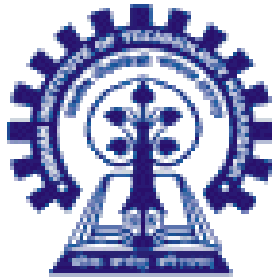


# IS-LM Model

## Macroeconomics II



# IS-LM Model

- Keynesian cross model treats investment as autonomous or as dependent merely on income.
- For the rational behavior of the firms, planned investment varies inversely with the real interest rate.
- **Reasons**
  - Rise in  $r$  makes investment in plant and machinery becomes less attractive as the cost of the borrowing rises
  - If internal funds are utilized, investment in plant and machinery becomes less attractive, as higher interest rates push up the earnings on competing financial investment (lending)
  - A rise in  $r$  makes the number eligible investment projects ( $NPV > 0$ ) to fall.

# Present value of an Income Stream

- The *present value (PV)* of Re. 1 available in n years time = Rs.  $1 / (1 + r)^n$ . The expression  $1 / (1 + r)^n$  is the *discount factor* for period n.
- The PV of an income stream of (Rs.) R1 in period 1, R2 in period 2, ... Rn in period n is:

$$PV = \frac{R1}{1 + r} + \frac{R2}{(1 + r)^2} + \dots + \frac{Rn}{(1 + r)^n}$$

- PV is inversely related with r.
- If an investment project generates cash flows per period over a known and fixed lifetime. The cost is incurred in the current period. In order to decide whether to accept or reject a project the *NPV has to be positive* (where,  $NPV = PV - Co$ ).

# Continued...

- With the recognition that interest rate is important in investment function, the IS-LM model comes into existence.
- This involves introduction of two markets:
  - Good Market
  - Money Market

# Description of the Model: Fixed Price Model

- John R Hicks transformed the Keynesian model into simultaneous equation model (IS-LM)
- In this case, two conditions are considered:
  - Fixed price
  - A closed economy

# Good Market Equilibrium: IS Curve

$$\text{Consumption function, } C = C_0 + b(Y - T_0) \quad (1)$$

$$\text{Investment Function, } I = I_0 - dr \quad (2)$$

$$\text{Equilibrium Condition } Y = C + I + G_0 \quad (3)$$

To present it in  $S = I$  form

$$S = s(Y) \quad (i)$$

$$I = i(r) \quad (ii)$$

$$\text{Equilibrium Condition } S = I \quad (iii)$$

- The goods market has three equations and four unknowns: C, I, Y and r

# Cont....

- Substituting Equation (1) and (2) in (3) we get,

$$Y = \frac{1}{(1-b)} (C_0 - bT_0 + I_0 + G_0) - \left(\frac{d}{1-b}\right) r$$

Or  $Y = KA_0 - dKr$  (IS Equation) (4)

Where,  $K = \text{Multiplier}$

$A_0 = C_0 - bT_0 + I_0 + G_0$  autonomous expenditure

- Equation for IS curve shows the locus of all combinations of income and interest rate at which  $S = I$
- Interpreting it**
- $Y - C = I + G_0$  (where  $Y - C$  is the unconsumed income which may be used for paying taxes and household saving)

$$S_h + T = I + G_0$$

- As  $T - G_0$  is government saving ( $S_g$ )

$$S_h + T - G_0 = I$$

Or  $S_h + S_g = I$

Or  $S = I$

# Money Market Equilibrium: LM Curve

- Based on the Keynesian Liquidity Preference Theory

## Motives for Holding Money

- Money is demanded not only for carrying out transactions but also as a store of value.
- Hence people demand money for two purposes
  - Transaction demand for Money ( $M_t$ )
  - Speculative Demand for Money ( $M_{sp}$ )

$$M_t = ePY$$

$$M_{sp} = fr$$

- Speculation refers to the expectations regarding the price of the bonds.
- Changes in these expectations induce shifting the wealth between bond and real balances (money)
- Expectations are determined by current rate of interest.
- If  $r$  is high, it would be expected to fall (bond prices to rise), the bond holders would like to hold more bonds to reap the benefit of the capital gain, hence the demand for money will be low.
- If  $r$  is low, the demand for money will rise.
- Hence,  $M_{sp}$  is inversely related to  $r$ .
- In the absence of speculative motive, a high  $r$  also implies that one foregoes a lot of interest income by holding money instead of interest bearing assets.



# Cont...

- Hence, the demand for real money balances varies directly with the real income and inversely with the rate of interest.

$$\frac{L}{p} = eY - fr \quad (5)$$

- ✓ where  $L$  = nominal amount of money demanded (liquidity demand)
- ✓  $e, f$  = parameters denoting sensitiveness of the money demand to changes in income and interest rate, respectively.
- Equilibrium,  $L = M_0$  (6)
- ✓ where  $M_0$  is the Money Supply.
- Money market has two equations (5, 6) and three endogenous variables ( $L, Y, r$ )

- Solution of equation (5) and (6)

$$Y = \frac{1}{e} \left( \frac{Mo}{P} \right) + \left( \frac{f}{e} \right) r \quad \text{(LM equation)} \quad (7)$$

- LM curve shows the combinations of money income and interest rate at which money market is in equilibrium.
- Solving for r, (from equations 4 and 7)

$$r = \frac{e}{f} \left[ Y - \frac{1}{e} \left( \frac{Mo}{P} \right) \right]$$

- Substituting the value of r in Equation 4,

$$Y = kAo - dk \left[ y - \frac{1}{e} \left( \frac{Mo}{p} \right) \right] \left[ \frac{e}{f} \right]$$

$$\text{or } Y \left[ 1 + \frac{deK}{f} \right] = k \left[ Ao + \frac{d}{f} \left( \frac{Mo}{p} \right) \right]$$

Dividing both the sides with K we get,

$$Y = \frac{Ao + \frac{d}{f} \left( \frac{Mo}{P} \right)}{\frac{1}{k} + \frac{de}{f}} \quad (8)$$

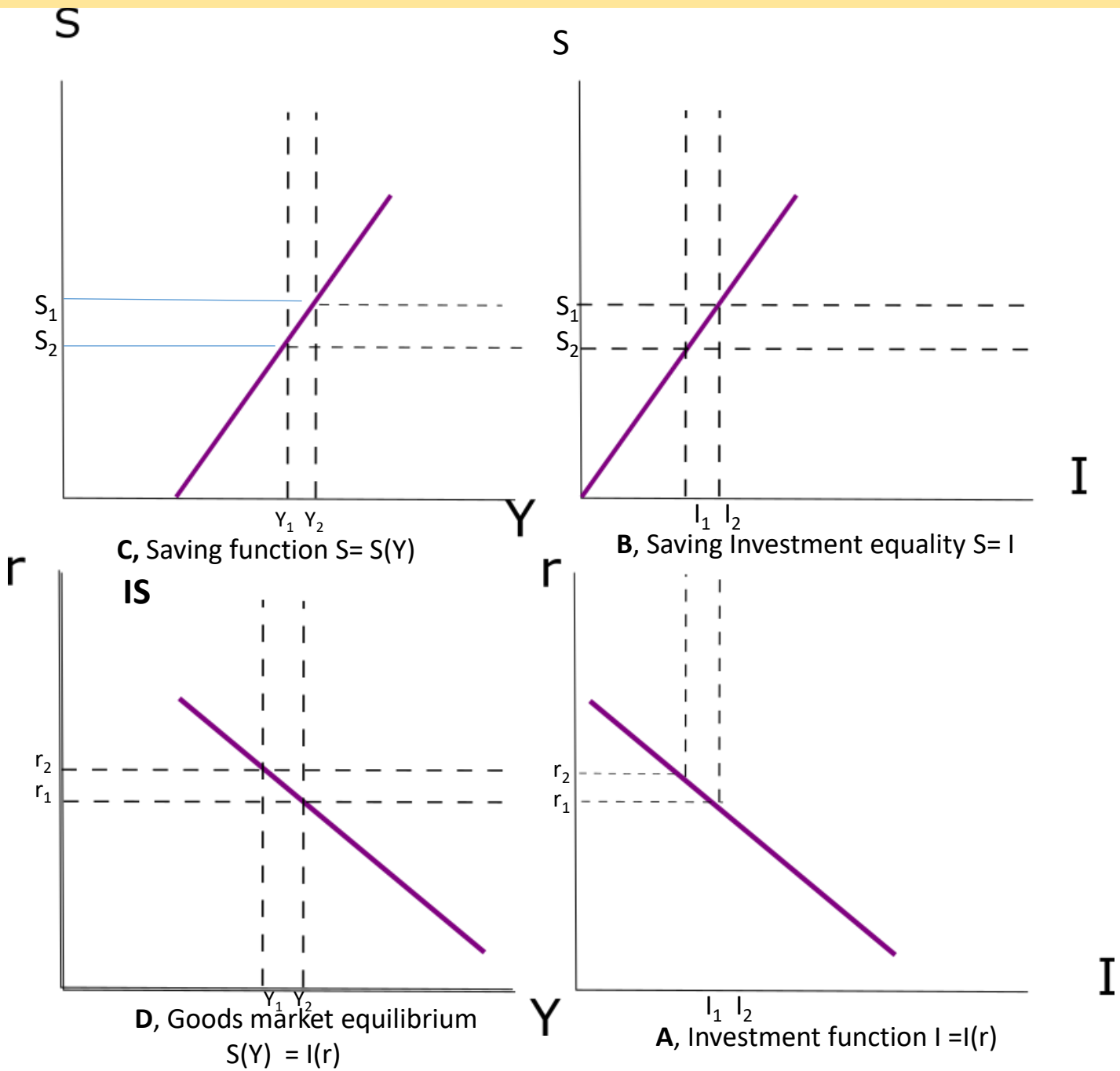
# Observations regarding IS Curve

- The position of the IS curve depends
  - Positively on  $K$
  - Positively on  $A_0$
- Slope of the IS curve
  - IS curve is steeper, lower the value of  $K$
  - IS curve is steeper, lower the interest sensitiveness of investment ( $d$ )

# Observations regarding LM curve

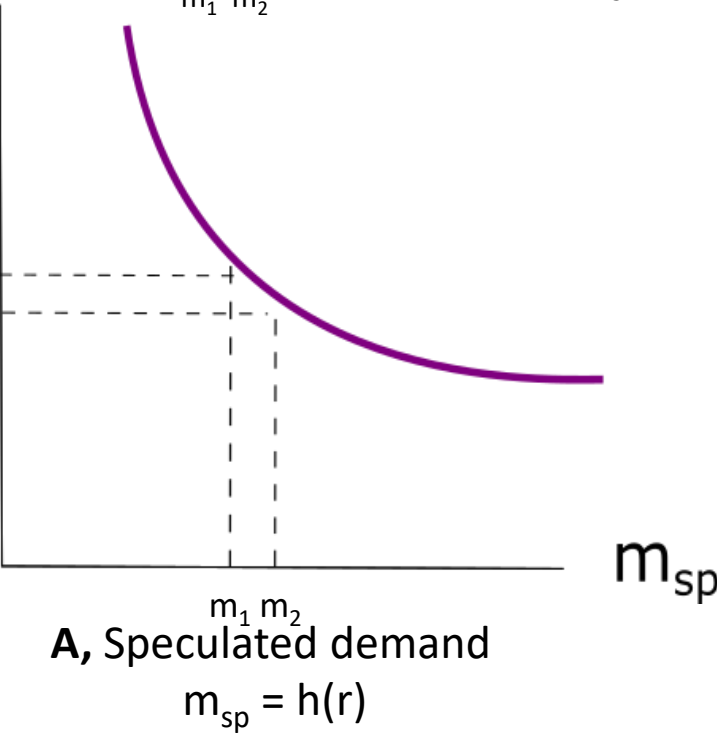
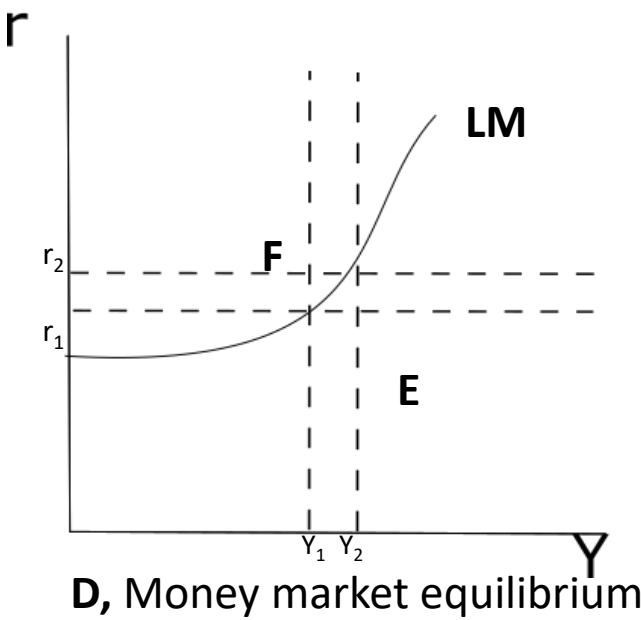
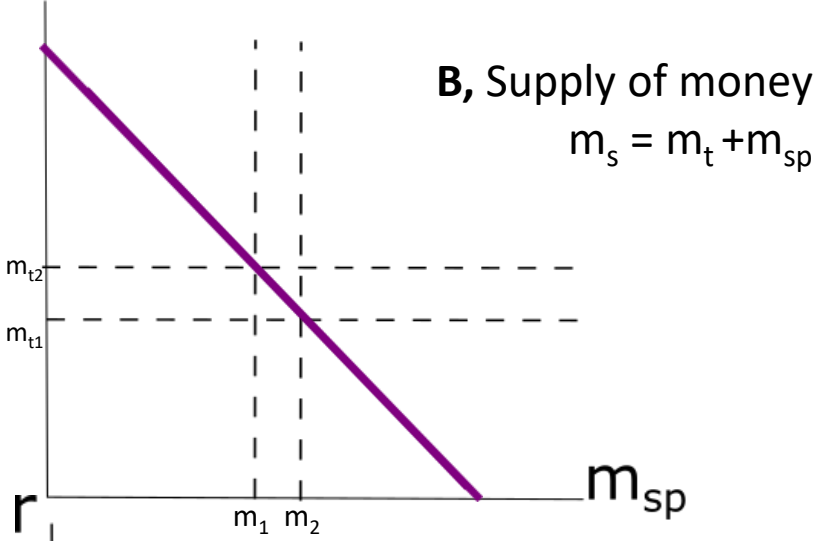
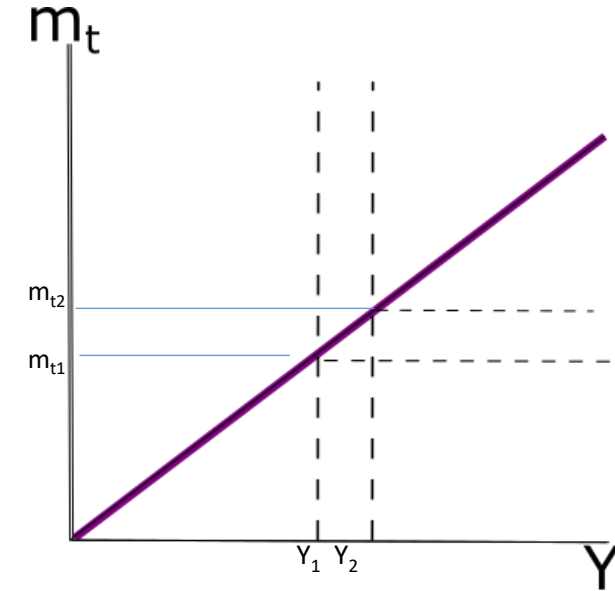
- Position
  - Positively on nominal quantity of money supply
    - Negatively on the price level (P)
  - Negatively on the sensitiveness of the money demand to the changes in income
- Slope
  - The curve is flatter, larger the interest sensitiveness of money demand
  - The curve is flatter, lower the income sensitiveness of the money demand

Derivation of IS curve.



Derivation of LM curve.

**C, Transaction demand**  
 $m_t = k(Y)$



# IS-LM model.

- IS and LM curves are super-imposed on one graph to explain the simultaneous determination of income and interest rate.
- The curves are assumed linear and they are plotted in the following figure.

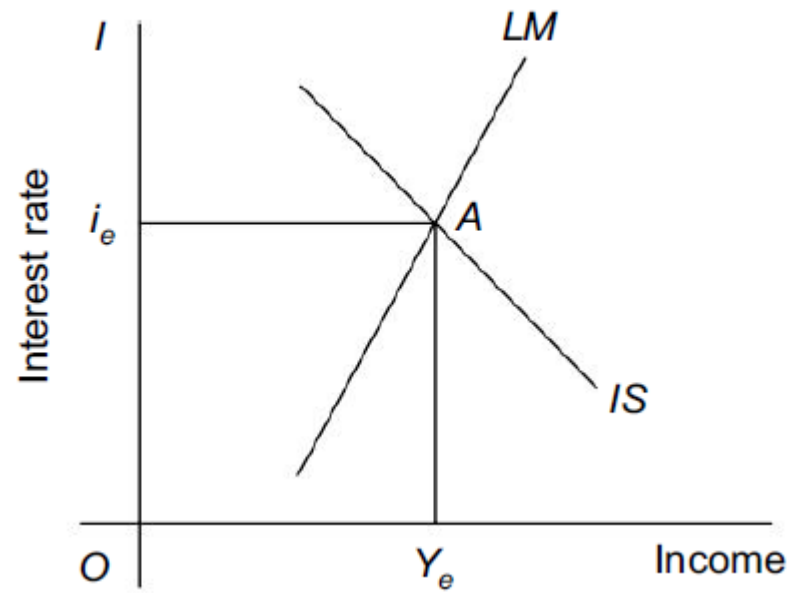


Figure:- IS LM model

- It can be observed that when the interest rate is zero, income takes a positive value on IS curve.
- Similarly, LM curve has a positive intercept on the income axis.
- At the point of intersection full level of employment is achieved.
- Thus the model is consistent with
  - ❑ Full Employment Equilibrium, If  $Y_e = Y_f$
  - ❑ Under-full employment, if  $Y_e < Y_f$
  - ❑ Over-Full employment, if  $Y_e > Y_f$

# From Disequilibrium to Equilibrium.

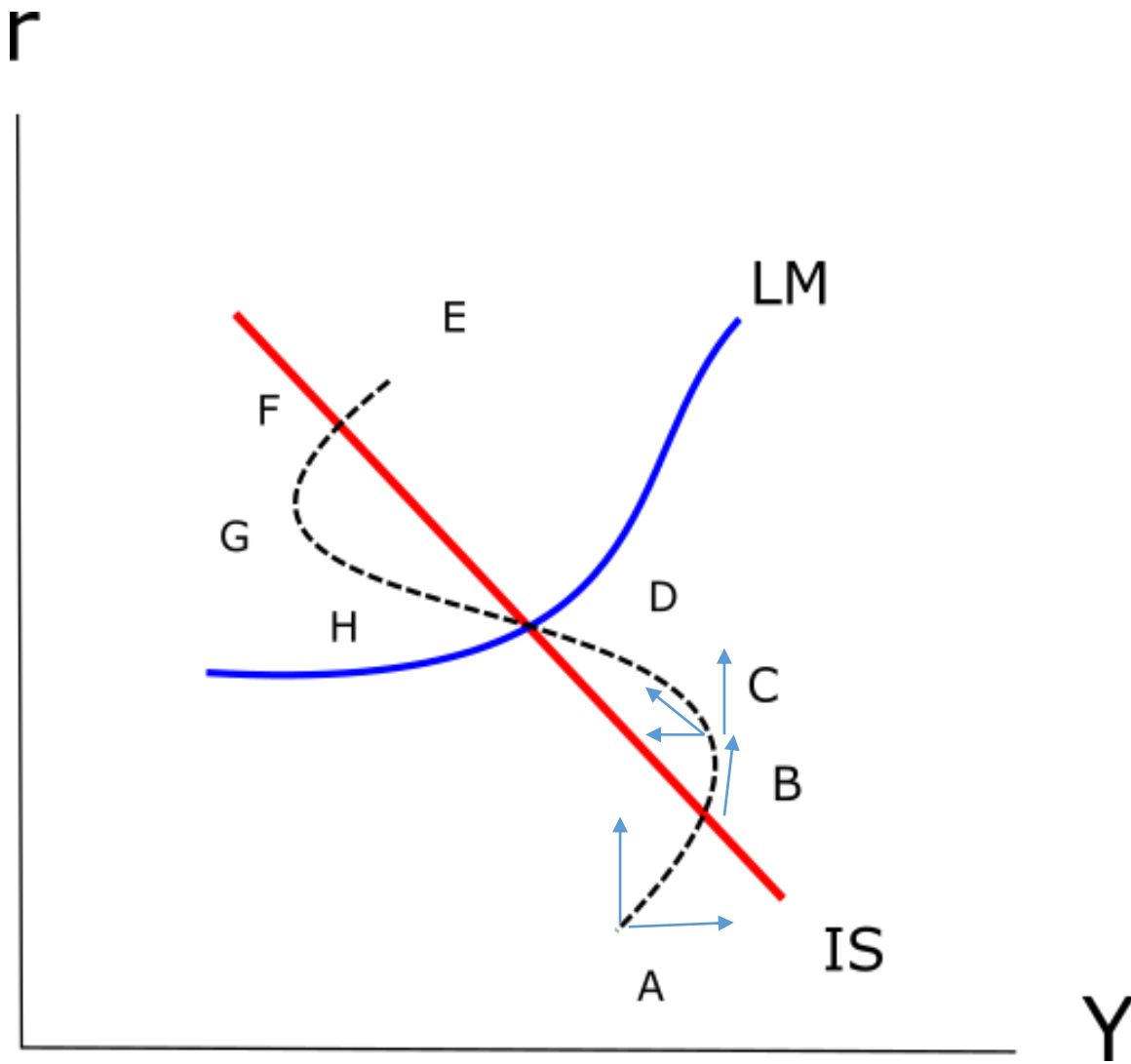
- Disequilibrium in IS-LM will be at any where other than the intersection the curves.
- All those combinations that do not lie on a line, are identified under these four conditions.
- Four Spaces;

□ Space	Goods Market	Money Market
▪ I	$I < S, (C+I) < Y$	$M_d < M_s$
▪ II	$I < S, (C+I) < Y$	$M_d > M_s$
▪ III	$I > S, (C+I) > Y$	$M_d > M_s$
▪ IV	$I > S, (C+I) > Y$	$M_d < M_s$

- Any combination of  $Y$  and  $r$  that lies anywhere to the right of the IS curve is a combination at which  $S > I$  and  $y > (C+I)$  and vice versa.
- Any combination of  $Y$  and  $r$  that lies anywhere to the left of IS curve is a combination at which  $S < I$  and  $Y < c+I$
- Any combination that lies to the right of LM curve,  $M_d > M_s$
- Any combination that lieas to the left of the LM curve,  $M_d < M_s$



# From Disequilibrium to Equilibrium.



# The Theory of Liquidity Preference and LM curve

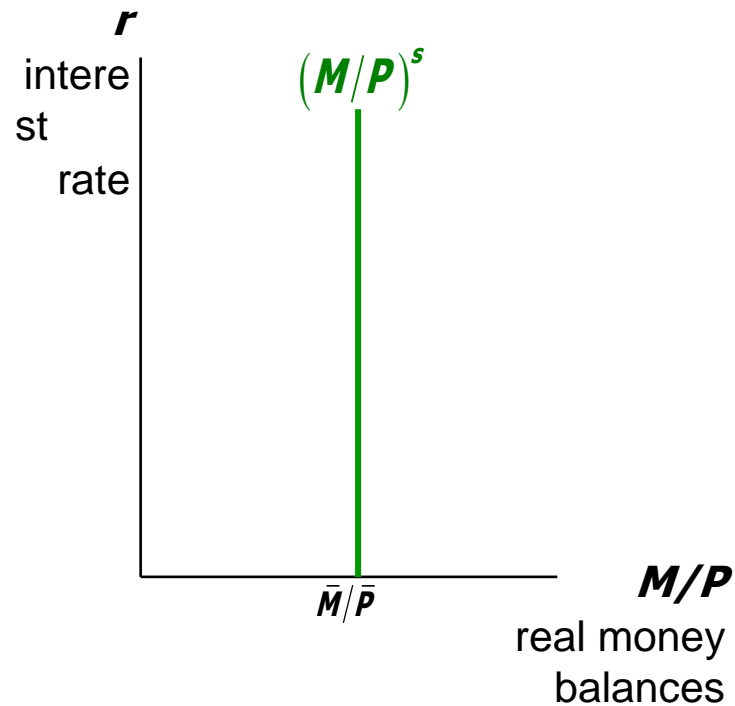
## The Theory of Liquidity Preference

A simple theory in which the interest rate is determined by money supply and money demand.

### Money Supply

The supply of real money balances is fixed:

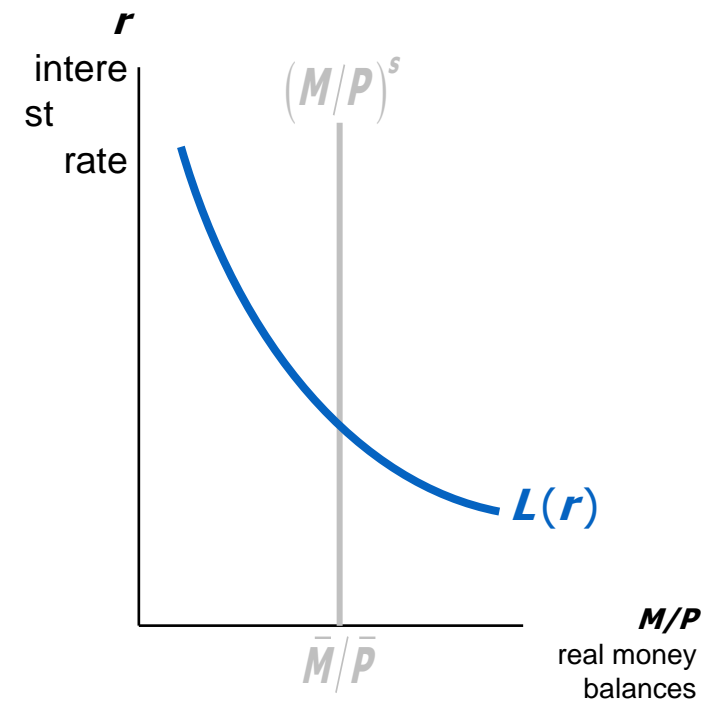
$$(M/P)^s = \bar{M}/\bar{P}$$



### Money Demand

Demand for real money balances:

$$(M/P)^d = L(r)$$

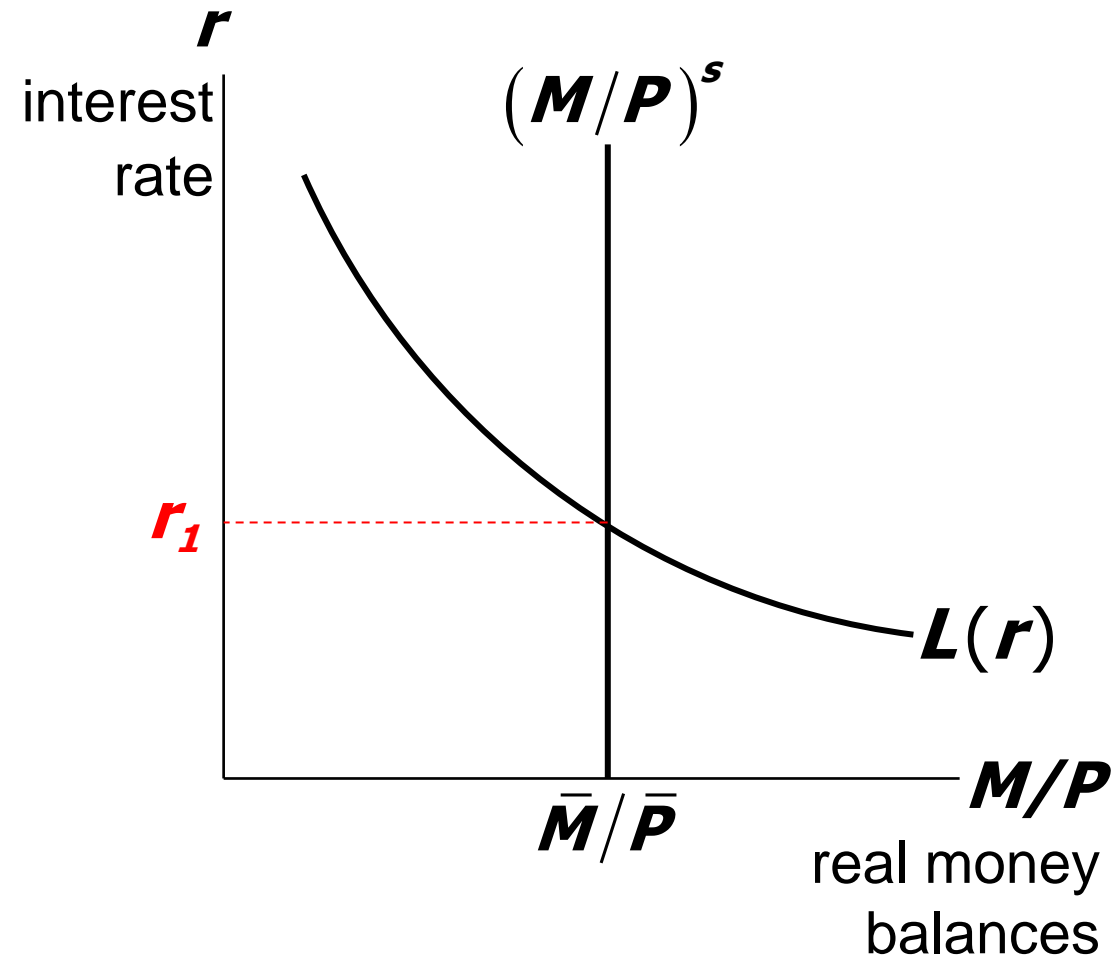


# The Theory of Liquidity Preference and LM curve

## Equilibrium

The interest rate adjusts to equate the supply and demand for money:

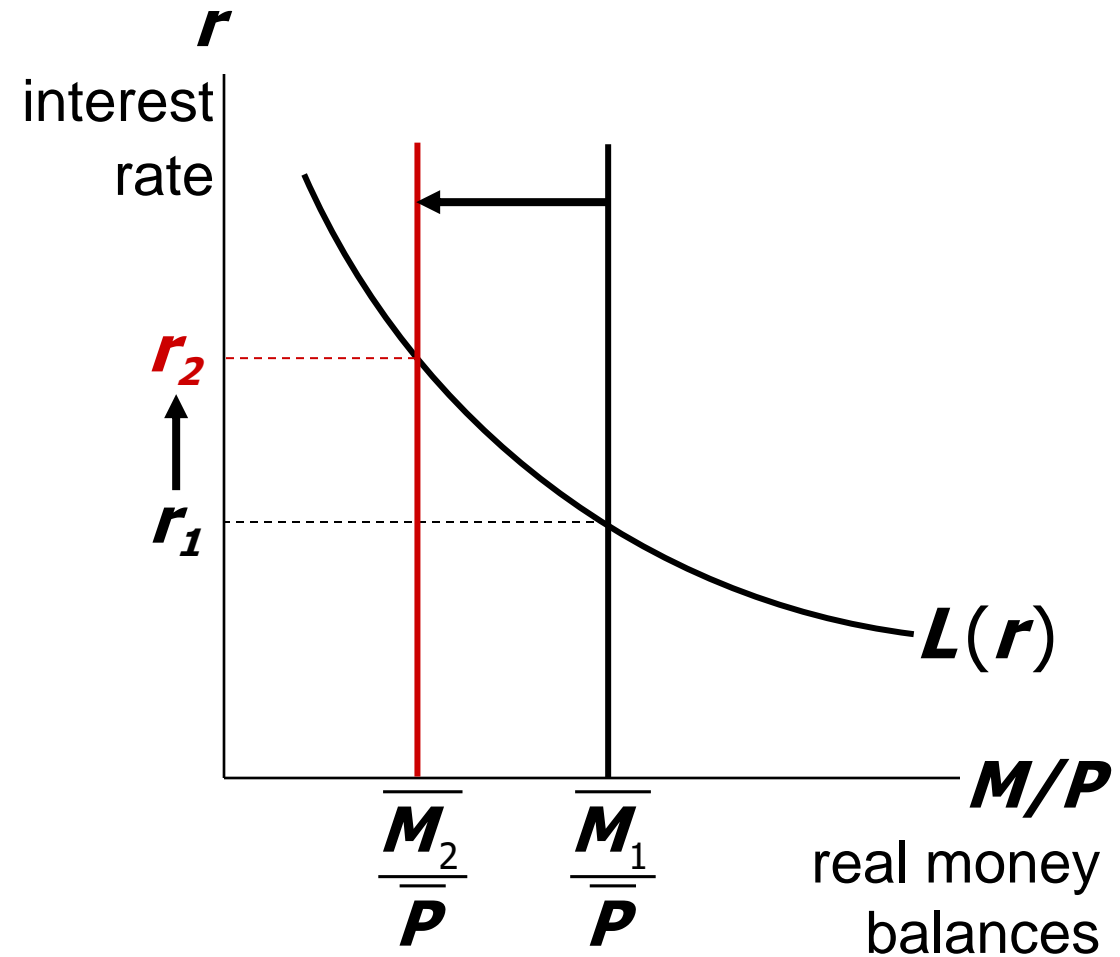
$$\bar{M}/\bar{P} = L(r)$$



# The Theory of Liquidity Preference and LM curve

Raises the interest rate

To increase  $r$ ,  
Fed reduces  $M$



# The LM curve

Now let's put  $Y$  back into the money demand function:

$$\left(\frac{M}{P}\right)^d = L(r, Y)$$

The **LM curve** is a graph of all combinations of  $r$  and  $Y$  that equate the supply and demand for real money balances.

The equation for the  $LM$  curve is:

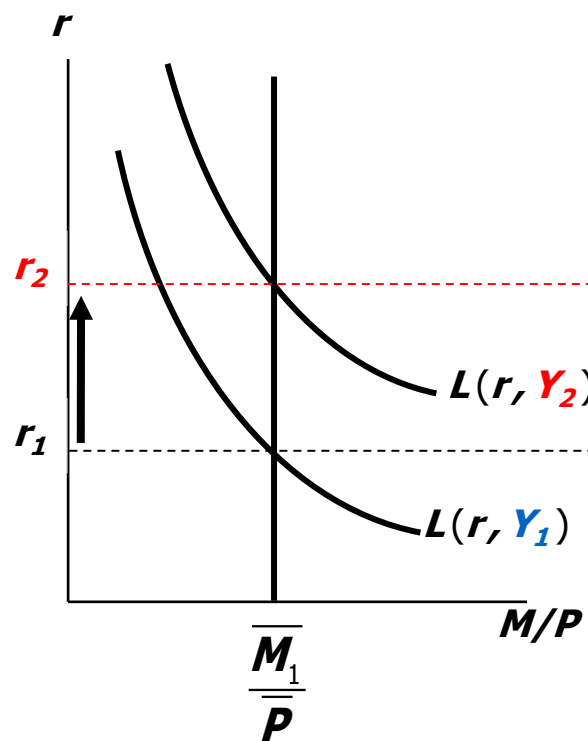
$$\bar{M}/\bar{P} = L(r, Y)$$

## Why the $LM$ curve is upward-sloping?

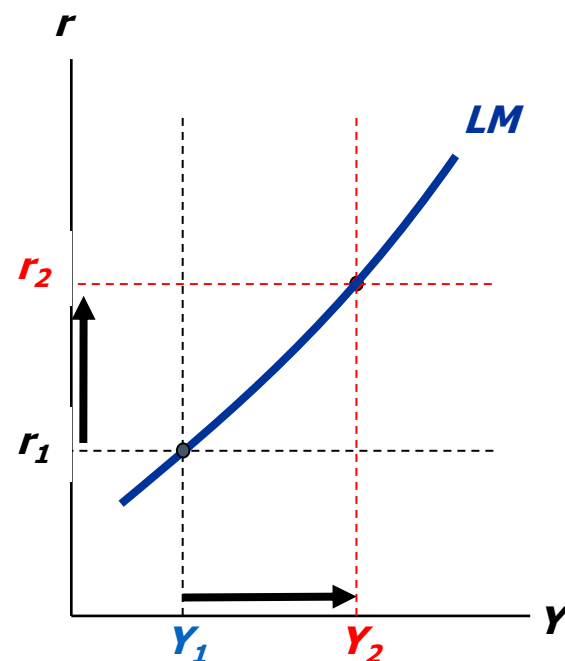
- An increase in income raises money demand.
- Since the supply of real balances is fixed, there is now excess demand in the money market at the initial interest rate.
- The interest rate must rise to restore equilibrium in the money market.

## Deriving the LM curve

(a) The market for real money balances



(b) The LM curve



- Liquidity trap refers to the situation in which an increase in money supply does not result in a fall in the interest rate but there is addition to the idle balances (interest elasticity of demand for money becomes infinite).
- Under normal conditions, an increase in money supply results in an excess cash balance that further leads to increase in bond price corresponding to the fall in interest rate.
- But when there is a situation of liquidity trap, individuals believe that bond price is too high and it will fall. Correspondingly, interest rates are too low, hence it will rise. They, therefore, believe that buying bonds would incur capital loss and as a result, they hold only money.
- This means an increase in money supply merely increases idle balances and leaves the interest rate unaffected.

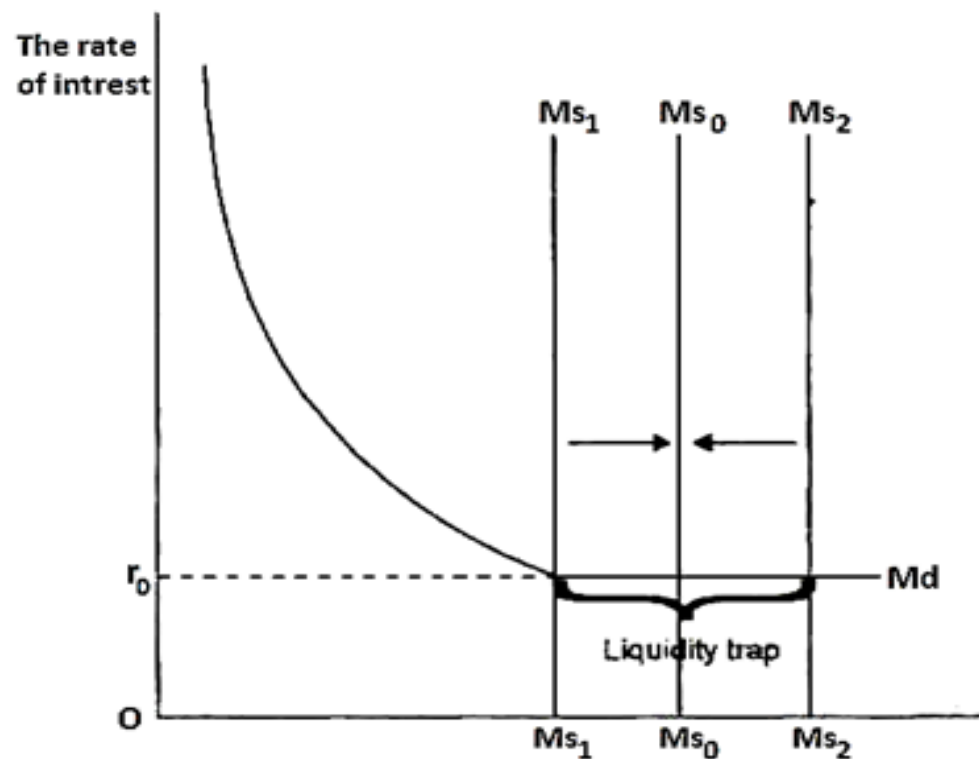
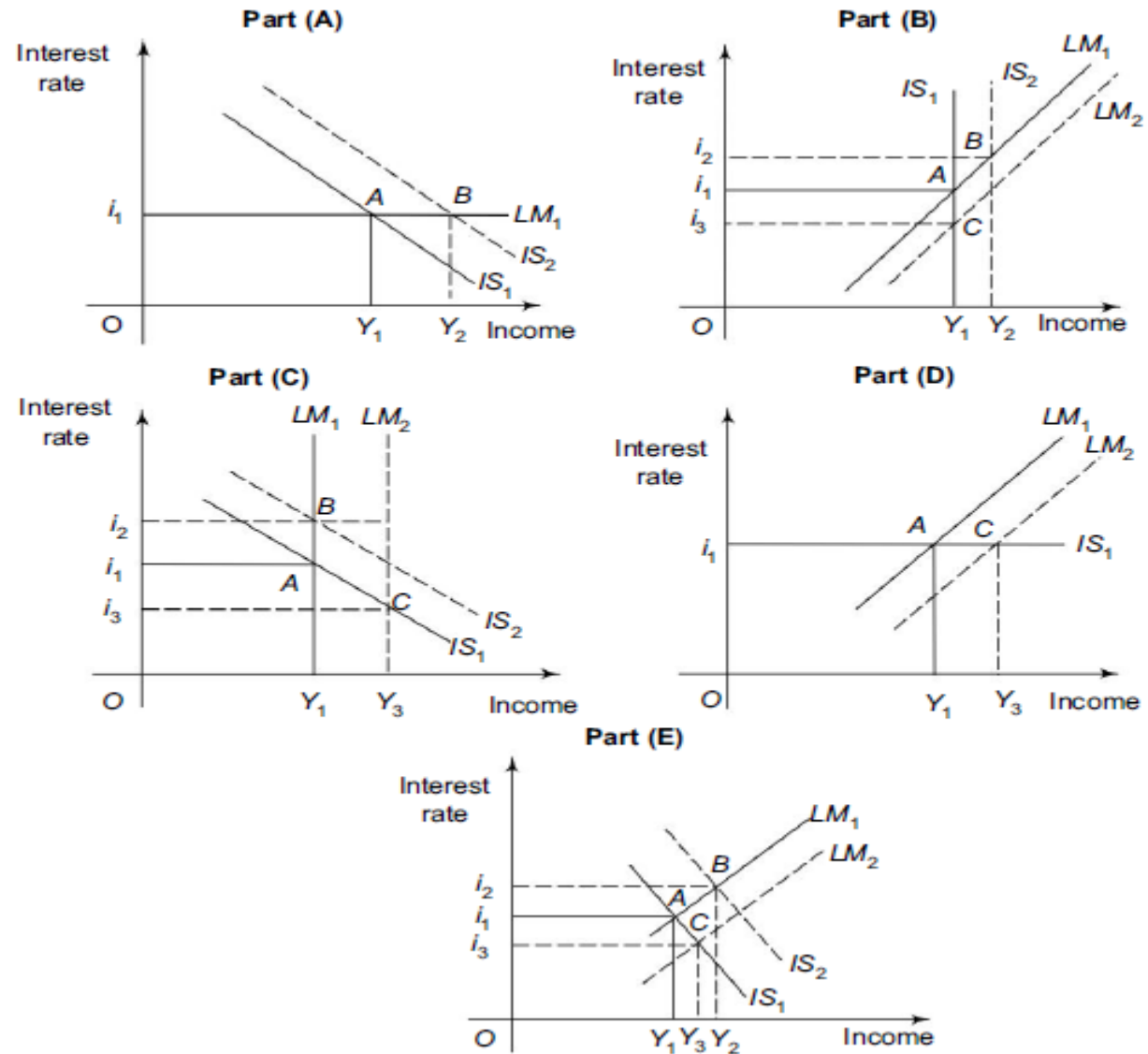


Figure :- Liquidity Trap

- Keynes pointed out that during depression when rate of interest rate is very low, the demand for money (or liquidity preference curve) becomes completely elastic (horizontal) and the rate of interest cannot fall more.
- Horizontal portion is referred to as liquidity trap.

# Economic Fluctuations and Stabilization Policies.



- Figure has 5 parts.
- Part A :-  $f = \infty$
- Part B :-  $d = 0$
- Part C :-  $f = 0$
- Part D :-  $d = \infty$
- Part E :- Intermediate situation.

Figure – Roles of Stabilization Policies



Elastic vs Inelastic of IS and LM functions

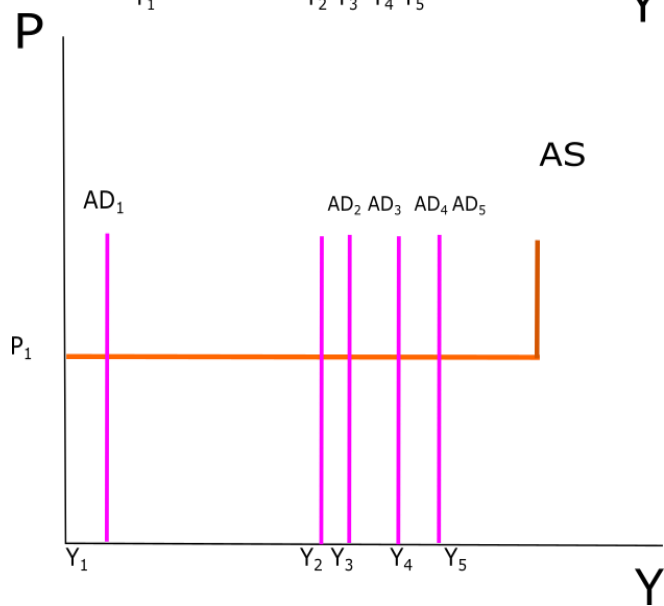
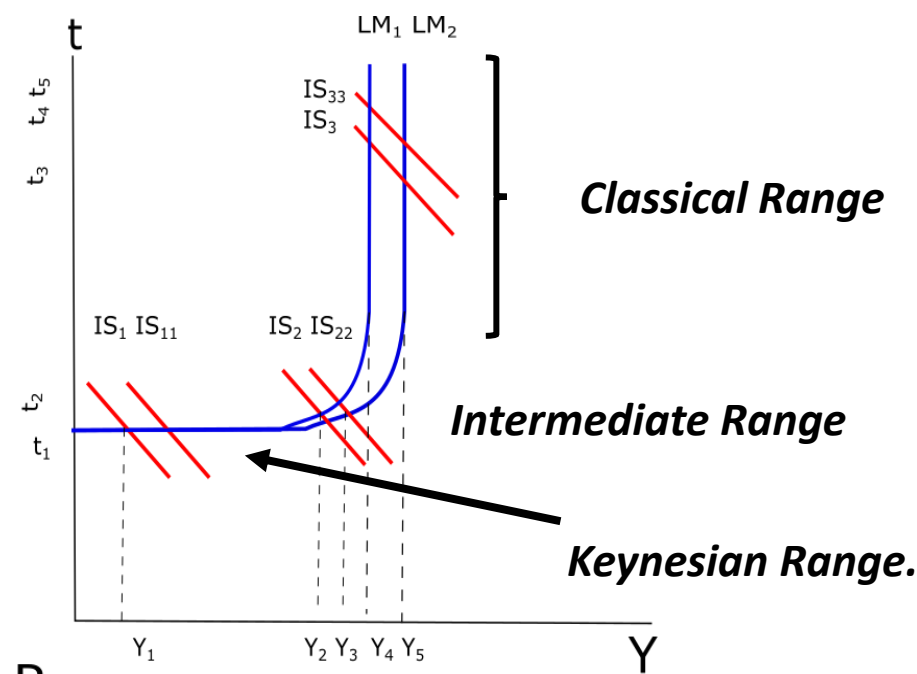
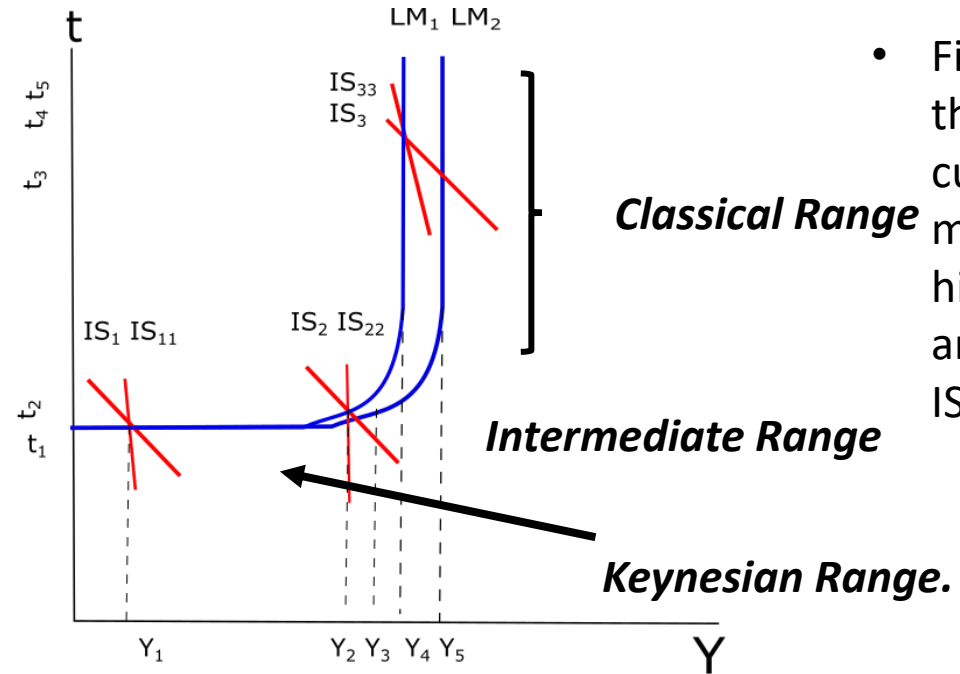


Figure 1



- Figure (2) shows three pairs of IS curve each made up of one highly inelastic and one elastic IS curves.

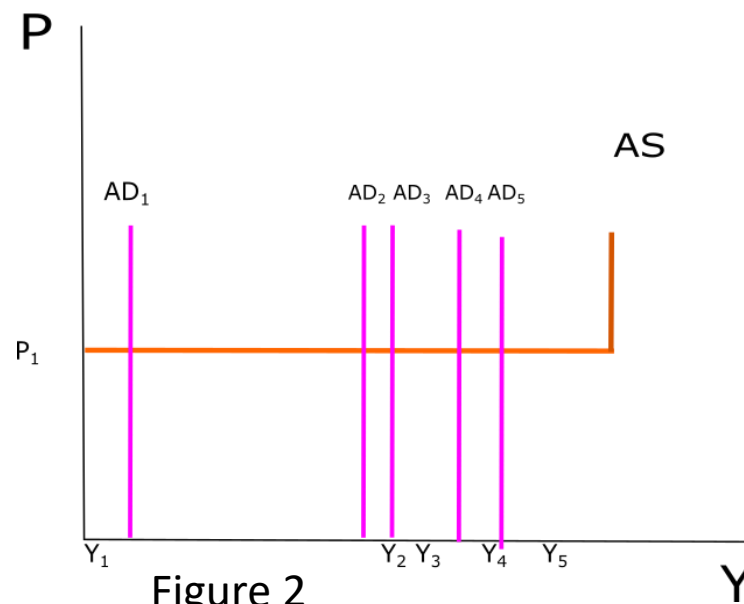


Figure 2

- Part B of both the figures show AD curves corresponding to the various levels of  $y$ .

## Elasticity of IS and LM functions

- With a fixed supply of money, the LM curve slopes upward to right.
- But, at one extreme the function, it may become perfectly elastic, and at other extreme, it may be perfectly inelastic with a range of varying elasticities in between.
- These three ranges can be seen in the figure (1) of the previous slide.
- In Part A of the figure,
  - Perfectly elastic range: Keynesian range
    - Perfect elastic occurs due to the consensus by wealth holders that the interest rate will fall no lower and that bond prices will rise no higher. Wealth holders stand ready to exchange securities for cash under this situation for which liquidity trap exists in this situation.
  - Perfectly inelastic range: Classical range
    - At some very high interest rate, the speculative demand for money may become zero. In such situation, wealth holders prefer to hold only securities and no idle cash.
  - Portion between the Keynesian and Classical range: Intermediate range.

- IS-LM framework provides a basis for comparing the effect of the two types of policies on income level and the interest rate. It also tells which one is more effective or ineffective in producing the desired change in income.

### ***Keynesian Range***

- The interest rate is already at an irreducible minimum.
- Monetary authority purchases securities as security holders are willing to sell them for cash at the existing prices.
- Therefore, expansion of money supply curve cannot cause the interest rate to fall below the rate given by the liquidity trap.
- Rise in income may not be achieved through monetary expansion but it can be achieved by producing the shift in IS curve.

- Fiscal measures such as increased in government spending or reduction in taxes could cause a shift in IS curve.

### ***Intermediate Range***

- In intermediate range both fiscal and monetary policies are effective.
- There is a change in level of output and interest rate under both the situations.

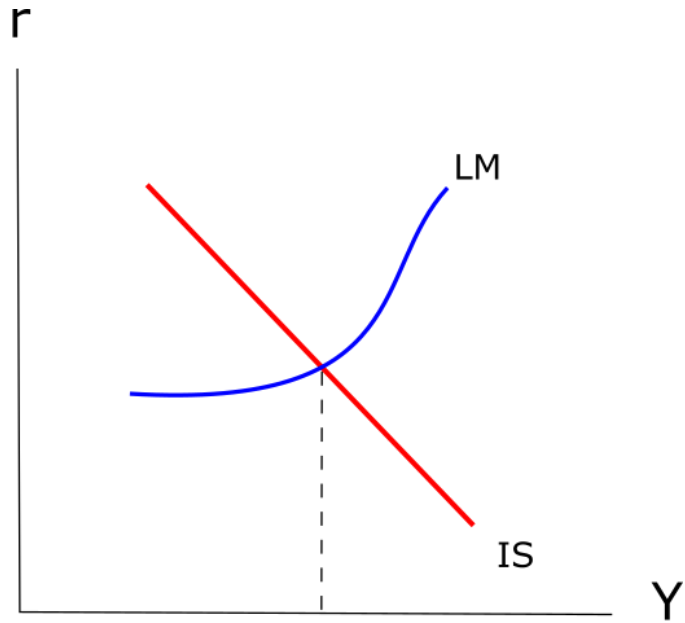
### ***Classical Range***

- Increase in Money supply in this range will cause shift in LM curve. As a result there will be an increase in income level and fall in the interest rate.
- Monetary Policy is effective.
- Fiscal Policy is completely ineffective as the movement of IS curve may change the interest rate but there will be no change in level of output.

# IS-LM Equilibrium and the AD curve.

- According to classical theory, AS curve is perfectly inelastic at the full employment level of output.
- The intersection of AD and AS curve mainly determine the price level at full level of employment.
- For this model the AS curve is elastic up to full employment level of output but perfectly inelastic after that.
- In this model, AD curve depends on all the factors that determine IS and LM curves.
- AD curve is mainly derived from the intersection of IS and LM curves under the assumption that neither IS nor LM curve will shift with changes in the price level.

# IS-LM Equilibrium and the AD curve.



- Part A of the figure shows the intersection of IS and LM curves.
- As price level is constant, at every price level IS and LM curves are constant with same level of quantity demanded.
- According to the present assumption, AD curve is inelastic at a same level of output.

