# Diploma Macro, Problem set 2, question 1

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Consider the Bernanke-Blinder extension to the ISLM model. Banks are assumed to hold bonds B, loans L and reserves R as assets, and have deposits D as liabilities, so that the representative banks balance sheet is:

$$B + L + R = D$$

Reserves are equal to the legal minimum reserve requirement $R = \tau D$, where $\tau = 1/3$. This yields the supply of deposits in the money market:

$$D^s = 3R$$

The demand for deposits is given by the traditional money demand equation

$$D^d = Y - \frac{1}{2} i_B$$

where $Y$ is real aggregate output, $i_B$ the bond interest rate. The demand for loans is described by

$$L^d = Y - \frac{1}{4}(i_L - i_B)$$

where $i_L$ is the loan interest rate. The supply of loans is given by

$$L^s = \frac{3}{4}(D - R)$$

Goods market equilibrium is described by

$$Y = 60 - \frac{1}{4}(i_L + i_B)$$

(a) *Derive the equilibrium bond interest rate $i_B$ in the money market in terms of output $Y$ and reserves $R$, and the equilibrium loan interest rate $i_L$ in the loan market in terms of $Y$ , $R$ and $i_B$. Give an intuitive explanation.*

- The interest rate $i_b$ is determined in the money market: $D^s = D^d$. Using this, we

get

$$i_b = 2(Y - 3R) \tag{1}$$

Interpretation: $D^d$ we can see the transaction demand for money, i.e. higher Y generates higher demand. The supply is inelastic. This is the upward sloping LM curve. Note that demand for money *is not* affected by interest rate on loans, $i_l$. This is the case even in the Bernanke-Blinder paper.

- First note that $L^s = \frac{3}{2}R$, so the supply curve is a vertical line in $L \times i_l$ space. The demand is downward sloping (negative coefficient on $i_l$) and an increase in $Y$ and $i_b$ would shift the curve up ($Y$) and down ($i_b$). The first effect is caused by higher demand for credit with fixed amount of reserved (here completely exogenous and a monetary policy instrument). The second effect is caused by substitutability between credit and deposits.

  The increase of $i_l$ hence can be caused by both, an increase in $Y$ or by an increase in $i_b$. $i_l$ is endogenous here, so it does not make sense to look what *would be* the effect of a change in $i_l$ on other variables, the causality goes in the opposite direction.

  To get $i_l$, let's look at the equilibrium condition at the loans market $L^d = L^s$. Using this, we get

$$i_l = i_b + 2(2Y - 3R) \tag{2}$$

hence now we have $i_l = i_l(i_b, Y, R)$.

(b) *Derive output $Y$ in terms of $R$ and $i_B$ such that there is equilibrium in both the goods market and the loan market. Give an intuitive explanation.*

Let's find CC curve, i.e. $Y = Y(R, i_b)$. Use the IS curve (so far in terms $Y = Y(i_l, i_b)$) and plug in the result (2) (which is $i_l = i_l(i_b, Y, R)$) to obtain $Y = Y(i_l, i_b) = Y(i_l(i_b, Y, R), i_b) = Y(i_b, R)$. The result (solved for $i_b$) is

$$i_b = (120 + 3R) - 4Y \tag{3}$$

The CC curve is downward sloping.

On more conceptual level, in this model, IS curve is given as a mapping $i_b \times y_l \to Y$. At the same time, LM curve is just mapping between $i_b$ and $Y$ (think of $R$ as an exogenous parameter). To relate IS to LM, we need somehow *flatten* the $i_l$ dimension of IS. This is possible, because we know what $i_l$ has to be in order to get an equilibrium on the loans market (given $Y$ and $i_b$), see equation (2).

(c) *Suppose the central bank increases the level of reserves from $R = 10$ to $R' = 12$. Compute the initial and new equilibrium level of output $Y$ and the bond interest rate $i_B$. Illustrate the effect graphically and provide an economic explanation.*

The equilibrium is the point of intersection of LM and CC:

$$\begin{aligned} 2(Y - 3R) &= (120 + 3R) - 4Y \\ &\dots \\ Y &= \frac{3}{2}R + 20 \end{aligned} \tag{4}$$

(i) using $R = 10$ we get $Y = 35$ and $i_b = 10$

(ii) using $R = 12$ we get $Y = 38$ and $i_b = 4$

Hence the increase in the reserves increases output and decreases $i_b$.

(d) *Suppose that the central bank subsequently raises the required reserve ratio to $\tau = 1/2$ to address liquidity problems in the banking sector. Explain how this affects the equilibrium level of output $Y$ and the bond interest rate $i_B$. Provide a graphical illustration.*

Now $\tau = 1/2$. The LM curve can be written as

$$i_b = 2(Y - 2R) = \underbrace{2(Y - 3R)}_{original\,LM} + \underbrace{2R}_{shift}$$

so the effect of changing $\tau$ can be seen to shift the LM curve left/up.

Similarly, at the loans market,

$$i_l = i_b + 2(2Y - 3R) + 3R, \tag{5}$$

so the CC curve takes form of

$$i_b = \underbrace{(120 + 3R) - 4Y}_{original\,CC} - \underbrace{\frac{3}{2}R}_{shift}, \tag{6}$$

so CC curve shifts left/down.

Observing new CC and LM curves, the slopes are not affected, but the both curves are shifted. The new equilibrium has lower output, but the effect on $i_b$ depends on the relative size of the shifts (possible to compute analytically).