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# IS-LM

# Roadmap

## 1) MARKET I : GOODS MARKET

- goods demand =  $C + I + G (+NX) = Y$  = goods supply (set by maximizing firms)
- IS curve

## 2) MARKET II : MONEY MARKET

- money demand =  $L_d(Y, r + \pi^e) = M_s/P$  = money supply (set by the Fed)
- LM curve

→ IS-LM EQUILIBRIUM = EQUILIBRIUM IN BOTH MARKETS I and II

# Goods Market

- **IS curve represents the equilibrium in the goods market:**

$$(1) \quad Y = C + I + G + NX$$

- Recall the definition of **private savings**  $S_{(hh)} = Y - T - C$
- Recall the definition of **national savings**  $S = S_{(hh)} + T - G$
- Combining them

$$(2) \quad S = Y - C - G$$

- From (1) and (2) the demand side of the economy can be written as:

$$\mathbf{S = I + NX}$$

The IS curve is named as it is because it documents the **relationship between Investment and Saving** (holding NX constant).

# Demand side : the IS curve

**C** is a function of PVLR ( $Y, Y^f, W$ ), tax policy, expectations, etc.

**I** is a function of  $r, A^f, K$ , and investment tax policy.

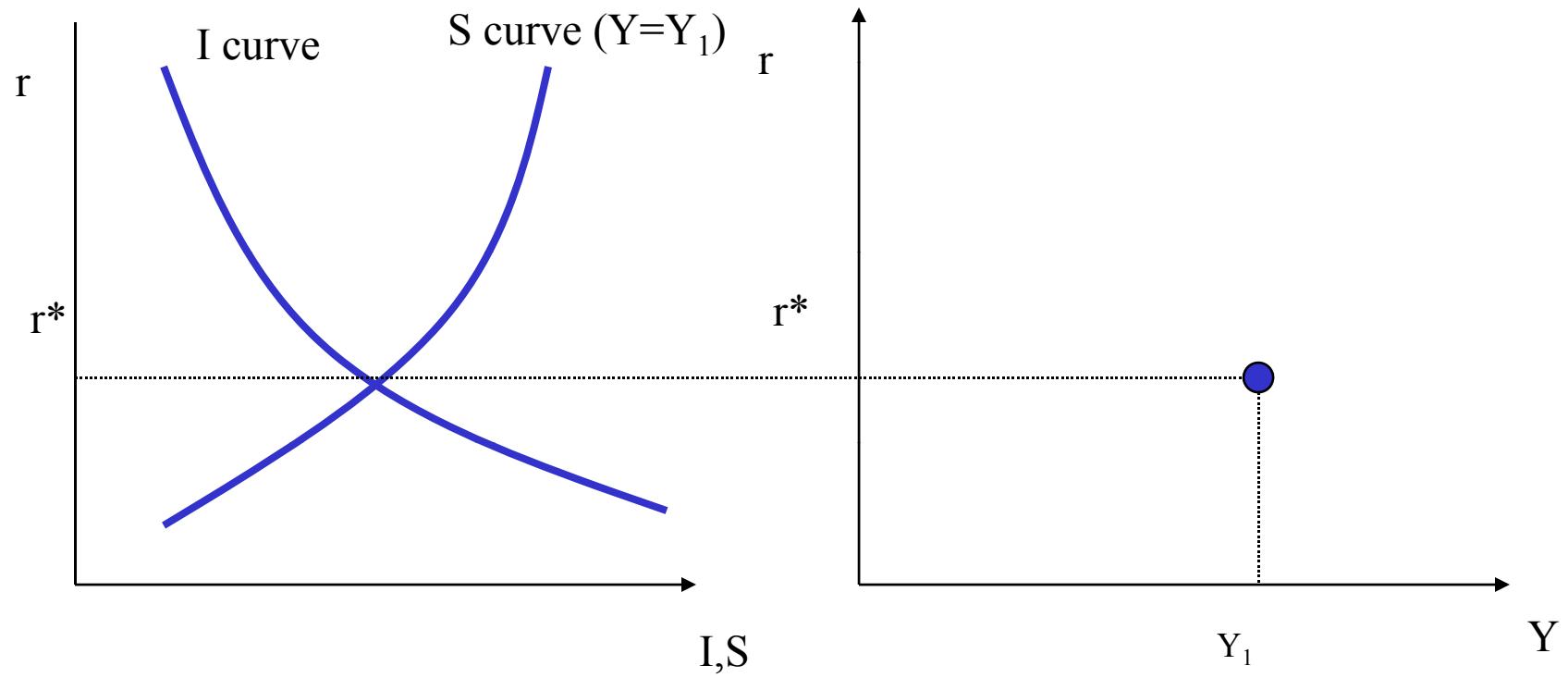
**G** is a function of government policy (we will discuss this shortly)

**NX** we will model in the last lecture of the course (for the U.S., NX is small)

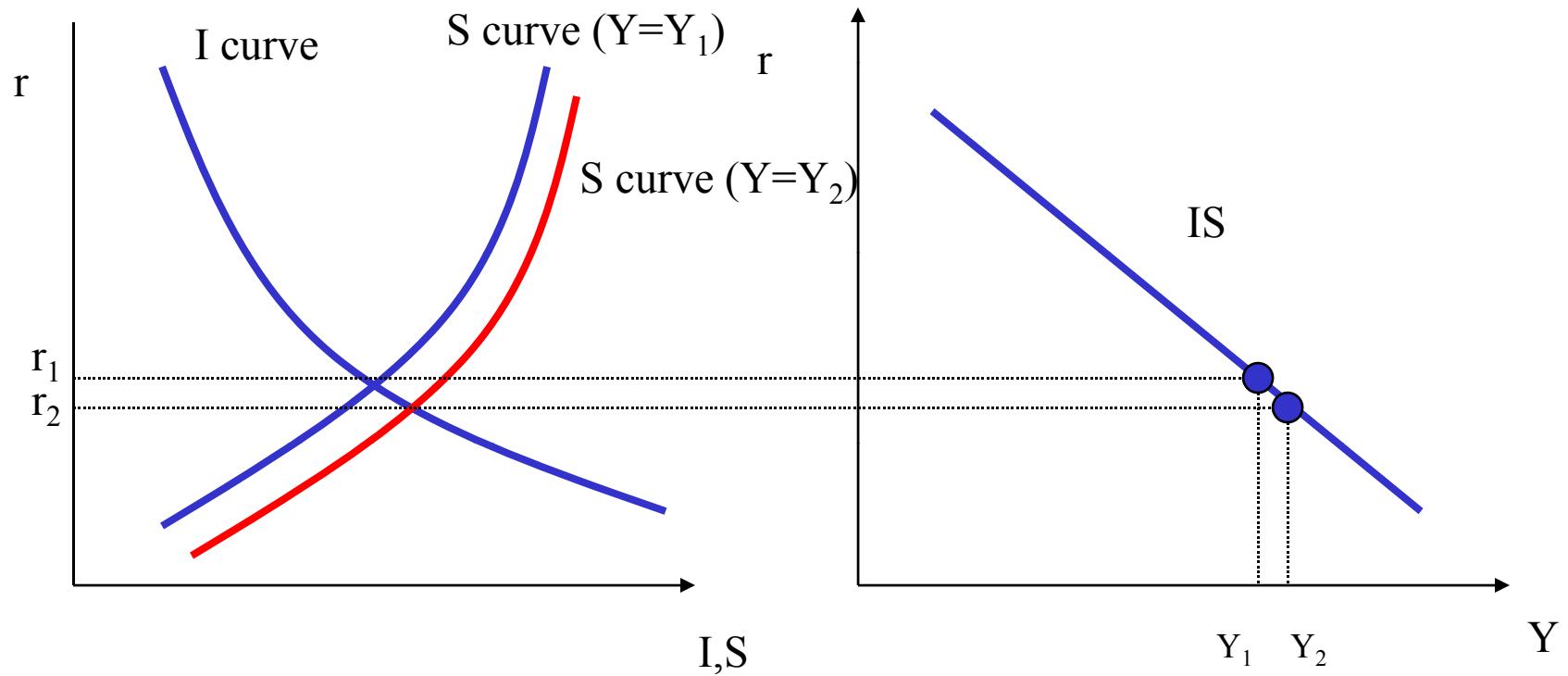
- **The IS curve relates  $Y$  to  $r$ .** How do interest rates affect  $Y$ ?
- **As  $r$  falls, Investment increases** (due to firm profit maximization behavior).
- **Also Consumption increases** (substitution effect dominates)

**IS curve is downward sloping in  $\{r, Y\}$  space.**

# IS Curve: Graphical Derivation

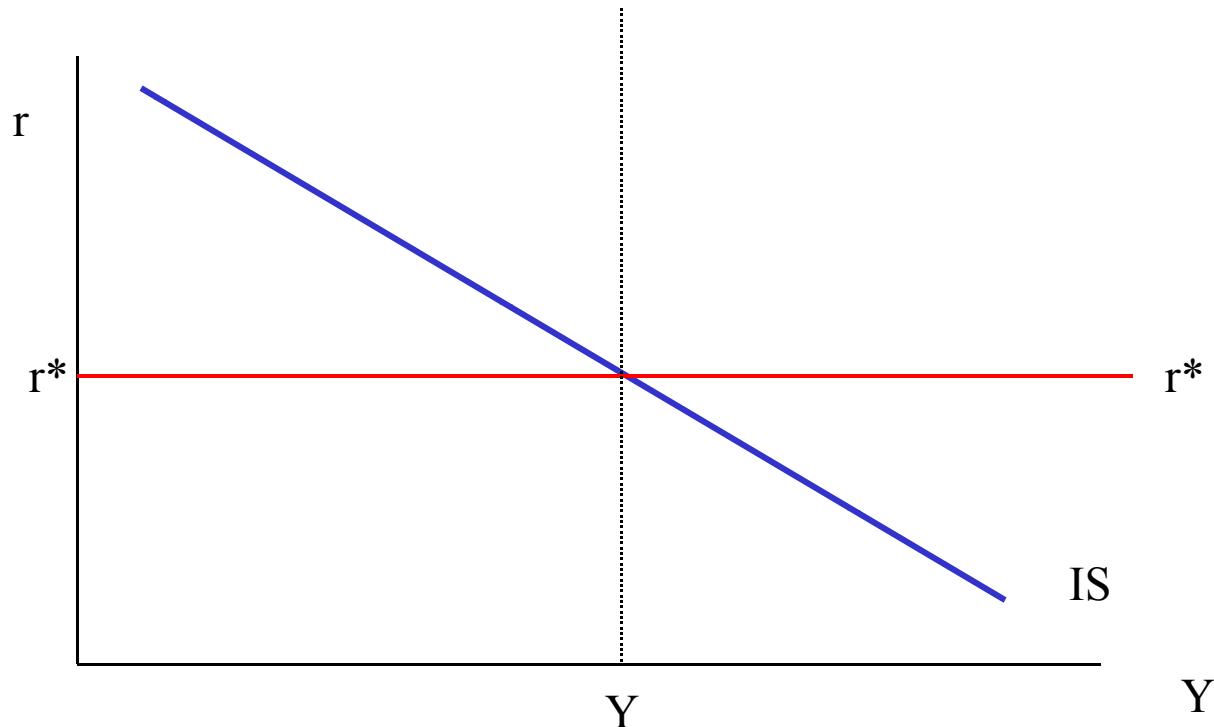


# IS Curve: Graphical Derivation



An increase in current  $Y$  leads to more desired  $S$ ,  
hence the equilibrium  $r$  needs to be lower!

# IS curve



Suppose  $r$  is set by the Fed at the level of  $r^*$  (we will explore this in depth later in the course). For a given  $r$ , we can solve for the level of output desired by the demand side of the economy.

We represent the demand side of the economy, drawn in  $\{r, Y\}$  space as the I-S curve. Why IS? Because the demand side of the economy can be boiled down to  $I = S$  (when  $NX$  is zero)

# What shifts the IS curve

## What shifts the IS curve to the right?

Anything that increases **C, I or G** (or NX when we model it):

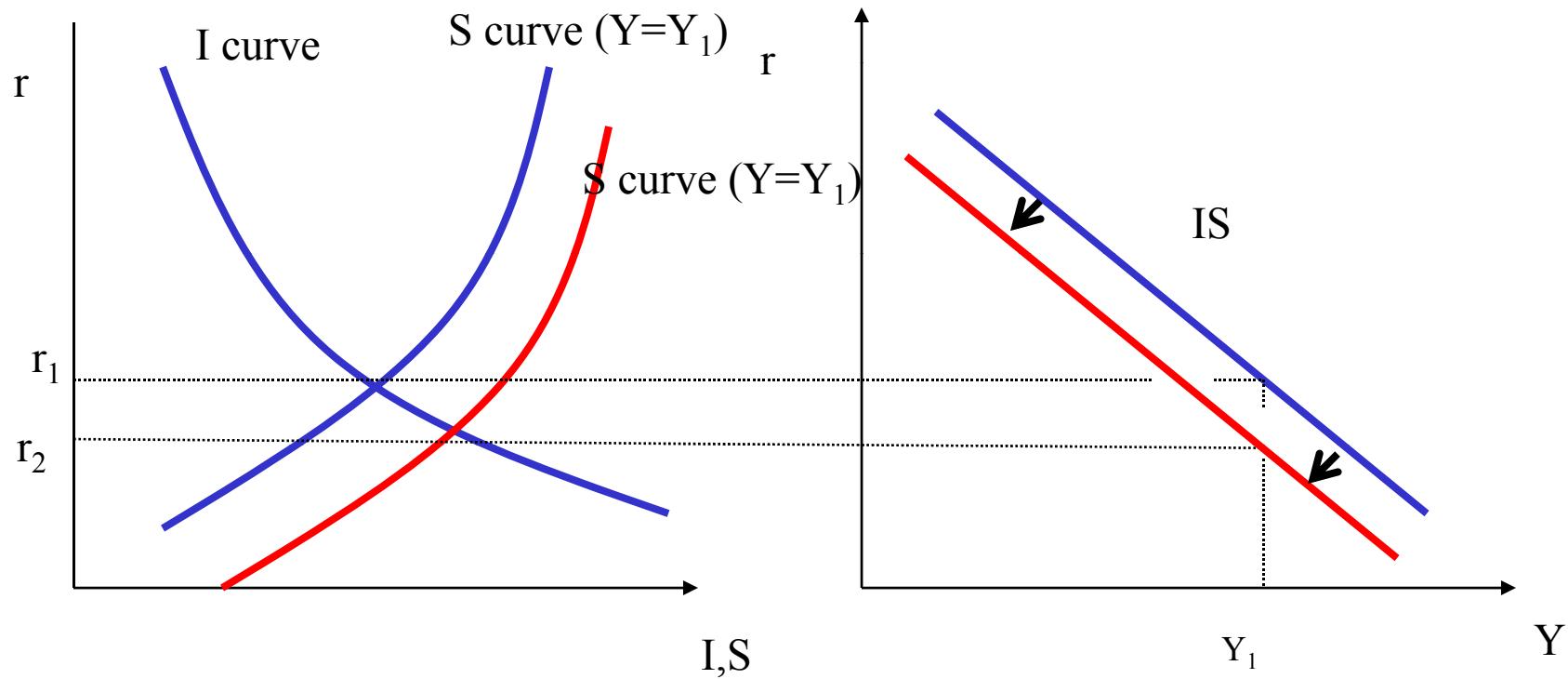
- higher expected income or wealth → higher PVLR → higher C
- higher consumer confidence → higher PVLR → higher C
- higher Tr or lower T (if the Ricardian equivalence fails) → higher C
- higher expectations about  $A^f$  → higher MPK<sup>f</sup> → higher I
- higher business confidence → higher MPK<sup>f</sup> → higher I
- lower  $\delta$  or mm, or lower  $t_K$  → lower adjusted user cost of K → higher I
- higher G

**Changes in r WILL NOT cause IS curve to shift**

(causes movement along IS curve)

# IS shift: Fall in Consumer Confidence

Imagine S decreases



An increase in desired S requires  $r$  to decrease if  $Y$  is unchanged!

# Money Market

**LM curve represents the equilibrium in the money market**

The Money Market is in Equilibrium when

$$M_s/P = L_d(Y, r + \pi^e)$$

$M_s/P$  = Real Money Supply

$L_d(Y, r + \pi^e)$  = Real Money Demand

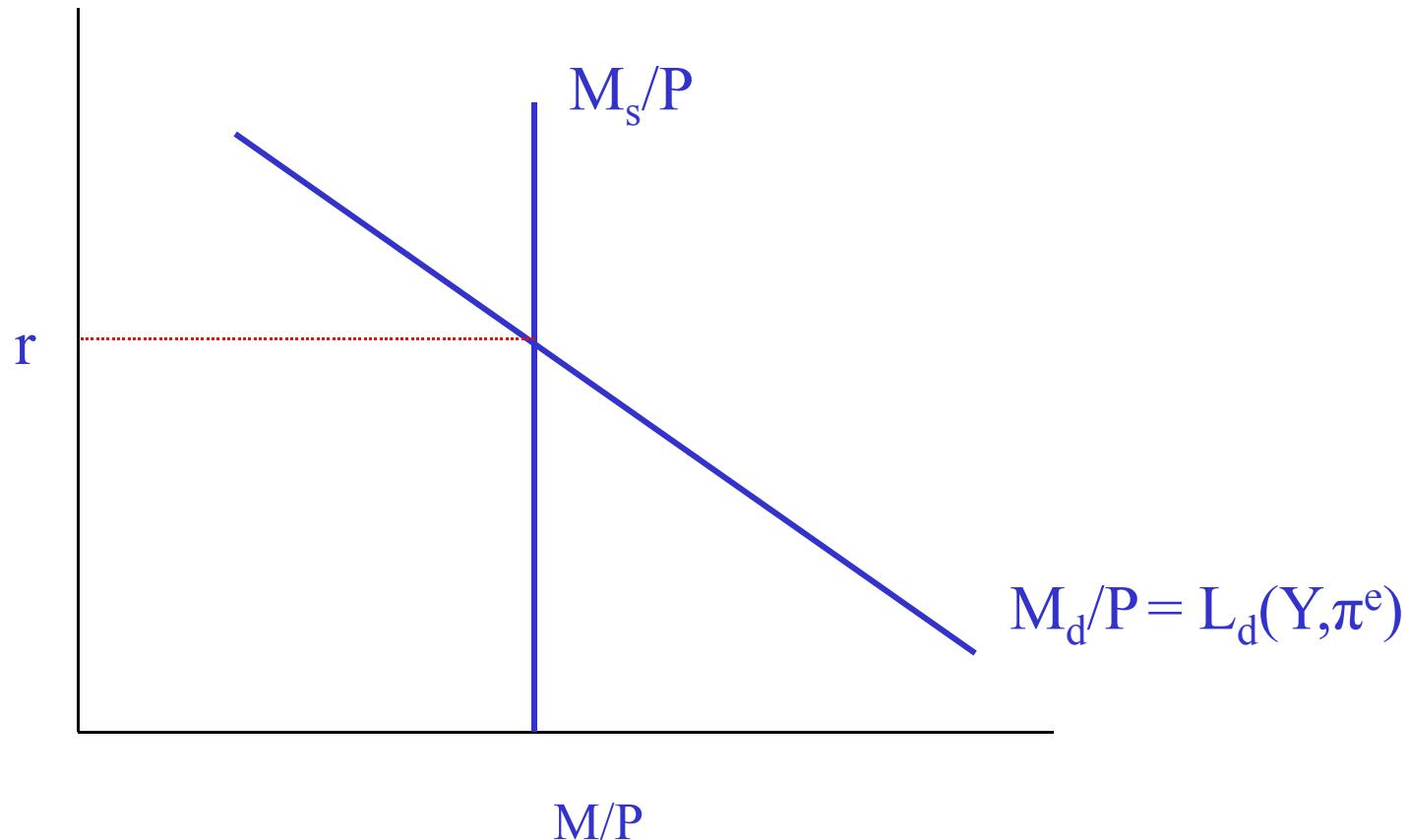
The money supply is decided by the Fed and does not change with interest rates

What shifts real money supply: M, P

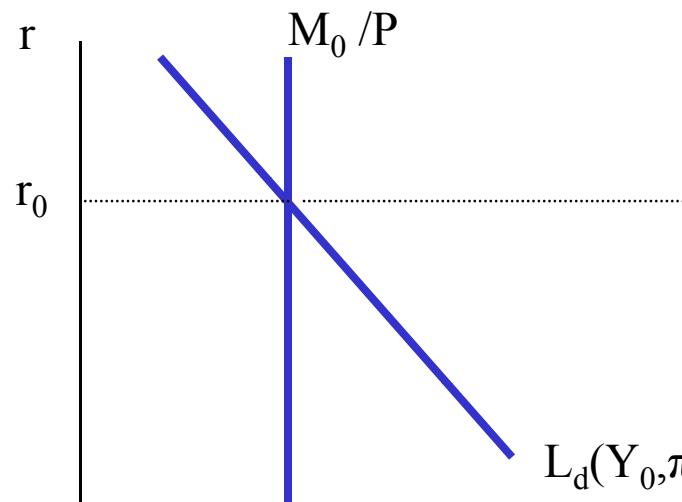
What shifts real money demand: Y,  $\pi^e$

LM curve is named as it is because it documents the **relationship between Liquidity and Money**

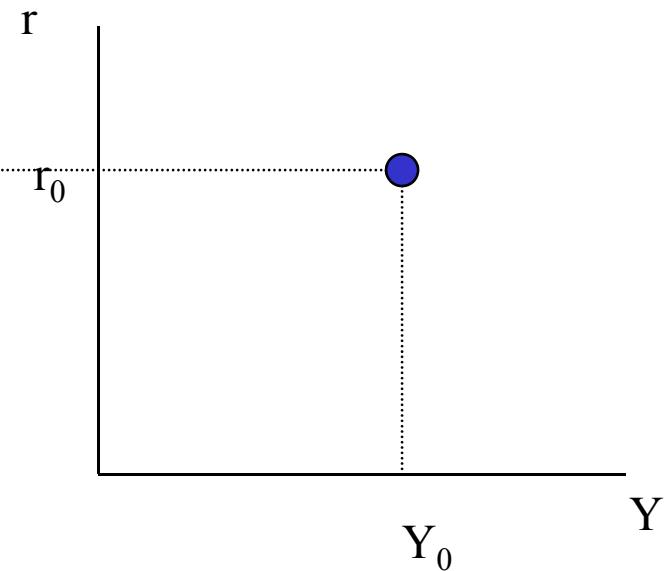
# Money Market Equilibrium



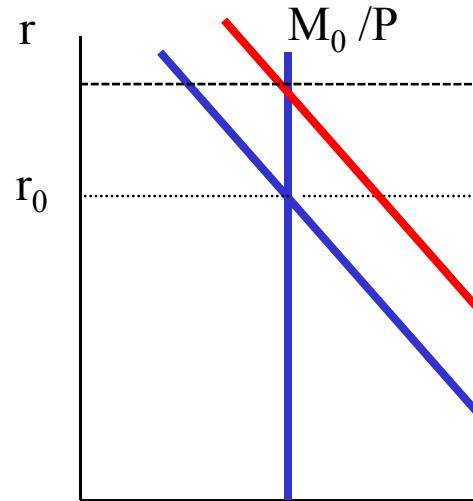
# LM Curve: Graphical Derivation



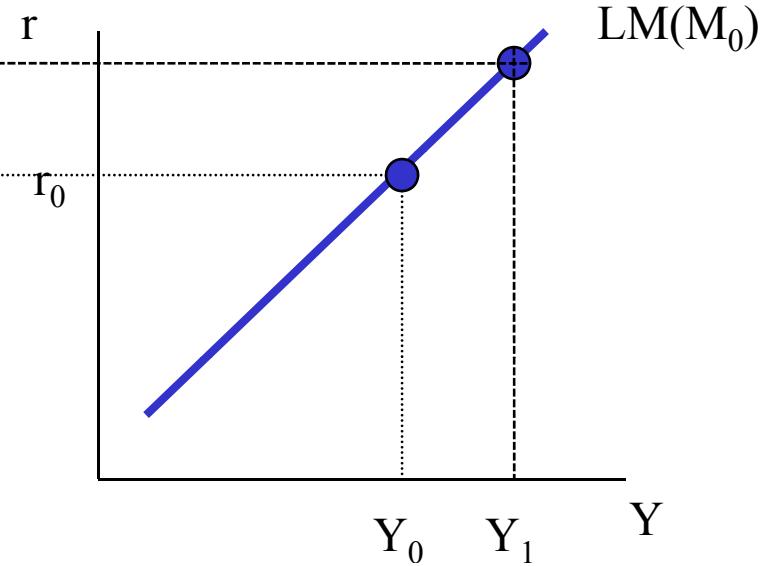
Money Market



# LM Curve: Graphical Derivation



Money Market



LM curve

An increase in the level of transaction will increase the interest rate (for given money supply)!

# What shifts the LM Curve

LM Curve: represents the relationship of  $Y$  and  $r$  through the money market

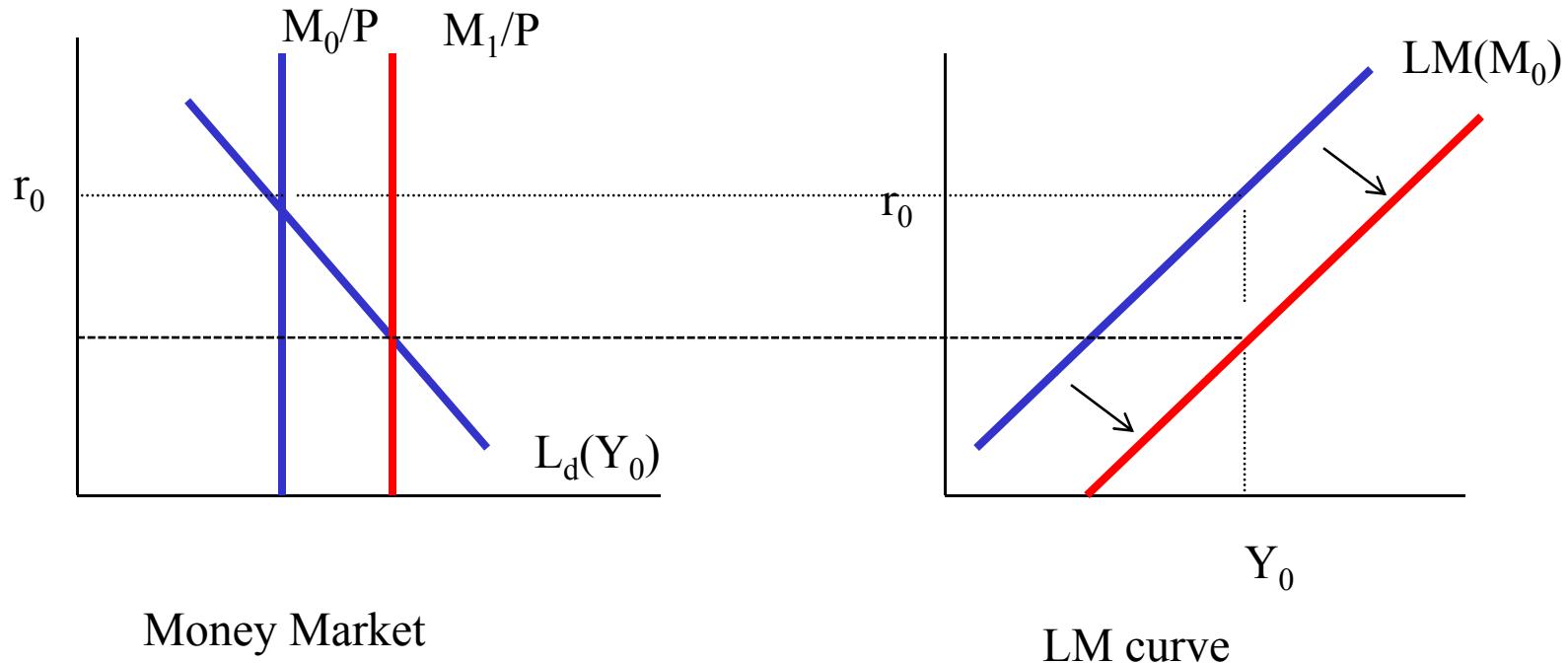
As  $Y$  increases -  $L_d$  shifts upwards - causing real interest rates to rise (increase in transactions demand increases the demand for money).

## What shifts the LM curve to the right?

- Higher nominal money supply  $\rightarrow$  higher  $M_s/P$
- Lower prices  $\rightarrow$  higher  $M_s/P$
- higher  $\pi^e$   $\rightarrow$  higher  $I$  and hence lower money demand

# LM Shift: Increase in Ms

Thought experiment: Suppose M increases. What would happen to r if Y was held constant?



An increase in the nominal money supply will cause the LM curve to shift to the right.

# Summing Up

## 1) MARKET I : GOODS MARKET

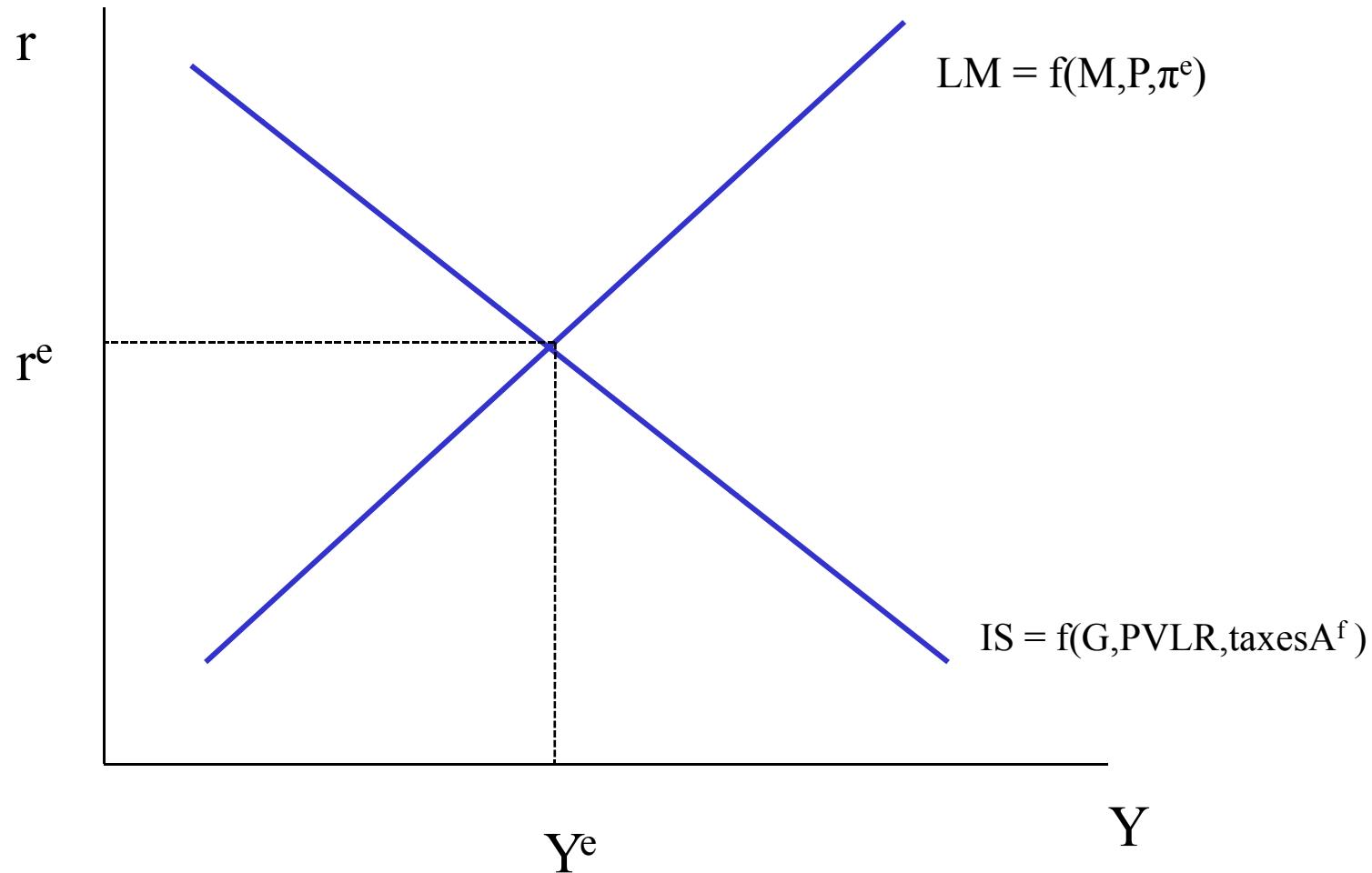
- goods demand =  $C + I + G (+NX) = Y$  = goods supply (set by maximizing firms)
- as the interest rate increases, I and C fall and the demand for goods falls
- IS curve is downward sloping

## 2) MARKET II : MONEY MARKET

- money demand =  $L_d(Y, r + \pi^e) = M_s/P$  = money supply (set by the Fed)
- as output increases, money demand increases and the interest rate has to increase to bring the demand back to the supply
- LM curve is upward sloping

→ **IS-LM EQUILIBRIUM = EQUILIBRIUM IN BOTH MARKETS I and II**

# IS-LM Equilibrium



# Short Run

- **SHORT RUN:** equilibrium given by intersection of IS and LM
- When aggregate demand for goods rises, assume that firms are willing to hire more workers in the short run to produce the extra output and meet the expanded demand
- **LONG RUN:** also labor market is in equilibrium and full employment:  
$$Y^* = f(N^*, K, A)$$
- In the long run, if there is higher demand, firms will increase prices until they hire the optimal amount of workers and produce the potential level of output.

# Labor Market

## FE Curve: the equilibrium in the labor market (Full Employment)

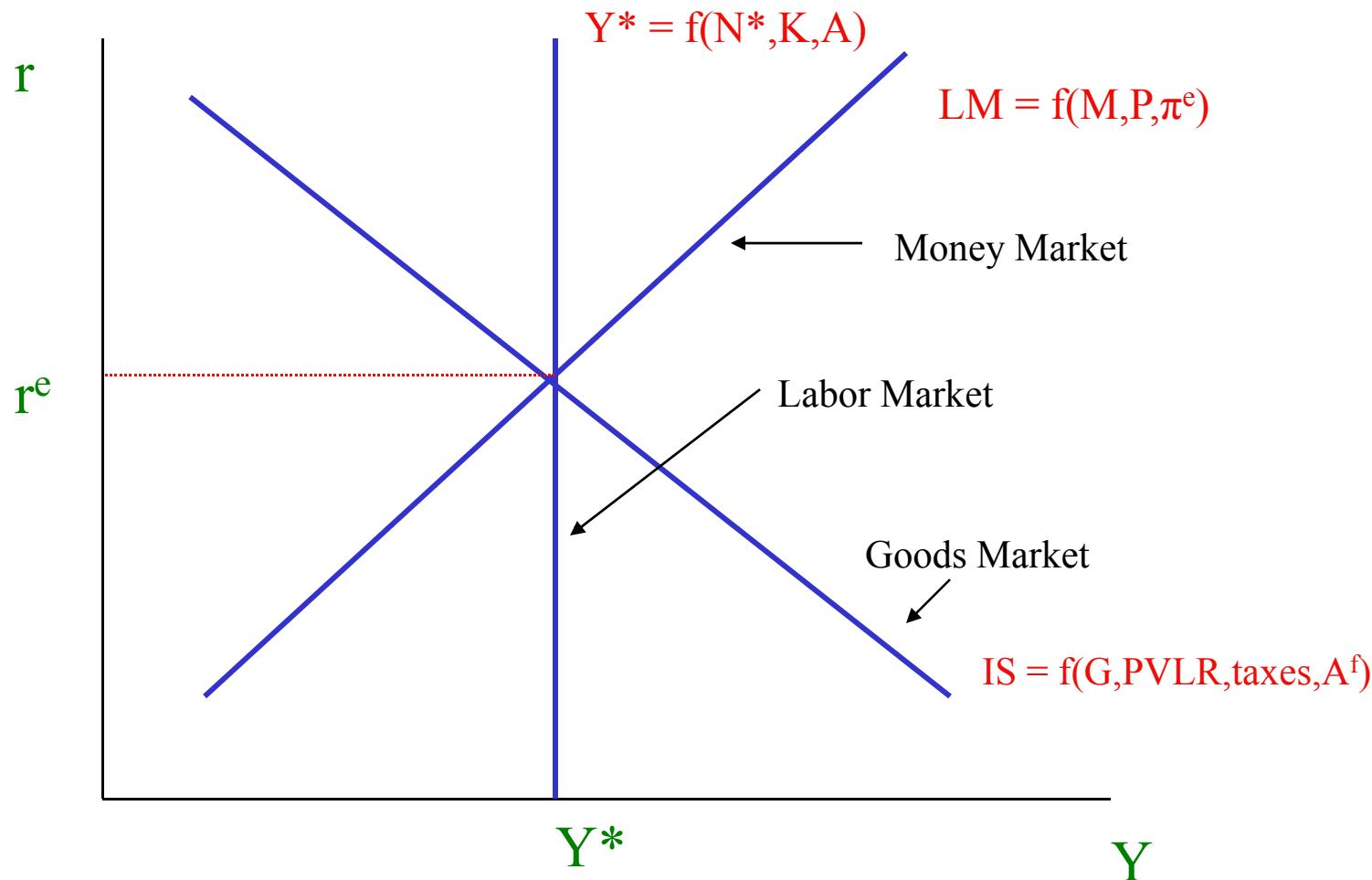
- Factors Affecting Labor Supply
  - The Real Wage ( $w/p$ )
  - The Household's Present Value of Lifetime Resources (**PVLR**)
  - The Marginal Tax Rate on Labor Income ( $t_n$ )
  - The Marginal Tax Rate on Consumption ( $t_c$ )
  - Value of Leisure (reservation wage) - non-'work' status (**VL**)
  - The Working Age Population (**pop**)
- Factors affecting Labor Demand:
  - TFP (**A**)
  - Capital (**K**)

**Y\* is not sensitive to r!**

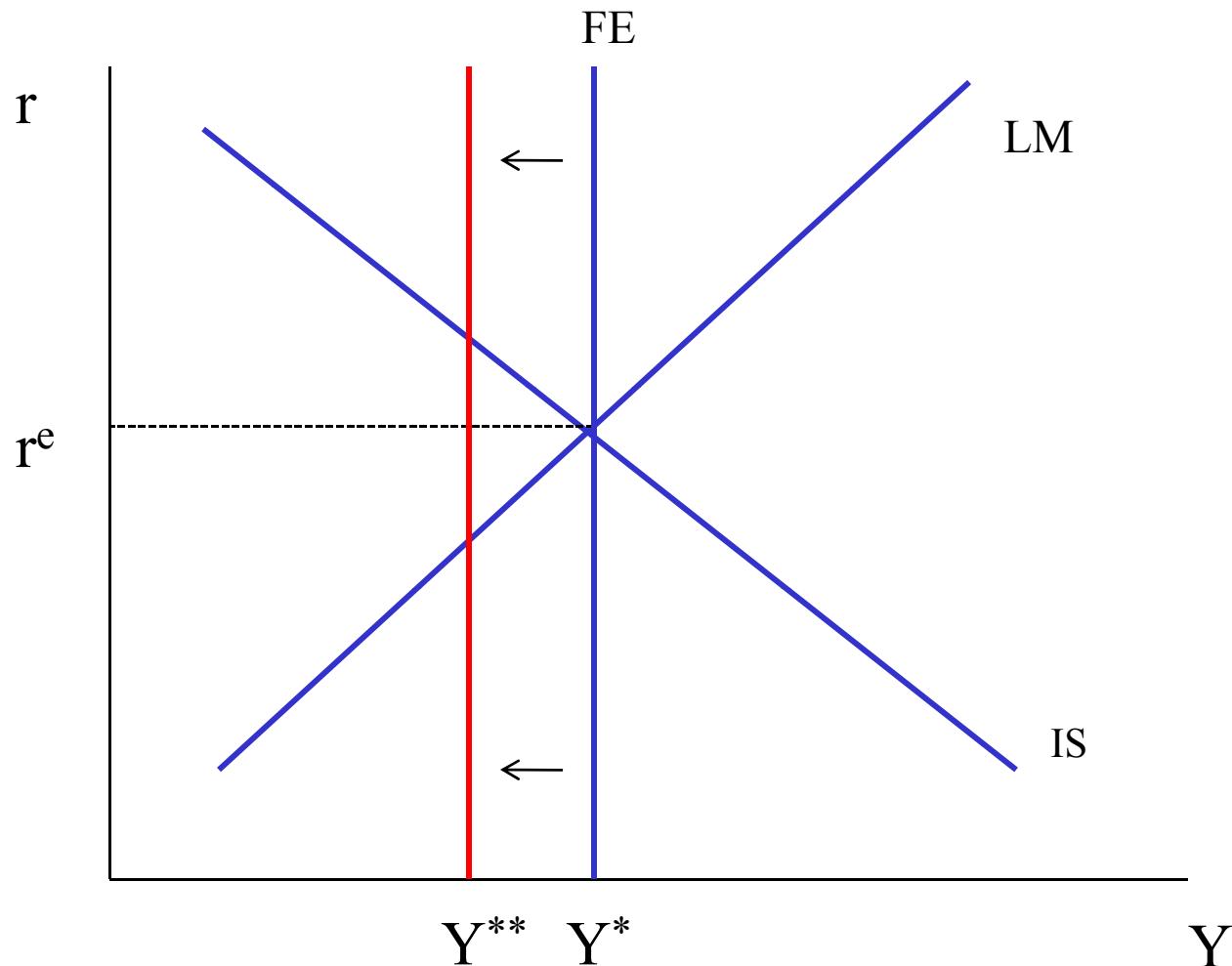
## What shifts $Y^*$ ?

- Anything that affects the **labor market** will affect  $Y^*$ !
- If  $N^*$  increases,  $Y^*$  will shift to the right.
- If  $N^*$  decreases,  $Y^*$  will shift to the left.
- For example,  $Y^*$  will shift right if:
  - $A$  increases
  - $K$  increases
  - population increases
  - labor income taxes fall (and income effect is small relative to substitution effect)
  - labor income taxes rise (and income effect is large relative to substitution effect)

# IS-LM-FE Equilibrium

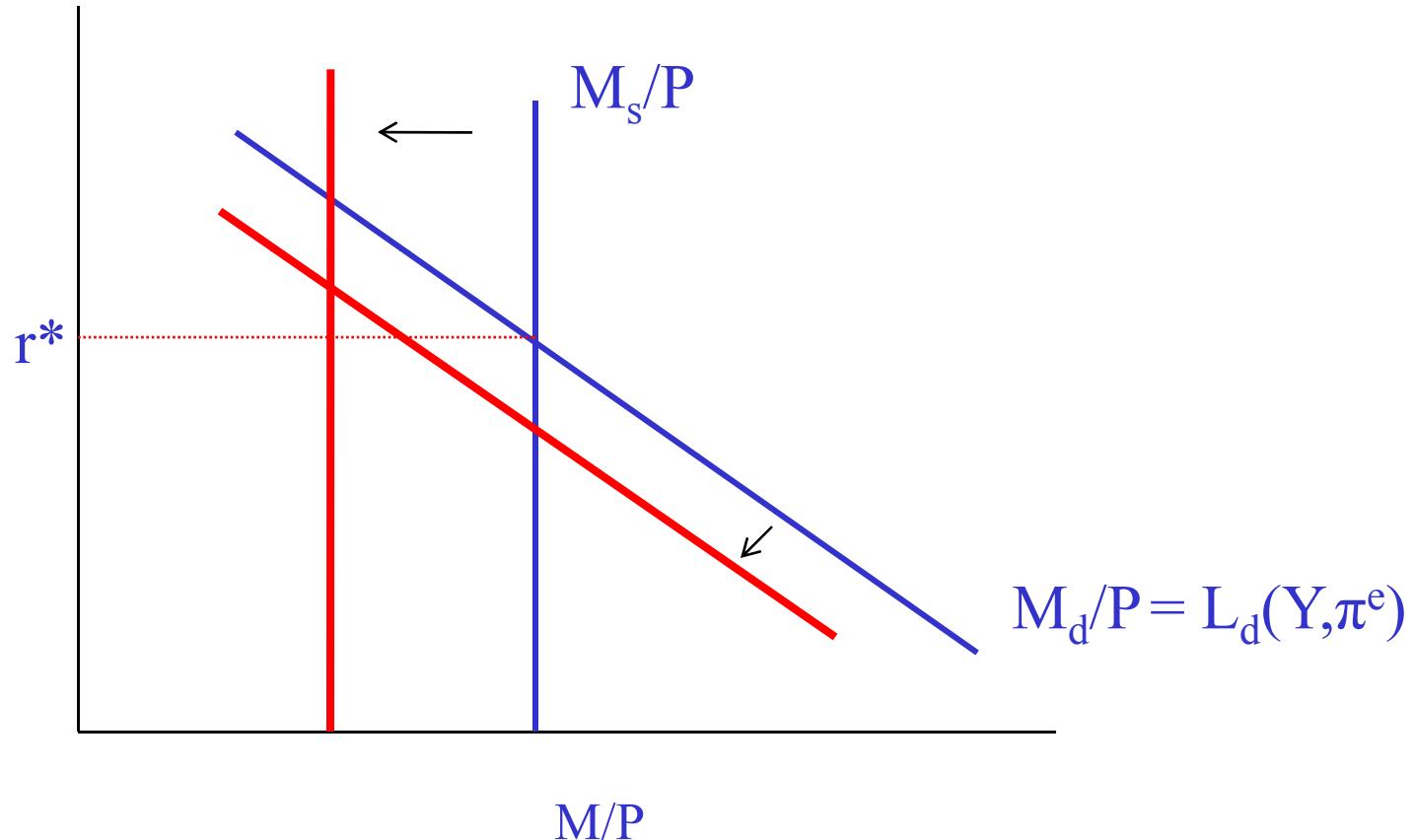


## Temporary Decrease in A (Step 1)

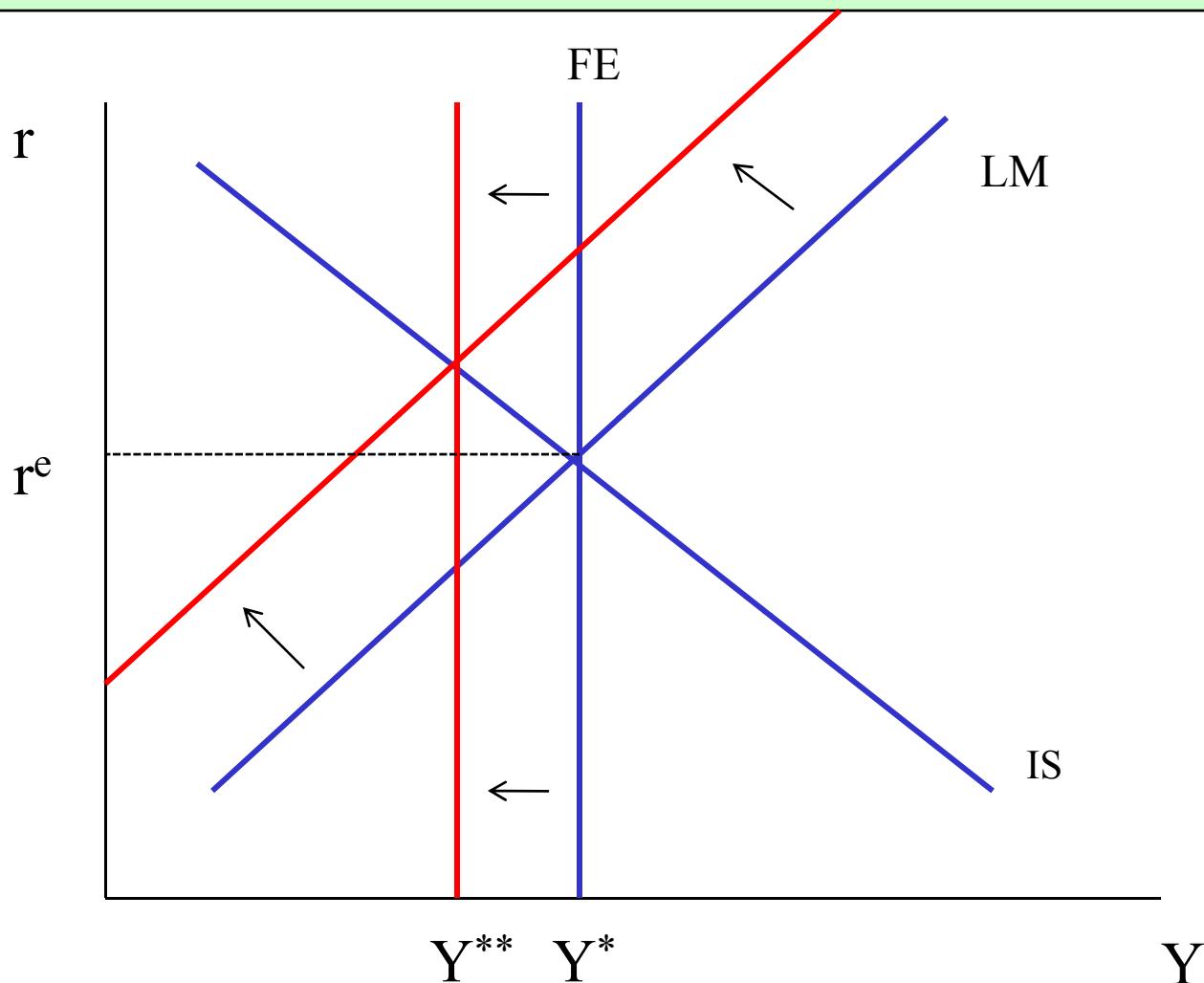


Firms are not going to be willing to produce  $Y^*$  anymore for long, hence  $P$  will increase!

## In the Money Market...



## Temporary Decrease in A (Step 2)



In the new long run equilibrium, output is lower, interest rate higher and prices higher!

# Short Run versus Long run!

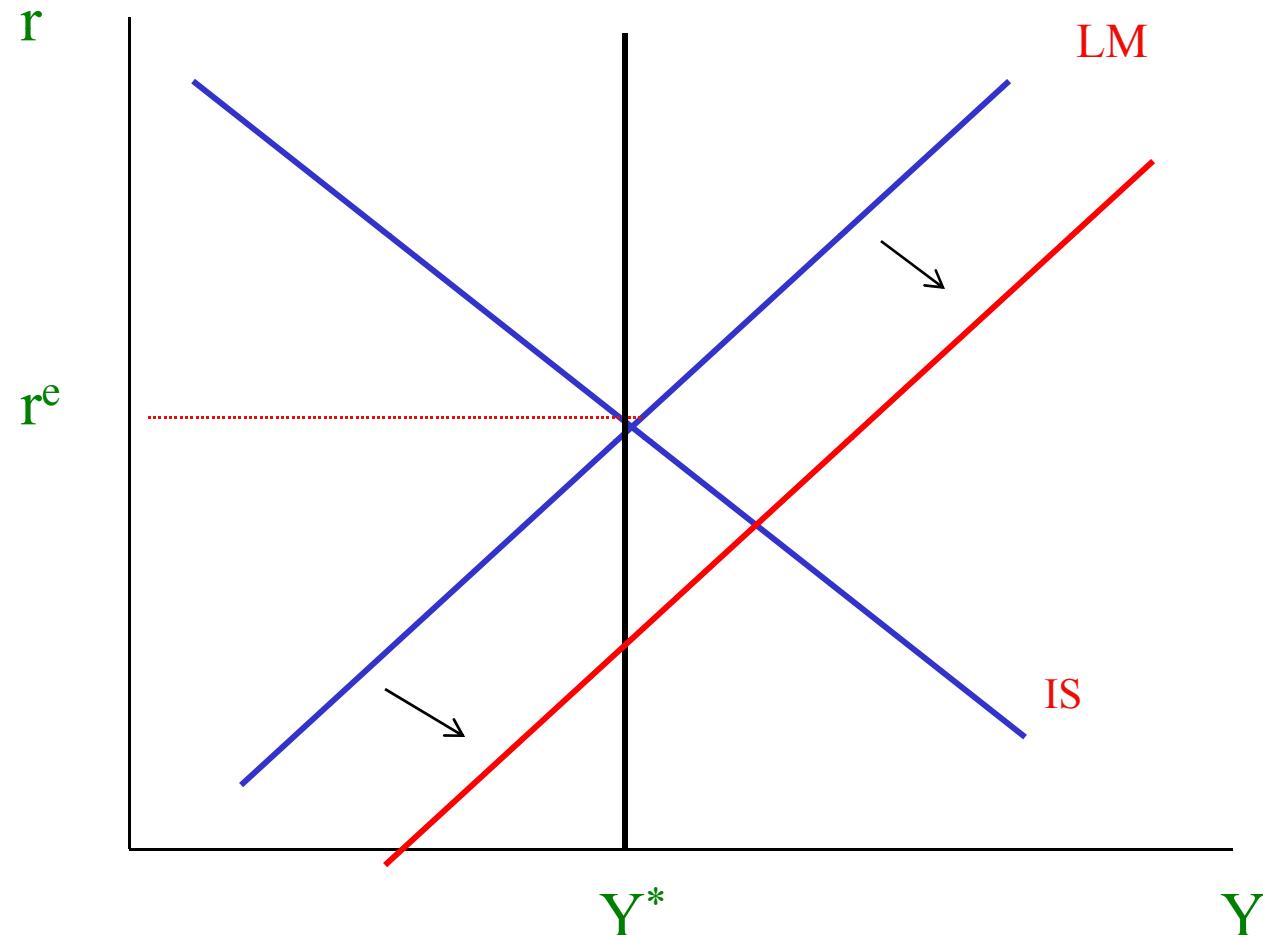
- Conventional Definition:
  - **SHORT RUN:** Prices are sticky
  - **LONG RUN:** Prices adjust
- Traditional debate in Macroeconomics on the “length” of the Short Run!
  - **Classical economists:** prices adjust fast
  - **Keynesian economists:** prices adjust slowly
- Basic Distinction:
  - Business Cycle: focus on the short run
  - Growth: focus on the long run

# Long Run

- The short run equilibrium is an equilibrium in the sense that the aggregate quantity of goods produced is equal to the quantity demanded
- **It is not an equilibrium in the sense that to meet the aggregate demand of goods, firms have to produce more (or less) output than their potential level  $Y^*$ !**
- $Y^*$  is the level of output that maximizes firms' profits. Hence, firms are producing more (or less) than what they would like.
- **This will induce at some point firms to change prices.** If  $M$  increases, firms will start to increase prices up to the point that  $M/P$  is the same as before, so that the demand is equal to  $Y^*$ !

# Monetary Policy in the Short Run

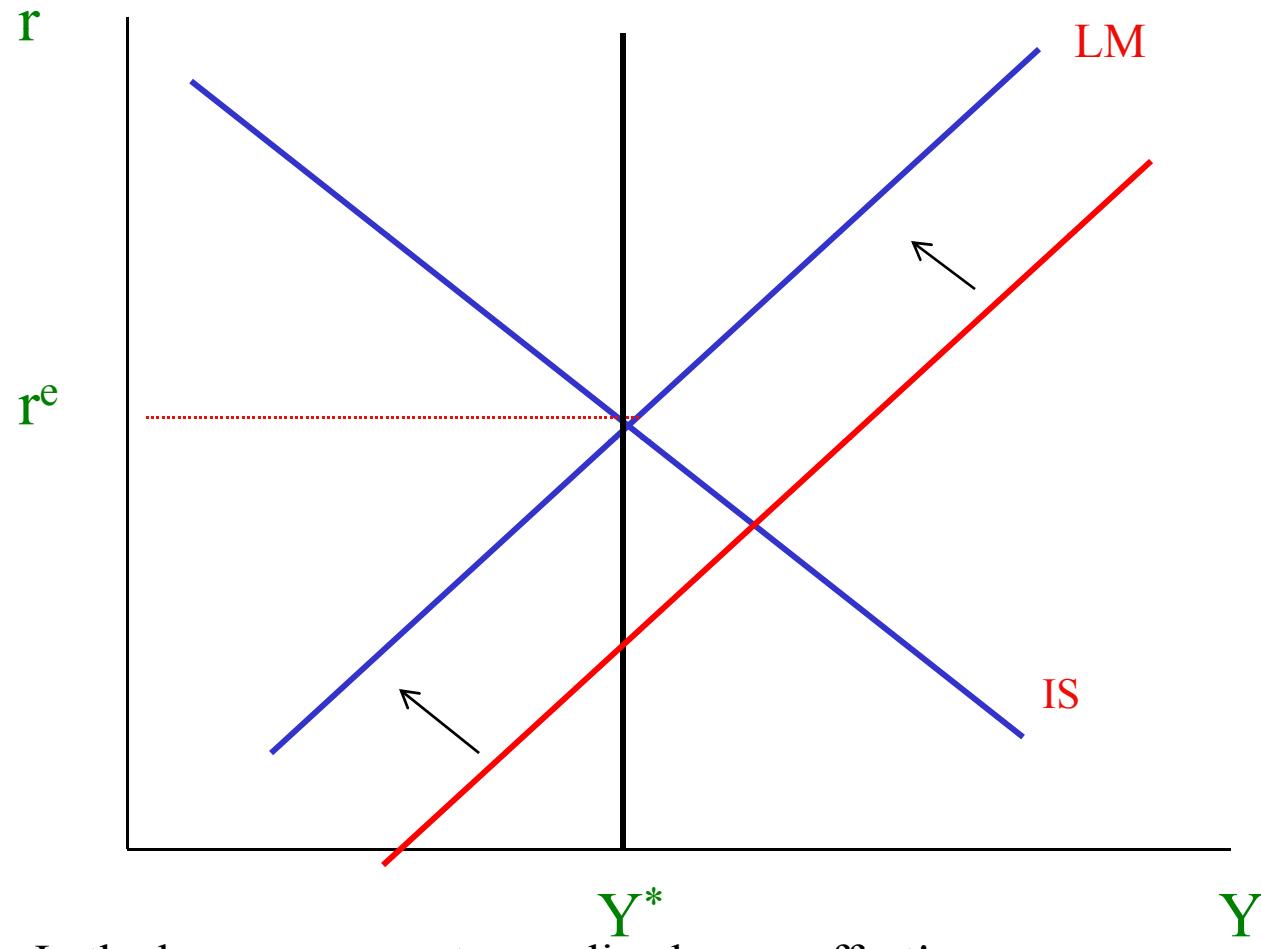
SHORT RUN:  $P$  are fixed



As  $M$  increase, money holders have more money than what they need and increase the demand for bonds and decrease  $r$ . This increases  $I$  and  $C$ .

# Monetary Policy in the Long Run

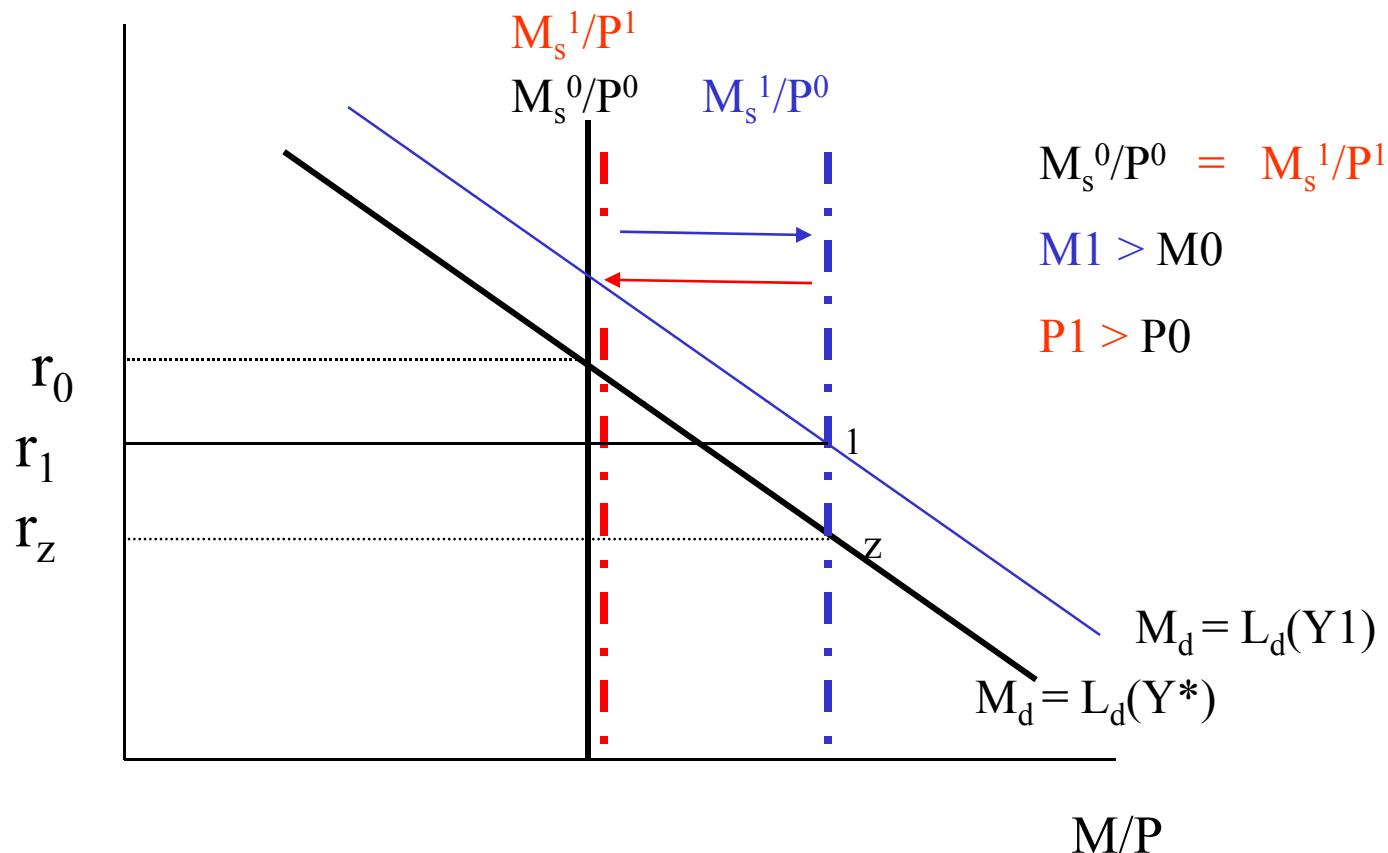
LONG RUN: prices adjust and back to the general equilibrium



In the long-run, monetary policy has no effect!

# Money Market (Short run / Long run)

The effectiveness of Monetary Policy will depend on how sticky prices are

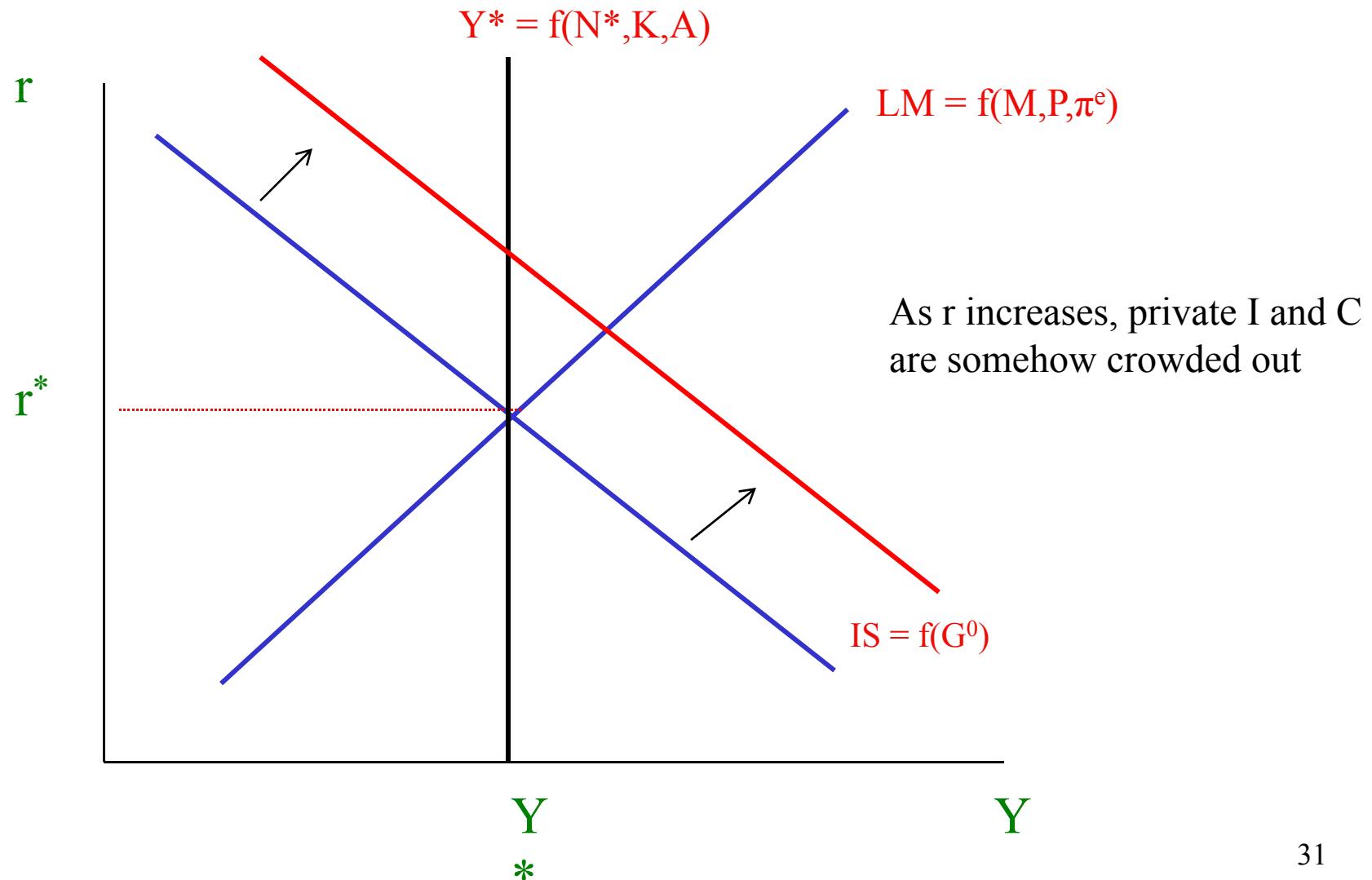


# Monetary Neutrality

- **Consensus: after some economic disturbance prices will eventually restore the economic general equilibrium**
- Disagreement on the speed of this adjustment!
- Classical economists: prices adjust immediately
  - Money is Neutral!
- Keynesian economists: prices are sticky
- **Money is neutral only in the long run, it is non-neutral in the short run!**

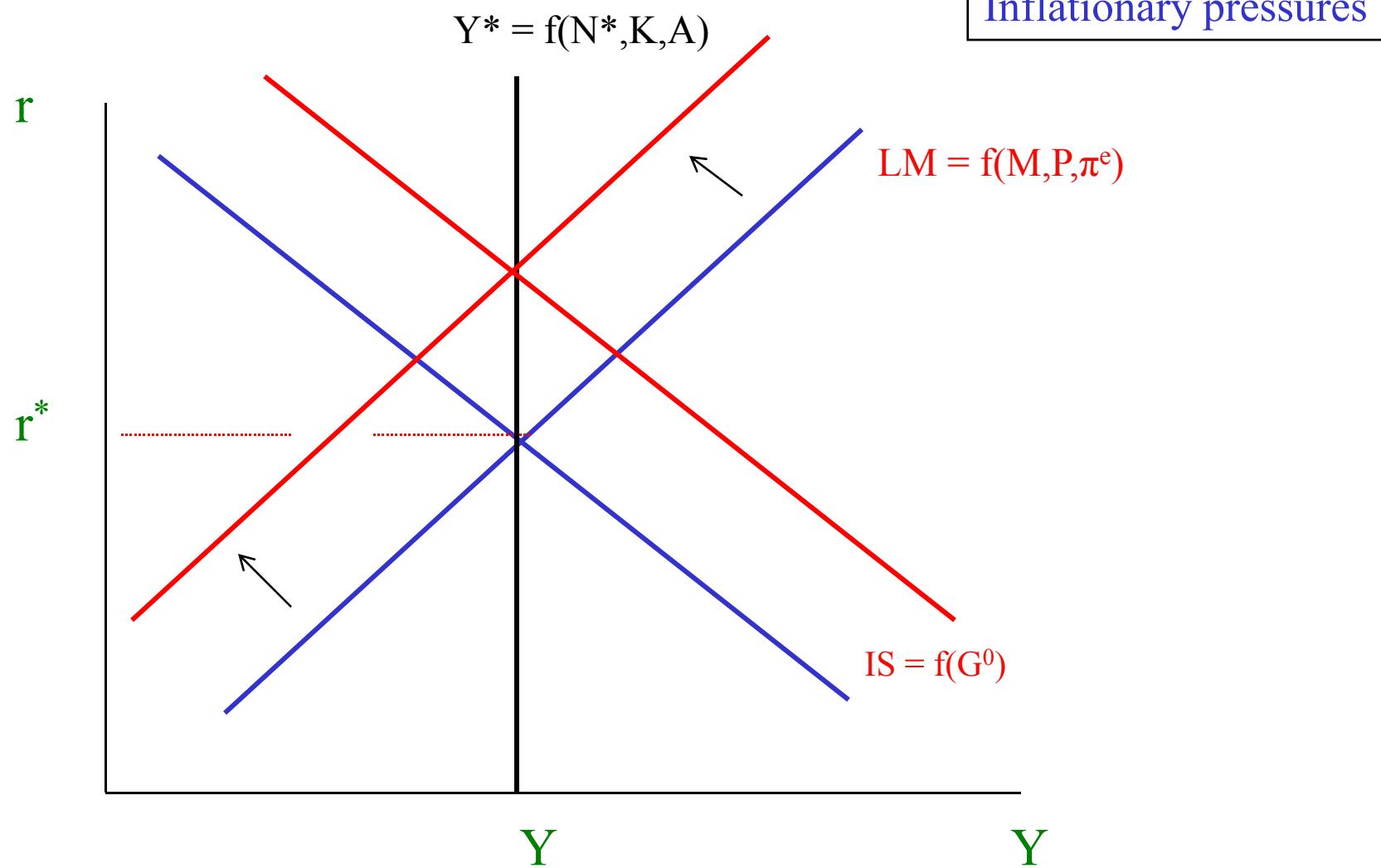
# Fiscal Policy in the Short Run

Suppose  $G$  increases



# Fiscal Policy in the Long Run

If fiscal policy doesn't affect  $Y^*$ , then prices will rise and LM shifts in....



Output is unchanged and  $G^*$  has crowded out C and I (through higher  $r$ )<sup>32</sup>

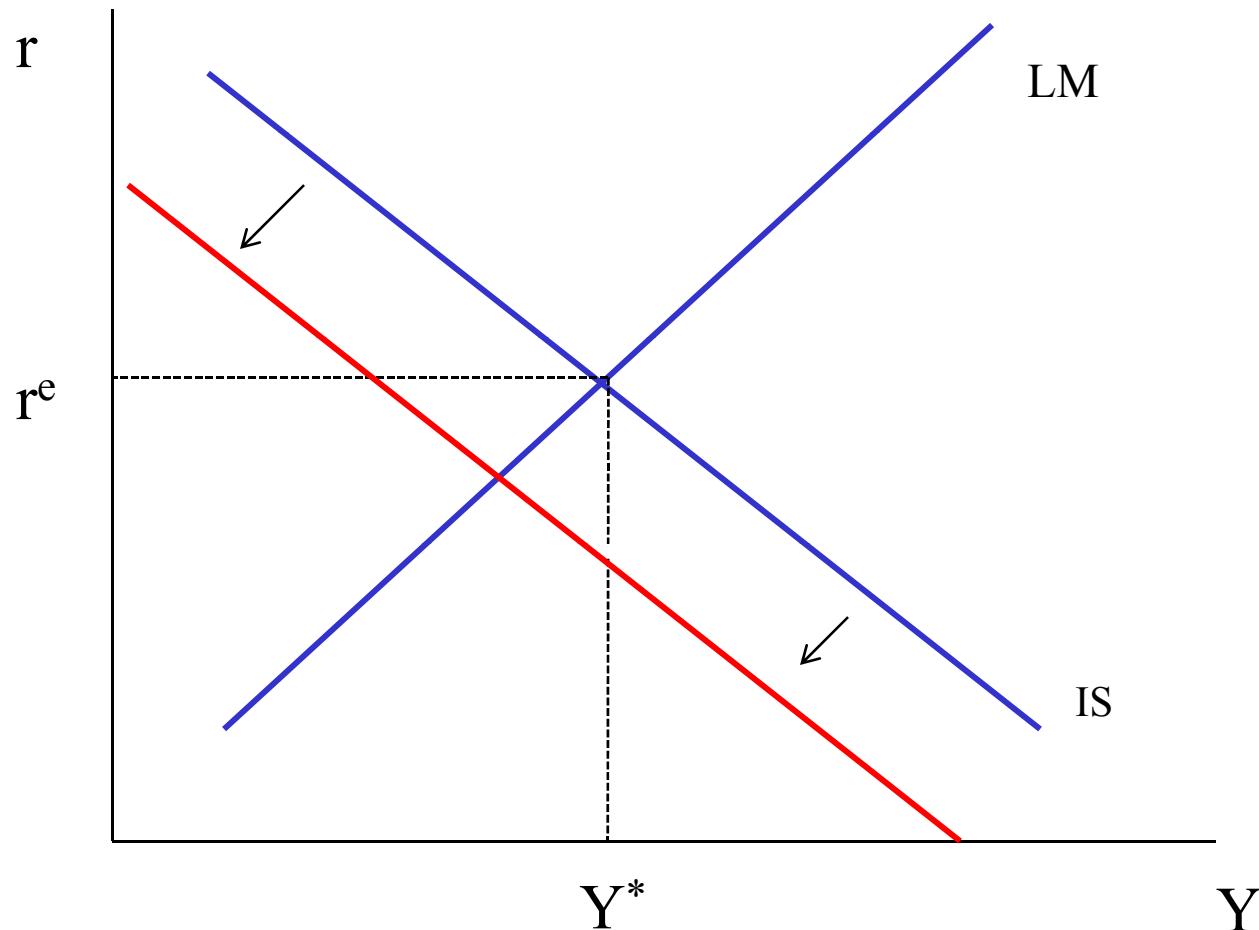
## A first look at the current recession

How can we represent the current recession in the IS-LM model?

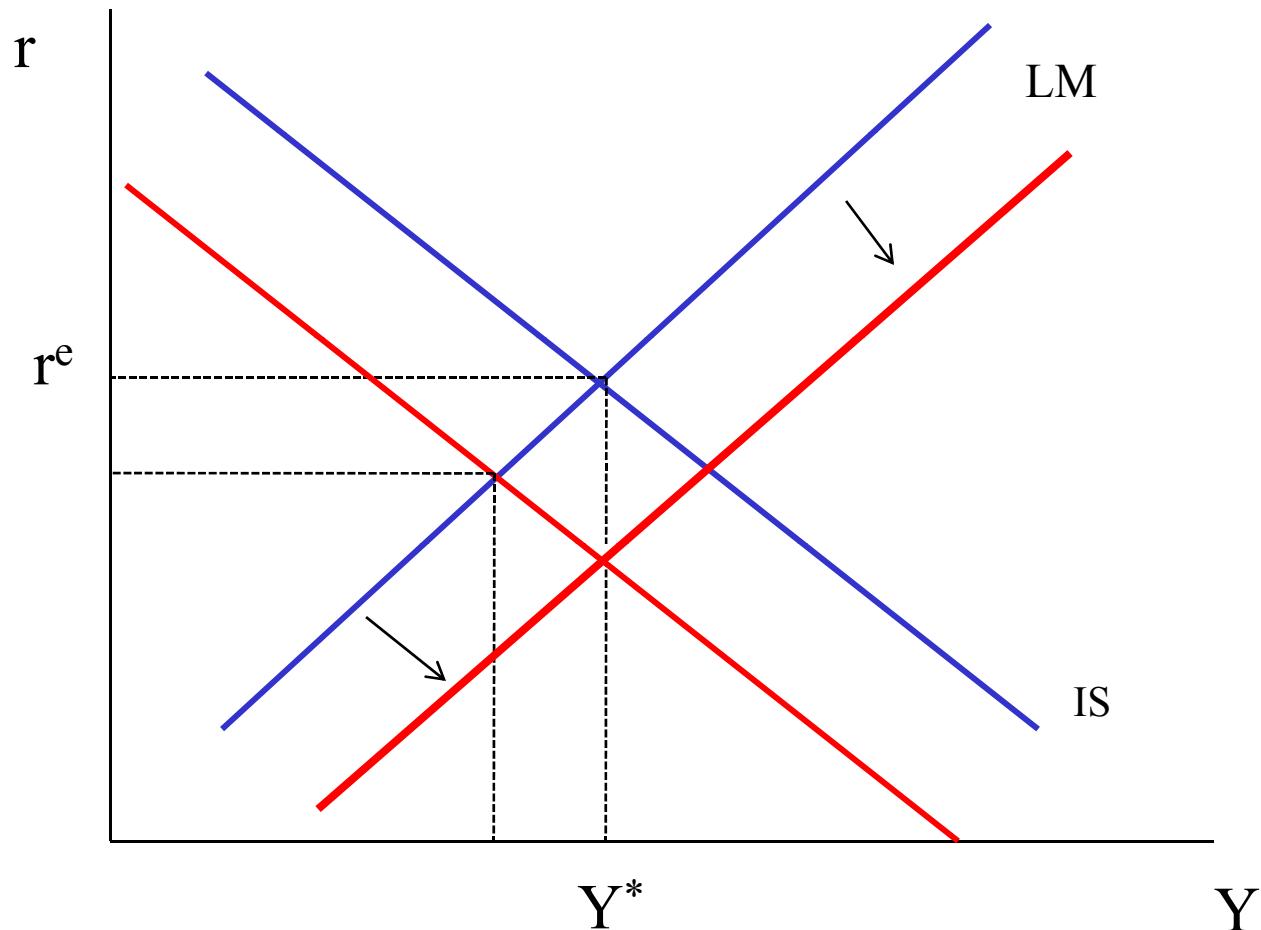
As a **negative shock to the IS Curve** for different reasons:

- 1) Direct reduction in C and I due to credit crunch
- 2) Fall in consumer and business confidence
- 3) Fall in financial wealth (NPVLR)

## Fall in private demand: a recession



# Fighting the recession: Monetary Policy



Expansionary Monetary Policy by the Fed:  $M^s$  increases  
Recall: prices are fixed for now.

# When Monetary Policy does not work...

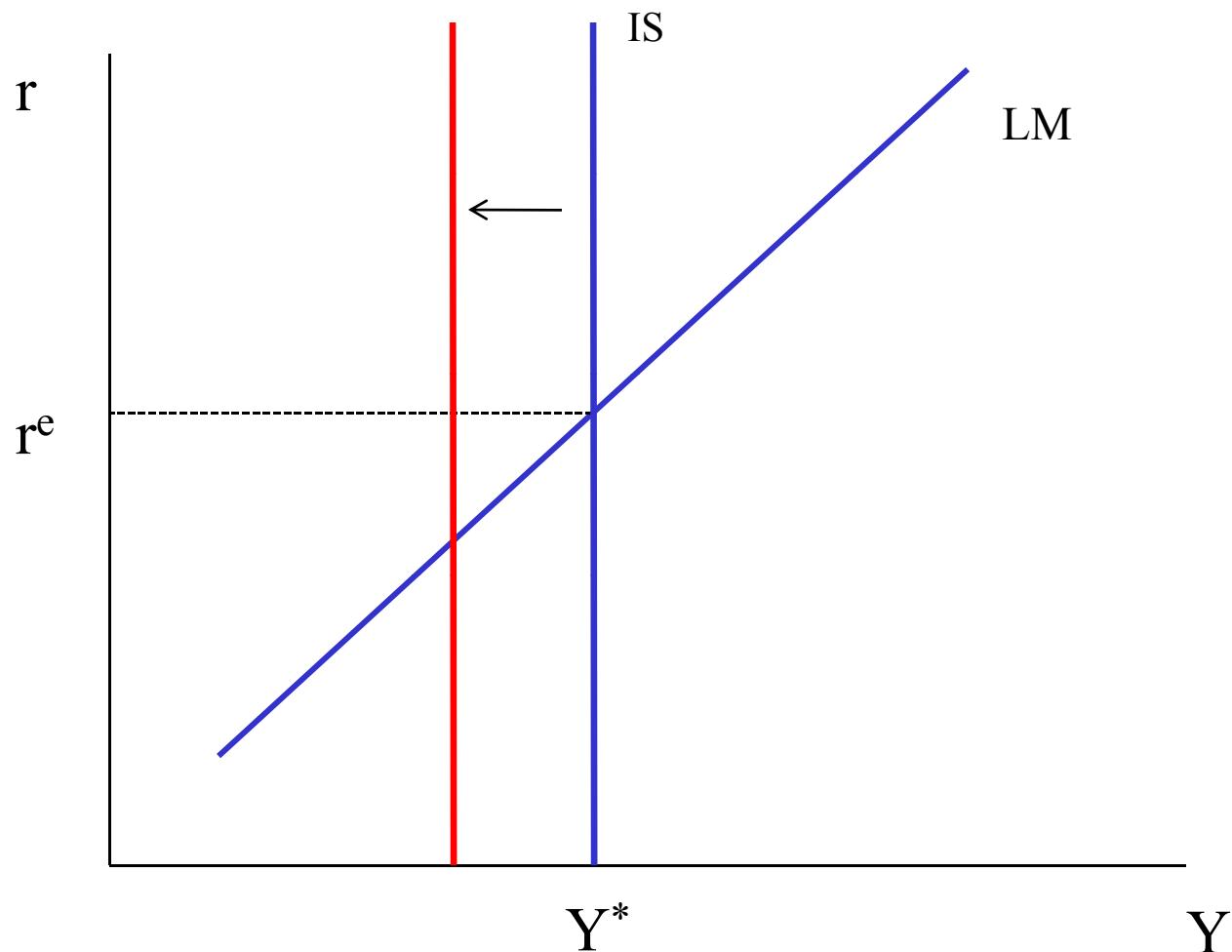
## 1) Vertical IS Curve

- firms don't respond much to interest rate changes if they think that the banking system is frozen
- The effect of an expansionary monetary policy is damped

## 1) Horizontal LM Curve → Liquidity Trap

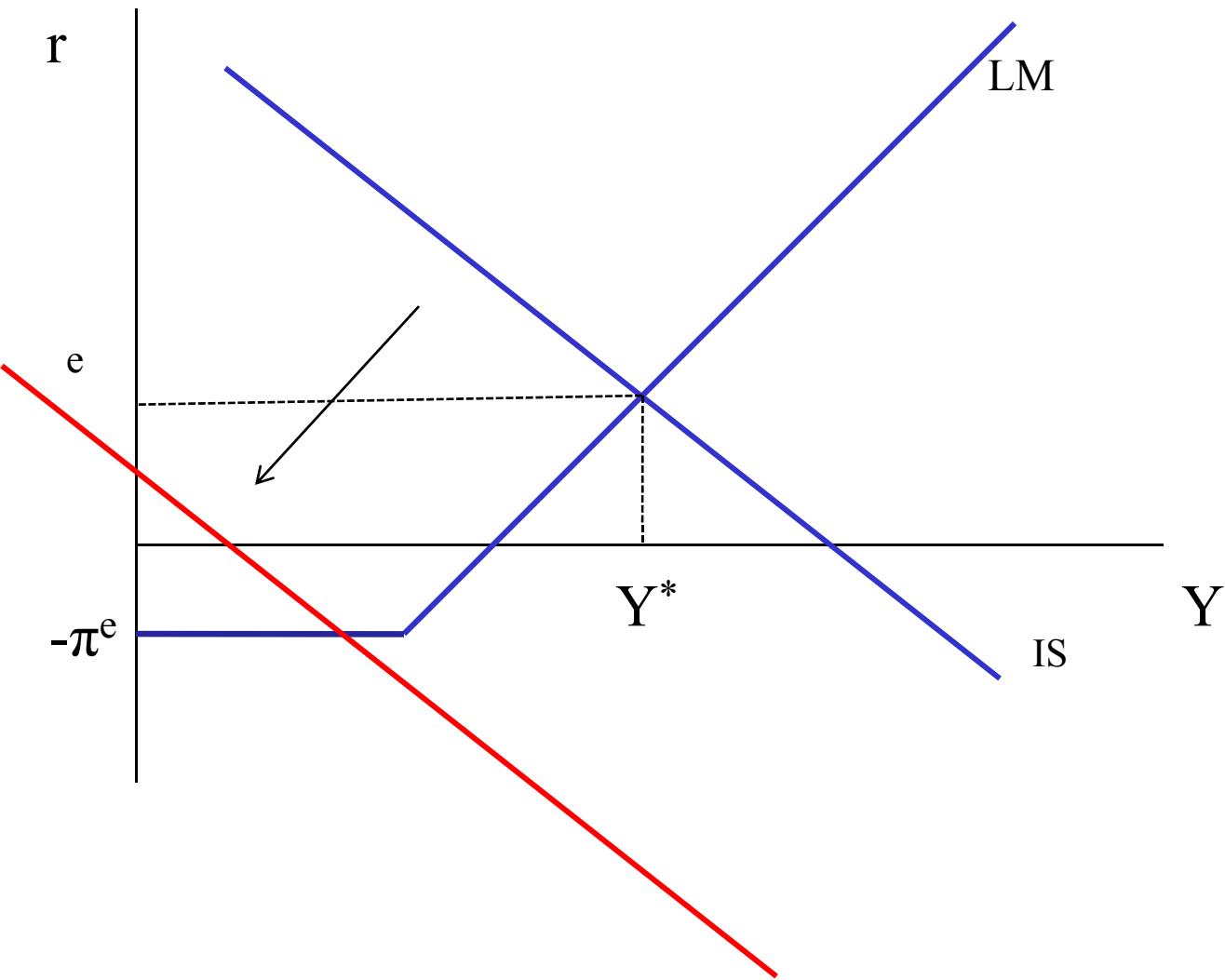
- Nominal interests rates are bounded at zero
- Lower bound on  $r$  is equal to  $-\pi^e$  and the Fed cannot reduce it further!
- This is what is happening now in the US and what happened in Japan in the late 1990s
- Read Krugman's Babysitting the Economy (From Week 1)

## Vertical IS

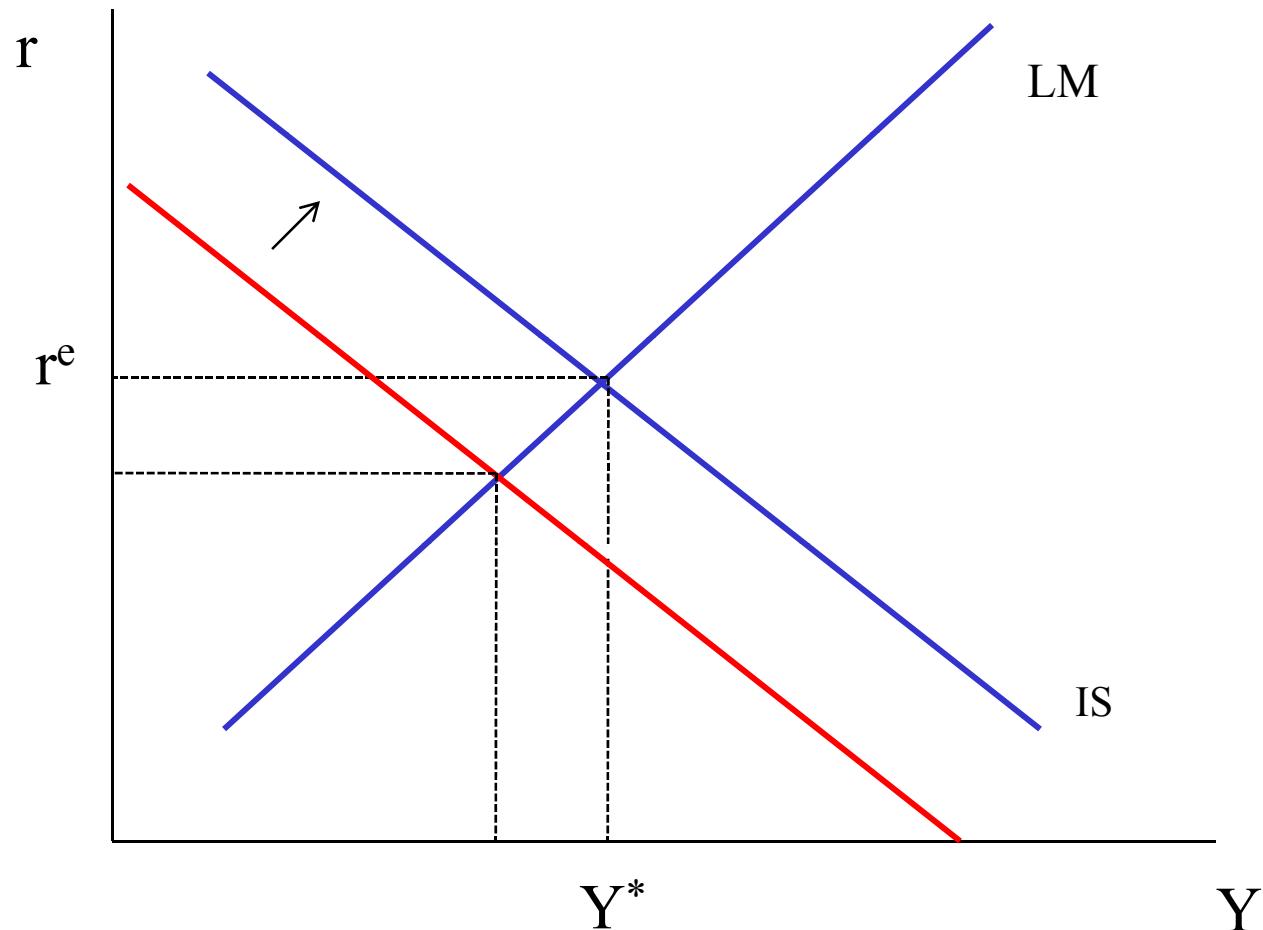


What if  $M_s$  increases?

# Liquidity Trap



## Fighting the Recession: Fiscal Policy



If monetary policy does not work →

fiscal stimulus:  $G$  increases

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14.02 Principles of Macroeconomics

Fall 2009

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