

Lecture 15: The LM Curve

I. OVERVIEW

- In the last lecture, we derived the IS curve, the first part of the model of economic fluctuations known as the IS-LM model. The IS Curve summarized all the combinations of interest rates and GDP that clear the market for goods and services in the economy.
- However, keep in mind that ANY point along the IS curve is consistent with equilibrium in the market for goods and services; the IS curve by itself cannot give us the value of output in the economy because it does not have anything to say about the level of interest rates in the economy.
- In today's class completed our development of the IS-LM model by looking at the LM curve, a relationship that describes the behavior of the money market, which determines interest rates in the economy.

II. THE LM (Liquidity Preference = Money Demand) CURVE

- What is referred to as money in this section is currency (coins and dollar bills) issued by the Federal Reserve and checking account balances held in banks by the public and by firms.
- To simplify things, we assume that money does not pay interest and that all other non-monetary financial assets (savings accounts, certificates of deposits, bonds, money market accounts) pay an interest rate of r .
- The LM curve consists of the combinations of income and interest rates that clear the market for money balances (i.e. equate money demand and money supply). In order to identify the combinations of Y and r that make up the LM curve, we first look at the demand for money.
- We can express the demand for money, as a function of the interest rate on financial assets r , prices P and income Y .

$$M^d = f \left(\begin{array}{c} Y \quad P \quad r \\ (+), (+), (-) \end{array} \right)$$

- The intuition for this function is as follows.
 1. When r is high, the demand for money is low because money pays no interest - the opportunity cost of holding money instead of other financial assets rises.
 2. When Y is high the demand for money is high, richer people who buy more goods are likely to hold more money.
 3. When prices P are high the demand for money is high since people need more money to complete their transactions.
- NOTE: The appropriate interest rate here is the nominal interest rate, the actual interest rate paid to the holders of financial assets.

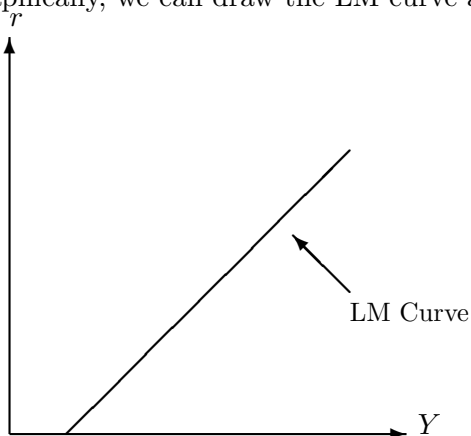
- If we use i to denote the nominal interest rate, the relationship between the real and nominal interest rates can be expressed as $i = r + \text{Expected rate of inflation}$. Since the IS-LM model is a short run model that works with an exogenous fixed price level (\bar{P}) so expected inflation can be thought of as being insignificant, in which case $i \approx r$
- A simple algebraic form would be $M^d = \bar{P}(\bar{M}^d + kY - hr)$ where k and h are parameters that denote how sensitive money demand is to GDP (income) and to the interest rate respectively. We also acknowledge that money demand can be affected by other factors (the introduction of ATM's for example): the term \bar{M}^d represents exogenous changes to money demand, perhaps driven by these other factors.
- Price enters multiplicatively into the above money demand function because all else equal a doubling of the price level will require us to hold twice as much money to buy the same amount of goods and services.
- We assume that the supply of money is exogenously set by the Federal Reserve. Let the exogenous money supply be denoted by \bar{M}^s .
- In equilibrium, money supply = money demand. The LM curve can therefore be written as $M^s = M^d$, which is equivalent to

$$\bar{M}^s = \bar{P} [\bar{M}^d + kY - hr]$$

- We can rewrite this as an upward sloping (positive) relationship between r and Y as

$$r = \frac{1}{h} \left[\bar{M}^d - \frac{\bar{M}^s}{\bar{P}} \right] + \left(\frac{k}{h} \right) Y$$

- Intuitively we can explain the upward sloping LM curve as follows: If income is high then the demand for money will be high relative to the fixed supply. In order to equilibrate money demand and money supply, interest rates have to also be high to reduce money demand.
- Similarly, if income is low, then the demand for money will be low relative to the fixed supply. In order to equilibrate money demand and money supply, interest rates have to be low to increase money demand.
- Graphically, we can draw the LM curve as



III. THE SLOPE AND INTERCEPT OF THE LM CURVE

The Slope

- The slope of the LM Curve is

$$\frac{\partial r}{\partial Y} = \frac{k}{h}$$

- The LM curve is steep when the absolute value of the slope is large. This occurs when
 1. The parameter k is large.
 2. The parameter h is small.
- What is the intuition for these results? Well, a steep LM curve means that a given increase in Y requires a large increase in interest rates to equilibrate the money market. A high value of k means that money demand increases dramatically when Y increases by a given amount. This requires a large increase in interest rates to restore equilibrium.
- Similarly, a low value of h means that money demand does not respond very much to interest rates. This implies that for any increase in money demand driven by an increase in Y , interest rates have to increase dramatically to restore equilibrium.

The Intercepts

- The intercept of the LM curve can be found by setting $Y = 0$ as

$$r = \frac{1}{h} \left[\bar{M}^d - \frac{\bar{M}^s}{\bar{P}} \right]$$

- The horizontal intercept of the LM curve can be found by setting $r = 0$. This can be calculated as

$$Y = \frac{1}{k} \left[\frac{\bar{M}^s}{\bar{P}} - \bar{M}^d \right]$$

- However, keep in mind that neither the interest rate nor the output level can be negative, so the LM curve will only be defined in the northwest quadrant.
- These are not particularly intuitive and for the most part, we will almost never use the exact values in our analysis once we figure out what causes the intercepts to change.

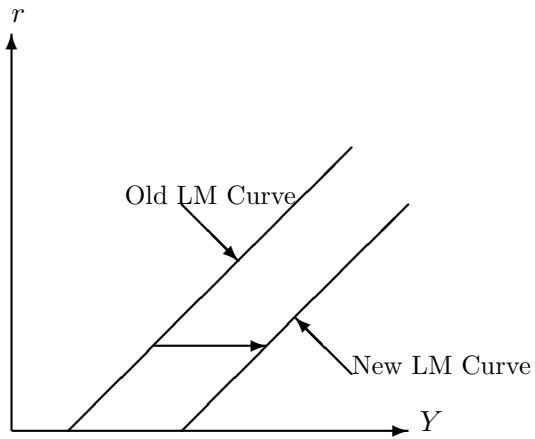
IV. SHIFTS IN VS. MOVEMENTS ALONG THE LM CURVE

- The other important thing to note is that changes in money demand brought about by changes in Y or by changes in r are reflected as movements along the LM curve. When income decreases, money demand falls and as a result interest rates must decrease to restore money market equilibrium. When income increases, money demand rises and as a result interest rates must increase to restore money market equilibrium.
- What causes the LM curve to shift? The intercepts are $r = \frac{1}{h} \left[\bar{M}^d - \frac{\bar{M}^s}{\bar{P}} \right]$ and $Y = \frac{1}{k} \left[\frac{\bar{M}^s}{\bar{P}} - \bar{M}^d \right]$. So there are three factors, money supply (\bar{M}^s), exogenous money demand (\bar{M}^d) and price \bar{P} , that shift the LM curve.

1. If the Fed **increases** the money supply (expansionary monetary policy) then from the equation we can see that the vertical (r) intercept will be lower and the horizontal (Y) intercept will be larger, i.e. the LM curve shifts **out** (to the right).
 2. Conversely, if the Fed **decreases** the money supply (contractionary monetary policy), then we can see that the vertical (r) intercept term will be higher and the horizontal (Y) intercept will be smaller- the LM curve shifts **in** (to the left).
 3. Since \bar{P} appears in the denominator of the $\frac{\bar{M}^s}{\bar{P}}$ term above, you can see that an **increase** in the price level has the same effect as a **decrease** in the money supply - it shifts the LM curve **in** (to the left). Conversely, a **decrease** in the price level has the same effect as an **increase** in the money supply - it shifts the LM curve **out** (to the right).
 4. Exogenous increases in the demand for money have the opposite impact from increases in the supply of money. From the above equation, we can see that an **increase** in exogenous money demand raises the vertical intercept and makes the horizontal intercept smaller: the LM curve shifts **in** (to the left). Conversely exogenous **decreases** in the demand for money lowers the vertical intercept and makes the horizontal intercept larger: the LM curve shifts **out** (to the right).
- Once again keeping track of the math can be tedious so its best to seek intuitive explanations. The basic intuition is that the movement of interest rates depends on the relationship between money demand and money supply.
 - Exogenous changes that bring about **excess money demand**, i.e. drive money demand above money supply, cause interest rates to **rise** in order to lower money demand and equilibrate money demand and supply. The LM curve will shift **in**. These changes include a fall in money supply, a rise in prices or an increase in exogenous money demand.
 - Exogenous changes that bring about **excess money supply**, i.e. drive money supply above money demand cause interest rates to **fall** in order to raise money demand and equilibrate money demand and supply. The LM curve will shift **out**. These changes include an increase in money supply, a fall in prices or a decrease in exogenous money demand.
 - Another way of intuitively understanding the LM curve is as follows. When there is an excess supply of money, people are more likely to put the extra money into non monetary financial assets, so issuers of those assets can offer lower rates of interest yet still attract buyers.
 - Conversely, when there is an excess demand for money, people are less likely to put money into non monetary financial assets, so issuers of those assets must offer higher rates of interest to attract buyers.
 - A couple of graphical examples are provided below.

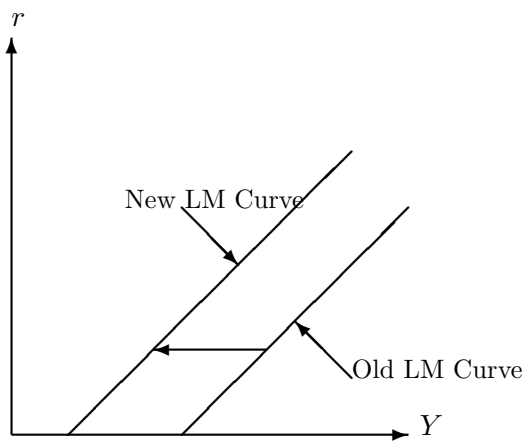
EXAMPLE 1

- An increase in the supply of money by the Fed $\bar{M}^s \uparrow$ will result in an excess supply of money. This will cause the LM curve to shift outwards in order to restore equilibrium.



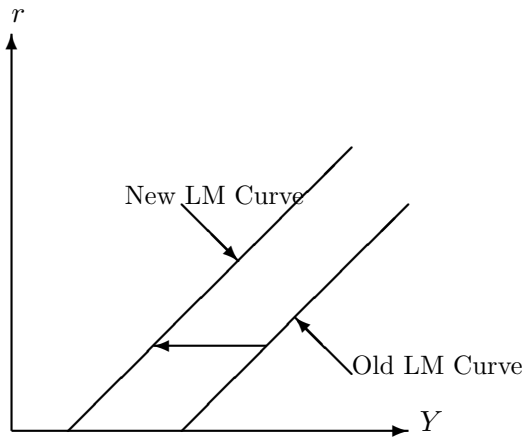
EXAMPLE 2

- A decrease in the supply of money by the Fed $\bar{M}^s \downarrow$ will result in an excess demand for money. This will cause the LM curve to shift inwards in order to restore equilibrium.



EXAMPLE 3

- An increase in the price level will raise money demand and result in an excess demand for money. This will cause the LM curve to shift inwards to restore equilibrium.



EXAMPLE 4

- A decrease in the price level will lower money demand and result in an excess supply of money. This will push interest rates down for any level of Y . This will cause the LM curve to shift outwards.

