand function is

$$M^d = \$Y \times (a - i), \tag{1}$$

where $\$Y$ is nominal GDP, $a > 0$ is a parameter, and $i \geq 0$ is the interest rate.

(a). Central Bank Controlling Money Supply

Suppose the central bank controls money supply.

1. Explain in words the benefit and the cost of holding money instead of bonds. Why is money demand (1) decreasing in interest rate?

2. Suppose the nominal GDP is \$10,000, and $a = 0.2$. When the central bank supplies $\$1,500$ amount money, what is the equilibrium interest rate?

3. There is a bond which pays you \$240 tomorrow. What is the price of bond under the nominal interest rate of $i = 0.2$.

(b). Central Bank Controlling Interest Rate

Now suppose the central bank controls the interest rate.

4. Assume the nominal GDP is \$10,000, and $a = 0.2$. Suppose the central bank sets $i = 0.08$. How much money does the central bank need to supply in order to achieve this?

2 Question 2: IS-LM Model (Lecture 5)

Consider the following linear version of IS-LM model. Consumption function is given by

$$C = c_0 + c_1(Y - T), \tag{2}$$

where $c_0 > 0$, $0 < c_1 < 1$, Y is income, and T is taxes. Investment function is assumed to be

$$I = b_0 + b_1 Y - b_2 i, \tag{3}$$

where $b_0 > 0$, $b_1 > 0$, $b_2 > 0$, and i is the nominal interest rate. Also assume $c_1 + b_1 < 1$. The demand for goods is given by

$$Z = C + I + G.$$

Assume G is exogenous.

(a) Equilibrium in Goods Market

1. Explain intuitively why it is reasonable to assume investment negatively depends on interest rate.

2. Using equilibrium condition, $Y = Z$, derive the mathematical expression for equilibrium output for a given interest rate, i. Explain also graphically how the equilibrium output is determined.

3. What is the government spending multiplier in this economy for a given interest rate, i? (That is, how much does the equilibrium output change in response to an increase in G?). Is the government spending multiplier lager than the case where investment is exogenous, $I = \bar{I}$? Why or why not?

(b) IS-LM Analysis

Assume that central bank chooses interest rate. Therefore the LM curve is given by $i = \bar{i}$.

4. Draw IS-LM diagram (take i on y axis, and Y on x axis), and explain how the equilibrium output is determined. What is the slope of IS curve?

5. How much does the equilibrium output change in response to a unit increase in $\bar{i}$? Explain using both math and diagram.

6. Suppose consumers all decides to save more because they start to worry about the future. We capture this by a fall in c_0. Suppose there is no policy responses. Explain what happens to equilibrium output using both math and IS-LM diagram. Are consumers able to save more in equilibrium? (That is, how much does the private saving, $S = Y - T - C$, respond in response to a unit decrease in c_0?)

7. Consider the situation in 7. This time, the central bank responds by changing interest rate, i, in order to keep the output at the same level. In response to a fall in c_0, how much does the central bank need to change i? Explain using both math and IS-LM diagram. In this case, how much are consumers able to save more in response to a unit decrease in c_0 in equilibrium? (**Hint**: Use the relationship that you derived in 4 and 5, and see how much the central bank needs to change $\bar{i}$ in order to keep Y same.)

8. Consider the situation in 7. This time, the government chooses G in order to keep the output at the same level. In response to a fall in c_0, how much does the government need to adjust G? Explain using both math and IS-LM diagram.

9. Consider the situation in 7, where there is a unit fall in c_0. Also suppose i and G are fixed. Suppose the equilibrium condition for financial market is given by

$$\frac{M}{P} = Y(a_0 - a_1 i),$$

where $a_0 > 0$, $a_1 > 0$, M/P is the real money supply, and the right hand side is the real money demand. How much does the equilibrium real money supply change in response to a unit decrease in c_0?

(c) IS-LM Model and Facts

10. IS-LM model predicts that an increase in interest rate decreases output. We want to see whether this prediction fits the fact. The following figure plots the quarterly real GDP growth rate over 1970-2017 on y axis, and the quarterly changes in federal funds rate (nominal interest rate) on x axis. They are positively related.

Based on this figure, suppose someone claims "IS-LM model is completely wrong because in the data, as the nominal interest rate goes up, output increases!" How would you react to this claim? (**Hint:** when or why does the central bank increase (or decrease) the nominal interest rate in real world?)

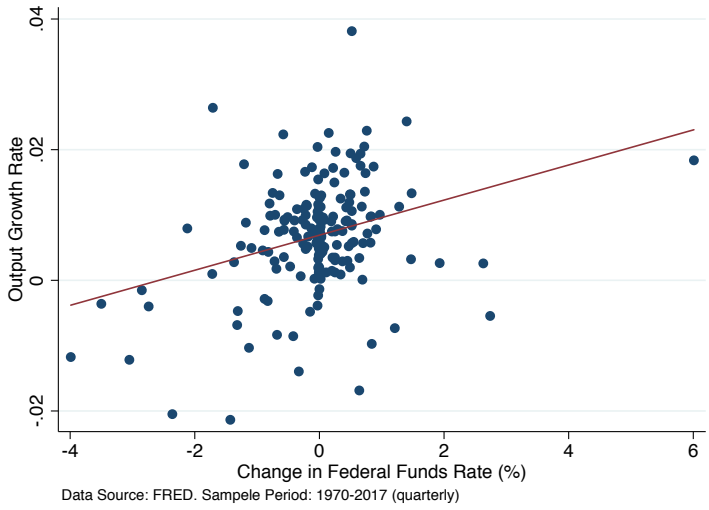

Figure 1: GDP Growth Rate and Changes in Federal Funds rate

3 Question 3: Extended IS-LM Model (Lecture 6)

(a) Nominal and Real Interest Rate and Risk Premium

Consider an economy with two assets, safe bonds and risky bonds. Safe bonds pay the nominal interest rate of i. Risky bonds default with probability p.

1. Suppose $i = 20\%$. If the price level today is \$200, and the expected price level tomorrow is \$240. What is the ex-ante real interest rate today?

2. Suppose $i = 5\%$ and $p = 25\%$. In order the risky bonds to deliver the same expected return as the safe bonds, what the risk premium, x, should be?

(b) Extended IS-LM Model

Consumption function is given by

$$C = c_0 + c_1 Y, \tag{4}$$

where $c_0 > 0$, $0 < c_1 < 1$, Y is income. Investment function is assumed to be

$$I = b_0 + b_1 Y - b_2(r + x), \tag{5}$$

where $b_0 \geq 0$, $b_1 > 0$, $b_2 > 0$, r is the real policy interest rate, x is the risk premium. Also assume $c_1 + b_1 < 1$. The demand for goods is given by

$$Z = C + I.$$

In this question, we are assuming there is no taxes or government expenditure for simplicity: $G = T = 0$.

The LM-curve is given by $r = \bar{r}$. Suppose $c_0 = 100$, $c_1 = 0.3$, $b_0 = 0, b_1 = 0.2, b_2 = 100$ and $x = 0.04$. The central bank sets the real policy rate at $\bar{r} = 0.1$.

3. Suppose x increase to 0.08. How much does the equilibrium output change? Explain also using IS-LM diagram.

4. In 4, now the central bank tries to undo the impact of risk premium change. How should the policy rate respond? Explain also using IS-LM diagram.

5. Currently the real policy rate, $\bar{r}$, is 10% and the risk premium is 4%. Risk premium changed to x', and the central bank is trying to undoes this, but faces the zero lower bound constraint on nominal interest rate, $i \geq 0$. The nominal interest rate and the real interest rate are related through $i = \bar{r} + \pi$, where π is inflation rate. Suppose $\pi = 2\%$. What is the level of x' that forces the zero lower bound to hit?

(c) Financial Intermediaries

6. Consider the following bank balance sheet:

Bank Balance Sheet

Assets	600	Liabilities	480
		Capital	120

What is the capital ratio and the leverage ratio of this bank?