

Economics of Banking and Finance Markets
Prof. Sukumar Vellakkal
Department of Economic Sciences
Indian Institute of Technology, Kanpur

Lecture - 52
IS-LM Framework - II

Hi everyone. Welcome to this session. In the last session, we have derived the conditions for money market, where we have shown that when money demand is equal to exogenously determined money supply, then money market is in equilibrium. And accordingly, we have derived the LM schedule, where the LM schedule slopes upward from left to right.

(Refer Slide Time: 00:36)

Objectives

Two important questions: slope and position

- 1) What determines the value of the slope of the *LM* schedule?
- 2) What factors shift the schedule? (the position of the *LM* schedule)

On the vertical axis, we have measured the rate of interest, and on the X axis, that is the horizontal axis, we have measured the level of income. So, then in the previous class, we had discussed that when the income increases the rate of interest also must increase, so that money demand will be equal to money supply. So, in this session we will be discussing two key aspects, two important questions, one about the slope of the LM schedule, another is the position of the LM schedule.

So, we will be answering the following two questions. One is what determines the value of the slope of the LM schedule? And second one, subsequently we will be answering, what factors shift the schedule from left to right or right to left?

(Refer Slide Time: 01:37)

LM Schedule

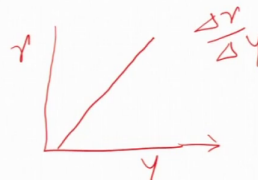
- The *LM* schedule slopes upward to the right.
- At higher levels of income, equilibrium in the money market occurs at higher interest rates.

Coming to the money market LM schedule, we have seen that the LM schedule slopes upward to the right, right. That means, at the higher levels of income equilibrium in the money market occurs only at higher interest rates.

(Refer Slide Time: 01:51)

LM equation

$$\bullet \quad \underline{M_o^s = M^d} = c_0 + \underline{c_1 Y} - \underline{c_2 r}$$
$$\bullet \quad \underline{M_o^s} = c_0 + c_1 Y - c_2 r$$



$$\bullet \quad r = \frac{c_0}{c_2} - \frac{M_o^s}{c_2} + \frac{c_1 Y}{c_2}$$

c_1 : income-induced change in money demand
 c_2 : interest elasticity of money demand

We have seen that the derivation; that means, money market equilibrium means money supply is equal to money demand. And money demand we have seen that one is $c_1 Y$ that is the income induced, the parameter c_1 denotes the income induced component of money

demand. That is part of income induced component of money demand. And c_2 that is positively related to the income, higher the income higher will be the demand for money.

The parameter c_2 denotes the interest elasticity part of money demand; that means, higher the rate of interest, lower will be the money demand because of the opportunity cost involved with the rate of interest. That means, higher the rate of interest means higher the opportunity cost of holding money or demanding money. So, that is negatively related.

So, at equilibrium point we can see that M_s is will be equal to M_d . So, rewriting this one, you already know that M_s is equal to M_d . So, let us take the M_d means this one, c_0 plus c_1Y minus c_2r . So, rewriting money supply M_0^s is equal to c_0 plus c_1Y minus c_2r . And this relationship is now very clear to you, I hope. Now, solving for r , the rate of interest, because we are looking for the slope of the LM curve; that means, on the LM curve we have drawn that rate of interest on the vertical axis Y axis and income on the X axis, right.

So, we know that we have drawn an LM curve, it slopes upward from left to right. So, if you want to know the slope, slope means slope of this diagram this curve is Δr divided by ΔY , that is the slope. So, solving it for r , you will get r is equal to c_0 by c_2 minus M_0^s divided by c_2 plus c_1Y divided c_2r .

So, in this it is already clear to you, c_1 means the income induced change in money demand. And c_2 is this one, the interest elasticity of money demand. So, a priori, based on the a priori assumption we know that c_1 has a positive sign, and parameter c_2 has a negative sign.

(Refer Slide Time: 04:41)

Slope of the LM schedule

- The slope of the LM schedule is the Δr (movement up the vertical axis in the LM graph) per unit ΔY (movement along the horizontal axis), holding constant the factors that fix the position of the schedule.
- From equation $r = \frac{c_0}{c_2} - \frac{M_0^s}{c_2} + \frac{c_1 Y}{c_2}$
- Computing this slope as $\frac{\Delta r}{\Delta Y}$ for fixed values of (c_0/c_2) and $(-\frac{M_0^s}{c_2})$, gives
- $\Delta r = \frac{c_1}{c_2} \Delta Y$
- Slope of LM = $\frac{\Delta r}{\Delta Y} = \frac{c_1}{c_2}$

Let us now see what are the factors that determine the slope of the LM schedule. The slope of the LM schedule is the Δr that is vertical axis in the LM graph per unit ΔY that is movement along the horizontal axis, holding constant the factors that fix the position of the schedule. So, we are looking for this one, that the slope of this curve. That means, the upward slope we have, and then further what determine this slope.

It can be this kind of slope, or it can be like this, or it can be like this. So, the slope it can be flatter, it can be steeper, it can be unitary elastic like that. So, what determines the slope of this LM schedule? So, this is LM, LM1, LM2 like that. So, what determines the slope of this LM curve? That is what we are going to look now.

From the equation, it is clear to you that the r is equal to c_0 by c_2 minus M_0^s divided by c_2 plus $c_1 Y$ divided $c_2 r$. So, from this, we can see that this part c_0 by c_2 minus M_0^s divided by c_2 is the intercept, this is the fixed position. The slope of this curve, slope of this curve is determined by the second component, that is this one, that means, $c_1 Y$ divided $c_2 r$, that determine the slope, here Y is the income, and here r is the rate of interest.

The slope of this curve, that is Δr divided by ΔY is determined by this one, this determined by $c_1 Y$ divided $c_2 r$. So, solving it for Δr , the computing the slope as Δr divided by ΔY for fixed values of c_0 by c_2 minus M_0^s divided by c_2 gives Δr is equal to c_1 divided c_2 times ΔY .

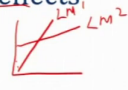
This is the slope of the LM curve is Δr divided by ΔY , can be slope can be measured as c_1 divided c_2 . So, slope of this LM curve that is slope means Δr divided by ΔY is equal to c_1 divided by c_2 . The parameter c_1 means the income-induced money demand and c_2 is the interest elasticity or interest rate-induced money demand.

So, the slope of LM curve is nothing, but the parameters of income induced money demand divided by interest rate induced money demand. That is the slope of the LM curve.

(Refer Slide Time: 08:16)

Factors That Determine the Slope of the LM Schedule

- The LM schedule is upward-sloping, but is it steep or relatively flat?
- The slope of the LM is important for policy effects.
- 2 important factors
 - i) income-induced change in money demand (c_1) ✓
 - ii) interest elasticity of money demand (c_2) ✓



What determines the slope of the LM schedule is already you got an idea; that means, one is c_1 and other one is c_2 . So, let us discuss this in detail. So, that the LM schedule is upward sloping, but is it steep or relatively flat? So, we can draw an LM schedule for example, like this that is this is steep, or this can be flat. So, we can draw like this LM1 is like that steep or LM 2 is flat. So, the question here: is it steep or relatively flat?

So, here the slope of the LM is important for policy effects as well. In the subsequent sessions, we will discuss why the slope of the LM is important for macroeconomic policy effects. So, there are two factors that determine the slope of the LM schedule. One is the income induced change in money demand that is one is c_1 and second one is interest elasticity of money demand.

(Refer Slide Time: 09:32)

c_1 : Income-induced increase in money demand
Higher the value of c_1 , the steeper will be the LM schedule

- Higher the value of c_1 , the larger the increase in money demand per unit increase in income, and hence, **the larger the upward adjustment in the interest rate required to restore total money demand** to the level of the fixed money supply.
- The value of c_1 is not a subject of much debate.
- Controversy on this subject centers on c_2 that determines the slope of the LM schedule.

So, let us discuss both in detail. If income induced increase in money demand, assuming higher value and lower value for income induced money demand, that is the assuming high value for c_1 or low value for c_1 . Let us see how LM curve looks like. What will be the slope of LM curve? So, if higher the value of c_1 , we can see that steeper will be the LM schedule.

So, that means, higher the value of c_1 larger the increase in money demand per unit increase in income, and hence the larger the upward adjustment in the interest rate required to restore total money demand to the level of the fixed money supply. So, what we have seen in the previous session that when income increases; that means, the GDP increases, to restore money market equilibrium, to restore money demand is equal to money supply that is the equilibrium, the interest rate must increase. So, the interest rate must increase, that is why we are getting an upward sloping LM curve.

So, suppose when we are having a high value of c_1 ; that means, the income induced demand for money demand is high; that means, larger the increase in money demand per unit increase in income. Or, that means, a small increase in income leads to high demand for money, then you can see that a larger upward adjustment in interest rate is required to restore total money supply.

Because the essential condition here is that interest rate must be raised, then only money demand will be equal to money supply. So, here the thing is that accordingly you can say that larger c_1 require a larger upward adjustment in the interest rate to restore total money demand

to the level of fixed money supply. The value of c_1 is not a subject of much debate. The controversy on this subject centred on c_2 , that determines the slope of the LM schedule.

(Refer Slide Time: 12:12)

interest elasticity

c_2

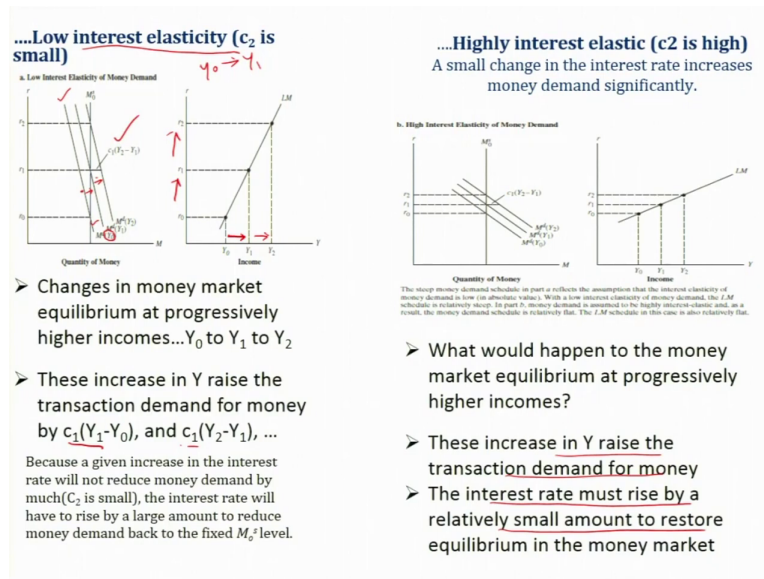
For a given income-induced increase in money demand (a given c_1), the amount by which the interest rate has to rise to restore total money demand to the value of the fixed money supply depends on *how elastic (sensitive) money demand is with respect to changes in the rate of interest (c_2r)*.

$$-c_2r = \Delta M^d / \Delta r$$

Another thing, for a given income induced increase in money demand; that means, for a given c_1 , the amount by which interest rate must rise to restore total money demand to the value of the fixed money supply also depends on how elastic money demand, how sensitive is the money demand with respect to changes in the rate of interest. That means, that we are now talking about c_2 .

So, for a given income induced increase in money demand, the amount by which the interest rate must rise to restore total money demand to the value of the fixed money supply depends on how elastic or sensitive the money demand is with respect to the changes in the rate of interest. So, minus c_2r is equal to $\Delta M^d / \Delta r$.

(Refer Slide Time: 13:09)



Now, the relationship between the interest elasticity of money demand and the slope of a LM curve, let us discuss by considering two cases. One is low interest elasticity. We assume that the parameter c_2 is high. So, what does it mean that the parameter c_2 is high?

Look at this figure, the first diagram that is Md. Md when the income level is Y_0 when the income level is Y_0 , this is the money demand curve. This is the money demand curve when the income is Y_0 .

Suppose there is an increase in income, what if income increases from Y_0 to Y_1 . When income increases from Y_0 to Y_1 , we have seen in the previous sessions that the money demand curve will be shifting right wards. And the slope of this money demand curve, you look at this one, this we have seen that low interest elasticity, low interest elasticity means it is steeper.

That means, when income increases, as a result because the interest elasticity is very small, when the interest elasticity is small, the adjustment in money demand to restore the equilibrium in the money market requires a large increase in rate of interest. Because the sensitivity of the interest the demand for money with respect to interest rate is very low.

So, what we can see here is that when income increases from Y_0 to Y_1 , we know that the rate of interest must increase.

The intuition here is we have seen in the previous sessions that when rate of interest increases, the opportunity cost of demanding money decreases. That means, people demanding money for transaction purpose decrease. High rate of interest discourages the transaction demand for money, so that the money demand will be equal the fixed money supply.

When income increases, they need more money. But since the money supply is already fixed, we can see that the high rate of interest discourages people in demanding more money, in proportion to increase income. It discourages them, and so that they will be demanding money the at the initial level. So, that money demand is equal to money supply.

We know that increase in rate of interest is essential in the money demand, but when the money demand sensitivity to rate of interest is very low; that means, a small change in income leads to more money demand.

But since the interest rate sensitivity of money demand is very small, we need a large increase in rate of interest. So, that the opportunity cost is so high, so that it will discourage them, it will discourage people in demanding money because of the very high opportunity cost. So, the equilibrium can be restored at the initial position.

Since the interest elasticity is very small, due to increase in income the money demand will increase. But a large change in the rate of interest is required to ensure that money demand is restored to the initial equilibrium position. So, changes in money market equilibrium at progressively higher income, you can see the curve will be shifting rightwards.

So, similarly we can see that rate of interest also increases. What we can see that this increase in Y raise the transaction demand for money by this one. So, you can see this is the increase in money demand. But because the given increase in the interest rate will not reduce money demand by much, because c_2 is small, the interest rate will have to rise by a large amount to reduce money demand back to the fixed money supply level. This is the case when the interest elasticity, that is c_2 is very small.

Let us take another case, the contrasting case where high interest elasticity; that means, c_2 is high. So, here what we can see that again the same example we can repeat here, that means, income increases from Y_0 to Y_1 , Y_1 to Y_2 and you know that since the money supply is fixed, when income increases money demand also increases. Since the elasticity is very high,

a small increase in rate of interest is sufficient to reduce the money demand. That means, the interest elasticity is very high.

That means, here you can see that when income increases from Y_0 to Y_1 , Y_1 to Y_2 , we know that demand for money increases. But this increase in Y raise the transaction demand for money, but the interest rate must rise by a relatively small amount to restore equilibrium in the money market because that opportunity cost idea works well here. Because the interest elasticity is very high when income increases obviously, people demand more money.

But since the elasticity is very high, a small rise in rate of interest is sufficient to restore equilibrium in the money market. That means, to reduce money demand because, as I said many times, money supply is already fixed, so the money demand should be equal to that fixed money supply. So, here when elasticity is very high, the high rate of interest reduces money demand, then finally, equilibrium will be restored.

Since elasticity is very high, a small rise in rate of interest is sufficient to restore money market equilibrium, that is money demand equal to money supply.

(Refer Slide Time: 20:17)

Relative values of C_1 and C_2

- Slope of $LM = \frac{\Delta r}{\Delta Y} = \frac{C_1}{C_2}$ ✓
- If the expression for the slope of the LM schedule ($\frac{C_1}{C_2}$) is large, then the schedule will be steep.
- This means that the more money demand increases per unit increase in income (the higher C_1) and the *less* sensitive money demand is to the interest rate (the lower C_2), the steeper will be the *LM* schedule.

- In contrast, if the expression for the slope of the schedule is small, then the schedule will be flat.

The slope of LM, we have seen, Δr by ΔY is equal to C_1 by C_2 . So, in the expression for the slope of the LM schedule if C_1 is large, then the schedule will be steep. So, this means that money demand increases per unit increase in income, that means, higher C_1 and the less

sensitive money demand is to interest rate; that means, the lower value of c_2 the steeper will be the LM schedule.

So, in contrast, if the expression for the slope of the schedule is small, then the schedule will be flat.

(Refer Slide Time: 21:06)

Two extreme cases of the slope

- $C_2 = 0$
- Then $M^d = c_0 + c_1 Y$
- $M_o^s = c_0 + c_1 Y$

Consequently, with the money supply fixed at for equilibrium, we must have

$$Y = (M_o^s - c_0) / c_1$$

Only one level of income can be an equi level of income for M market

- When $C_2 = 0$, it's a *classical case* because the Keynesian money demand function not differ substantively from the classical money demand function. As in the classical theory, money demand depends only on income.
- (The distinguishing feature of the Keynesian theory of money demand is the negative relationship between money demand and the interest rate.)

So, let us now, examine two extreme cases, two extreme cases of this slope.

In the previous session, we have taken the slope, one is steep, and another is flat. Steeper means inelastic, the flat means elastic. But we are going to make it steeper to take the more extreme case; let us make it vertical.

Other one is elastic, increase the elasticity further and make it perfectly elastic; that means, flat, it becomes more and more flat means this become horizontal, fully horizontal.

In the first case, what if c_2 is 0? That means, interest elasticity is 0; that means, the money demand is completely insensitive to rate of interest.

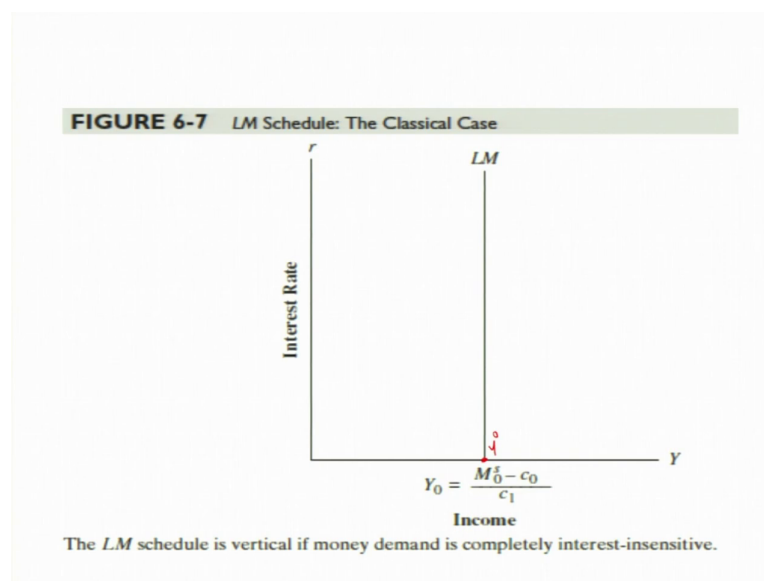
So, in this case, we can see that M^d , then in that case money demand is going to be a function of c_0 plus $c_1 Y$. Because we already assume that c_2 is equal to 0, that means, that is not part of the function anymore. So, in that way, the money demand replacing money demand is equal to c_0 plus $c_1 Y$. We can rewrite the equation as M_o^s money supply is equal to c_0 plus $c_1 Y$.

So, consequently with the money supply fixed at equilibrium, we must have Y is equal to M_0^s minus c_0 divided by c_1 . So, what we can see here is that only one level of income can be the equilibrium level for the money market equilibrium.

So, when c_2 is 0, so we can see that it is a kind of a classical economics case because Keynesian money demand function not differ substantively from the classical money demand function. Because as in the classical economic theory, money demand solely depends only on income. The classical economists did not consider money demand as a function of rate of interest because, for them, money demand is depending only on income.

So, the distinguishing feature of the Keynesian theory of money demand is that a negative relationship between money demand and interest rate. So, according to Keynes, money demand is a is negatively related to rate of interest and positively related to income.

(Refer Slide Time: 24:03)



So, in this case, the LM schedule would look like this. That means, there is only one level of income, that is this one. This is the Y_0 income, that Y_0 level of income is equal to money supply minus that is c_0 divided by c_1 . So, in this case, we can see that LM schedule is vertical if money demand is completely interest insensitive, that means, c_2 is equal to 0.

(Refer Slide Time: 20:45)

When C_2 is extremely large...approaching infinity

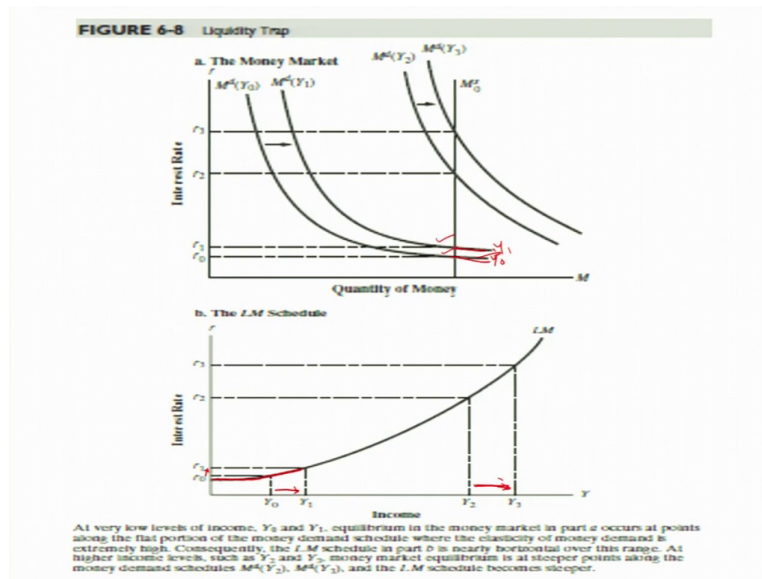
- *The liquidity trap*
- Keynes's theory of the speculative demand for money: expected increase in interest rate ✓
- The expected future capital losses outweighing the small interest earnings on bonds, the public would hold any increase in money balances with only a negligible fall in the interest rate.
- In this range of the money demand schedule, the interest elasticity of money demand becomes extremely high.

Let us now, look at the alternative case when the interest elasticity of money demand become extremely large, approaching infinity. So, what caused this? So, that means, c_2 is extremely large, that means, approaching infinity. So, our question what causes this? What we can see here is that especially this point we have seen that the c_2 is very high, especially at liquidity trap.

Especially, when we discuss the speculative demand for money where we have seen that the interest rate becomes very low relative to what is considered normal, particularly a consensus develop considering future interest rate increase as likely. The Keynesian theory of speculative demand for money was based on the expected increase in interest rate.

When the expected future capital losses outweighing the small interest earnings on bonds, the public would hold any increase in money balance with only a negligible fall in the interest rate. So, in this range of money demand schedule, the interest elasticity of money demand becomes extremely high, it becomes extremely high here.

(Refer Slide Time: 26:03)



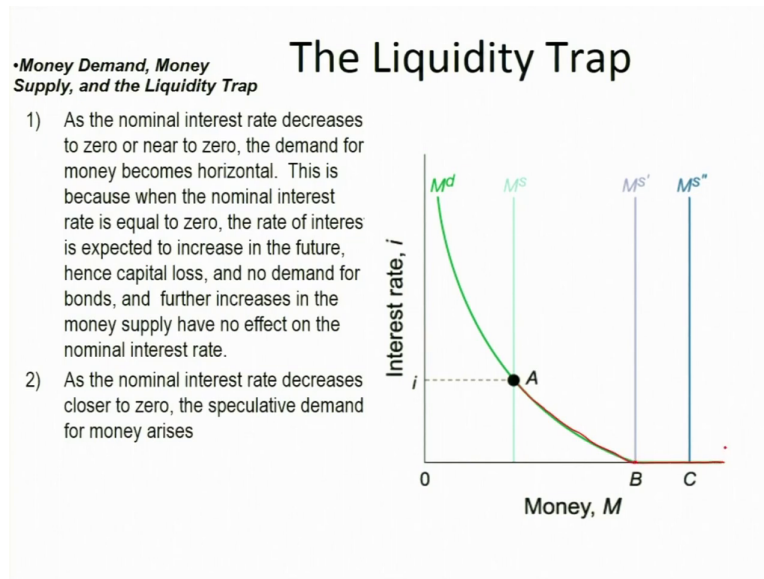
So, then we draw the LM curve using a high interest rate elasticity; that means, perfectly interest elastic, we can see that the LM curve looks like a liquidity trap. So, Keynes termed this is a liquidity trap, at this low level of income. The money demand curve becomes perfectly elastic in this point. It is very flat.

So, converting this one into a schedule, at the very low level of income, at these low-income levels with the money supply at M_0^s , the equilibrium interest rate is also so low that we are on the flat portion of the money demand schedule.

So, within this range, a rise in income that is from Y_0 to Y_1 , we can see here that a small rise in income from Y_0 to Y_1 requires only a slight rise in rate of interest. So, look at here. So, from r_0 to r_1 , for the money market equilibrium only a slight rise in interest rate is required to restore equilibrium in the money market. So, that money demand is highly responsive to changes in the interest rate.

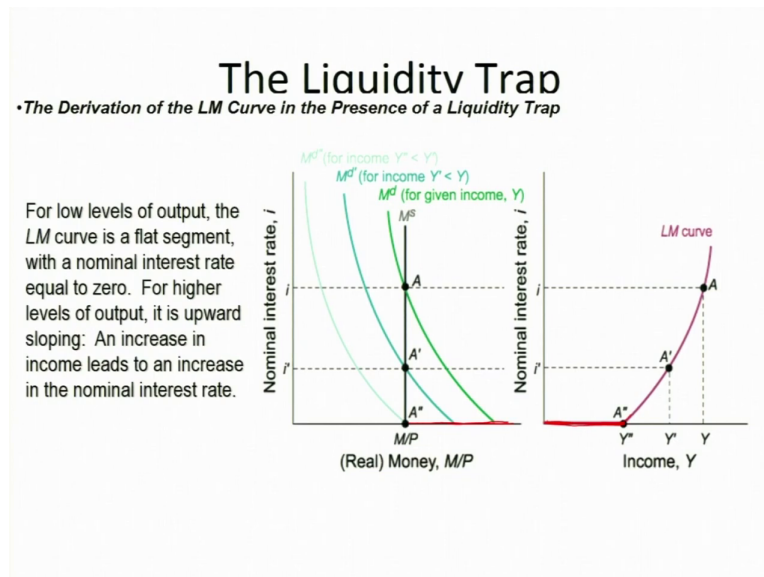
So, here in this place, here in this distance we can see that the LM schedule is nearly flat, LM schedule is nearly horizontal. Now, look at Y_2 , at this point at the higher levels of income Y_2 to Y_3 that is a normal period, increase in income would require a large increase in the interest rate to restore equilibrium in the money market. So, here the equilibrium interest rates are such that we are not in the liquidity trap here.

(Refer Slide Time: 28:18)



The liquidity trap looks like this. This is what we have seen in the previous sessions, the money demand after a certain point, the money demand become perfectly elastic.

(Refer Slide Time: 28:35)



Then, converting this one into a curve, we can see that the low level of income. That means, here when it becomes perfectly elastic in the money demand that part when we convert this one to LM curve; that means, the Y on the X axis and rate of interest on the Y axis LM curve would look like this. So, during recessionary time according to Keynes, Keynesian

economics, the LM curve is going to be perfectly elastic, this horizontal slope and afterwards it becomes slopping upwards.

When the economy is at a liquidity trap, increase in money supply is not going to make any impact in the economy. Formally, (Refer Time: 29:30) monetary policy is not going to make any impact. Let me stop here. In the next session, let us discuss what are the factors that shift the LM schedule.

Thank you. And see you in the next session.

Keywords: LM schedule, slope, position, income elasticity of money demand, interest elasticity of money demand, liquidity trap, perfectly elastic, perfectly inelastic, steep LM curve, flat LM curve