

# Topic 7: The IS-LM/AD-AS Model: A General Framework for Macroeconomic Analysis

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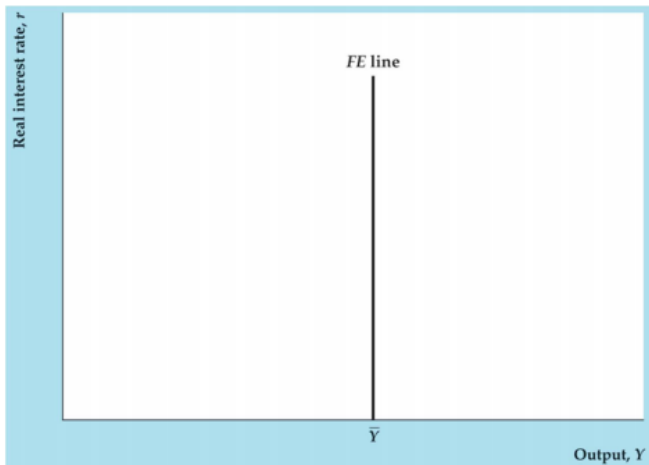
# Chapter Outline

- Discuss factors that affect the the full-employment ( $FE$ ) line (Equilibrium in the labour market).
- Discuss factors that affect the  $IS$  Curve (equilibrium in the goods market).
- Discuss factors that affect the  $LM$  Curve (asset market equilibrium).
- Describe the conditions necessary for general equilibrium using the complete  $IS - LM$  model.
- Discuss the role of price adjustment in achieving general equilibrium.
- Explain the fundamentals and implications of the  $AD - AS$  model.

# The FE Line: Equilibrium in the Labour Market

- We have discussed three main markets of the economy: the labour market, the goods market, and the asset market. In this topic we discuss how they fit into a complete macro system.
- Labour market in Topic 2 showed how equilibrium in the labour market leads to employment at its full-employment level ( $\bar{N}$ ) and output at its full-employment level ( $\bar{Y}$ ).
  - Adjustment in real wage brings equilibrium in the labour market.
- Our ultimate objective is a diagram that has the real interest rate on the vertical axis and output on the horizontal axis.
- If we plot output against the real interest rate, we get a vertical line, since labour market equilibrium is unaffected by changes in the real interest rate.

# The FE Line (1 of 2)



## The FE Line (2 of 2)

- Factors that shift the FE line. The full employment level of output is determined by the full-employment level of employment and the current levels of capital and productivity; any change in these variables shifts the FE line.
- The following summary lists the factors that shift the full-employment line. The full-employment line shifts right because of:
  - a beneficial supply shock.
  - an increase in labour supply.
  - an increase in the capital stock.
- The full-employment line shifts left when the opposite happens to the three factors above.

# Summary

## Factors That Shift the Full-Employment (*FE*) Line

A(n)	Shifts the <i>FE</i> line	Reason
Beneficial supply shock	Right	<ol style="list-style-type: none"> <li>1. More output can be produced for the same amount of capital and labor.</li> <li>2. If the <i>MPN</i> rises, labor demand increases and raises employment.</li> </ol> Full-employment output increases for both reasons.
Increase in labor supply	Right	Equilibrium employment rises, raising full-employment output.
Increase in the capital stock	Right	More output can be produced with the same amount of labor. In addition, increased capital may increase the <i>MPN</i> , which increases labor demand and equilibrium employment.

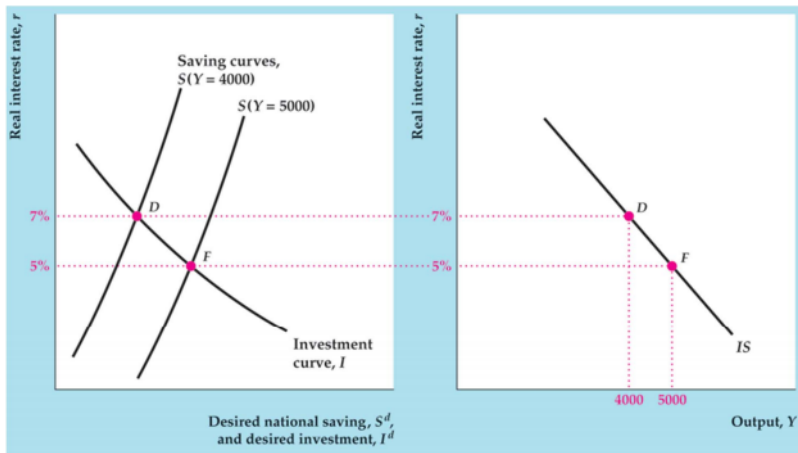
# The IS Curve: Equilibrium in the Goods Market

- The goods market clears when desired investment equals desired national saving or equivalently, when the aggregate quantity of goods supplied equals the aggregate quantity of goods demanded:

$$I^d = S^d \text{ or } Y = C^d + I^d + G$$

- Adjustments in the real interest rate help bring about equilibrium in the goods market.
- For any level of output  $Y$ , the  $IS$  curve shows the real interest rate  $r$  for which the goods market is in equilibrium.
- Derivation of the  $IS$  curve from the saving-investment diagram.

# Deriving the IS curve





# The IS Curve (1 of 3)

- Key features:
  - The saving curve slopes upward because a higher real IR increases saving.
  - An increase in output shifts the saving curve to the right, because people save more when their income is higher. ( $0 < MPC < 1$ )
  - The investment curve slopes downward because a higher real IR reduces the desired capital stock, thus reducing investment.

## The IS Curve (2 of 3)

- Consider two different levels of output:
  - At the higher level of output, the saving curve is shifted to the right compared to the situation at the lower level of output.
  - Since the investment curve is downward sloping, equilibrium at the higher level of output has a lower real interest rate.
  - Thus a higher level of output must lead to a lower real IR, so the IS curve slopes downward.
  - The *IS* curve shows the relationship between the real IR and output for which investment equals saving.

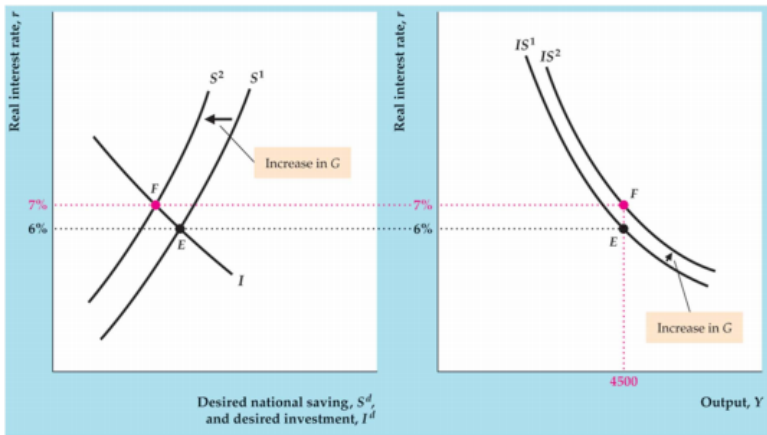
# The IS Curve (3 of 3)

- Alternative interpretation in terms of goods market equilibrium:
  - Beginning at a point of equilibrium, suppose the real interest rate rises.
  - The increased real interest rate causes people to increase saving and thus reduce consumption, and causes firms to reduce investment.
  - So the quantity of goods demanded declines.
  - To restore equilibrium, the quantity of goods supplied would have to decline.
  - So higher real IRs are associated with lower output, that is, the *IS* curve slopes downward.

## Factors that shift the IS curve (1 of 2)

- Any change that reduces desired national saving relative to desired investment shifts the *IS* curve up and to the right.
- Intuitively, imagine constant output, so a reduction in saving means more investment relative to saving; the interest rate must rise to reduce investment and increase saving.
- Similarly, a change that increases desired national saving relative to desired investment shifts the *IS* curve down and to the left.
- An alternative way of stating this is that a change that increases aggregate demand for goods shifts the *IS* curve up and to the right:
  - In this case, the increase in aggregate demand for goods exceeds the supply.
  - The real IR must rise to reduce desired consumption and investment and restore equilibrium.

# Effect on the $IS$ curve of a temporary increase in government purchases



## Factors that shift the IS curve (2 of 2)

- The following summary lists the factors that shift the *IS* curve: The *IS* curve shifts up and to the right because of
  - an increase in expected future output.
  - an increase in wealth.
  - a temporary increase in government purchases.
  - a decline in taxes (if Ricardian equivalence doesn't hold).
  - an increase in the expected future marginal product of capital.
  - a decrease in the effective tax rate on capital.
- The *IS* curve shifts down and to the left when the opposite happens to the six factors above.

# Summary

Factors That Shift the <i>IS</i> Curve		
An increase in	Shifts the <i>IS</i> curve	Reason
Expected future output	Up and to the right	Desired saving falls (desired consumption rises), raising the real interest rate that clears the goods market.
Wealth	Up and to the right	Desired saving falls (desired consumption rises), raising the real interest rate that clears the goods market.
Government purchases, $G$	Up and to the right	Desired saving falls (demand for goods rises), raising the real interest rate that clears the goods market.
Taxes, $T$	No change or down and to the left	No change, if consumers take into account an offsetting future tax cut and do not change consumption (Ricardian equivalence); down and to the left, if consumers don't take into account a future tax cut and reduce desired consumption, increasing desired national saving and lowering the real interest rate that clears the goods market.
Expected future marginal product of capital, $MPK^f$	Up and to the right	Desired investment increases, raising the real interest rate that clears the goods market.
Effective tax rate on capital	Down and to the left	Desired investment falls, lowering the real interest rate that clears the goods market.

# The LM Curve: Asset Market Equilibrium

- The interest rate and the price of a nonmonetary asset.
- The price of a nonmonetary asset is inversely related to its interest rate or yield.
  - Example: A bond pays \$10,000 in one year; its current price is \$9615, and its interest rate is 4%, since  $(\$10,000 - \$9615)/\$9615 = 4\%$ .
  - If the price of the bond in the market were to fall to \$9524, its yield would rise to 5%, since  $(\$10,000 - \$9524)/\$9524 = 5\%$ .
- For a given level of expected inflation, the price of a nonmonetary asset is inversely related to the real IR.



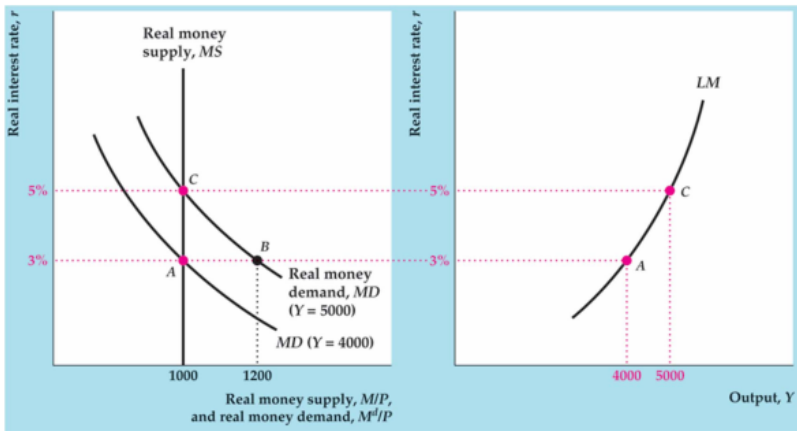
# The equality of money demanded and money supplied

- Equilibrium in the asset market requires that the real money supply equal the real quantity of money demanded.

$$\frac{M}{P} = L(Y, r + \pi^e)$$

- Real money supply is determined by the central bank and isn't affected by the real interest rate.
- Real money demand falls as the real IR rises.
- Real money demand rises as the level of output rises.
- The *LM* curve is derived by plotting real money demand for different levels of output and looking at the resulting equilibrium.

# Deriving the $LM$ curve



## By what mechanism is equilibrium restored?

- Starting at equilibrium, suppose output rises, so real money demand increases.
- The rise in people's demand for money makes them sell nonmonetary assets, so the price of those assets falls and the real IR rises.
- As the IR rises, the demand for money declines until equilibrium is reached.
- The *LM* curve shows the combinations of the real IR and output that clear the asset market:
  - Intuitively, for any given level of output, the *LM* curve shows the real IR necessary to equate real money demand and supply.
  - Thus the *LM* curve slopes upward from left to right.

## Factors that shift the LM curve (1 of 2)

- Any change that reduces real money supply relative to real money demand shifts the *LM* curve up:
  - For a given level of output, the reduction in real money supply relative to real money demand causes the equilibrium real IR to rise.
  - The rise in the real IR is shown as an upward shift of the *LM* curve.
- Similarly, a change that increases real money supply relative to real money demand shifts the *LM* curve down and to the right.

## Factors that shift the LM curve (2 of 2)

- The LM curve shifts down and to the right because of:
  - an increase in the nominal money supply.
  - a decrease in the price level.
  - an increase in expected inflation.
  - a decrease in the nominal IR on money.
  - a decrease in wealth.
  - a decrease in the risk of alternative assets relative to the risk of holding money.
  - an increase in the liquidity of alternative assets.
  - an increase in the efficiency of payment technologies.
- The *LM* curve shifts up and to the left when the opposite happens to the eight factors listed above.

# Summary

Factors That Shift the <i>LM</i> Curve		
An increase in	Shifts the <i>LM</i> curve	Reason
Nominal money supply, $M$	Down and to the right	Real money supply increases, lowering the real interest rate that clears the asset market (equates money supplied and money demanded).
Price level, $P$	Up and to the left	Real money supply falls, raising the real interest rate that clears the asset market.
Expected inflation, $\pi^e$	Down and to the right	Demand for money falls, lowering the real interest rate that clears the asset market.
Nominal interest rate on money, $j^m$	Up and to the left	Demand for money increases, raising the real interest rate that clears the asset market.

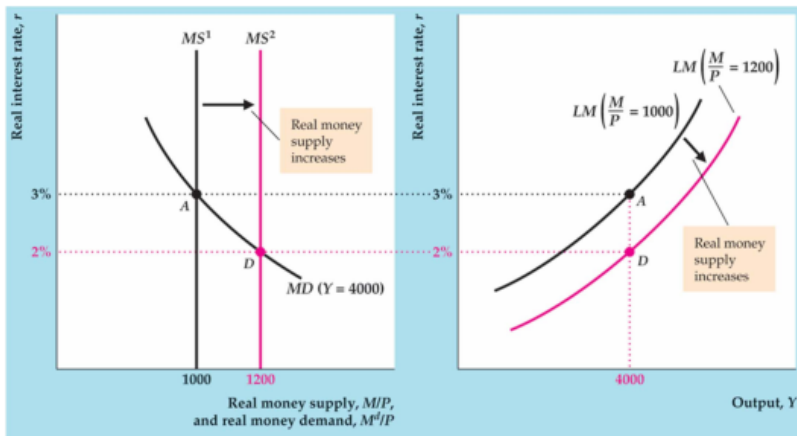
In addition, for constant output, any factor that increases real money demand raises the real interest rate that clears the asset market and shifts the *LM* curve up and to the left. Other factors that increase real money demand (see Summary table 9, p. 260) include

- an increase in wealth;
- an increase in the risk of alternative assets relative to the risk of holding money;
- a decline in the liquidity of alternative assets; and
- a decline in the efficiency of payment technologies.

# Changes in the real money supply

- An increase in the real money supply,  $M/P$ , will reduce the real IR that clears the asset market and shift the  $LM$  curve down and to the right.
- Similarly, a drop in real money supply shifts the  $LM$  curve up and to the left.
- The real money supply changes when the nominal money supply changes at a different rate than the price level.

An increase in the real money supply shifts the  $LM$  curve down and to the right

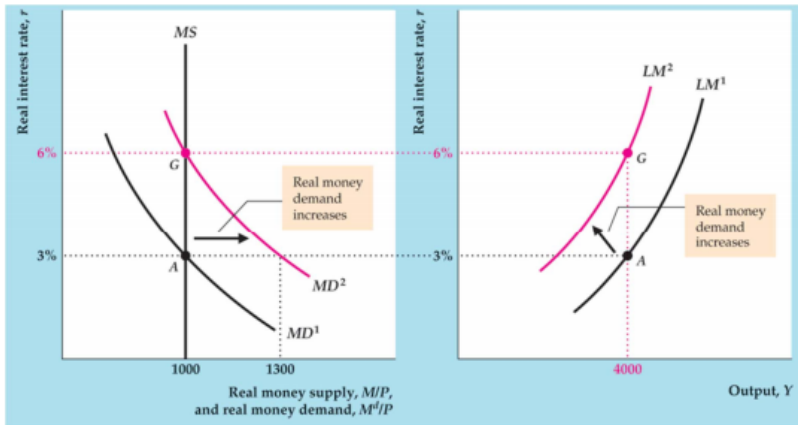




# Changes in real money demand

- A change in any variable that affects real money demand, other than output or the real IR, will also shift the  $LM$  curve.
- An increase in real money demand shifts the  $LM$  curve up and to the left.
- Similarly, a drop in real money demand shifts the  $LM$  curve down and to the right.

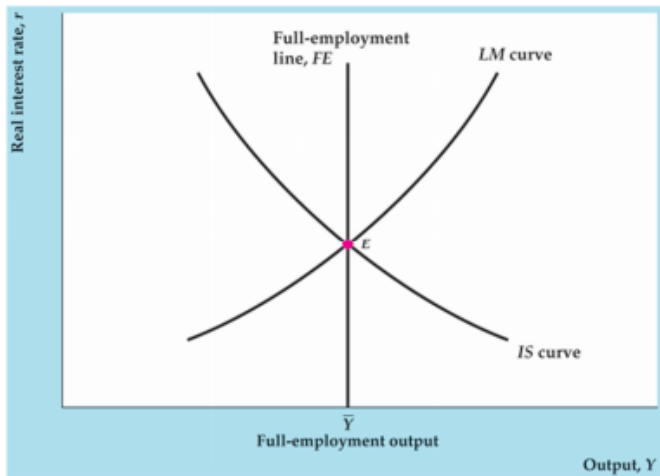
An increase in the real money demand shifts the  $LM$  curve up and to the left



# General Equilibrium in the Complete IS-LM Model

- When all markets are simultaneously in equilibrium there is a general equilibrium.
- It is a long-run equilibrium.
- This occurs where the  $FE$ ,  $IS$ , and  $LM$  curves intersect.

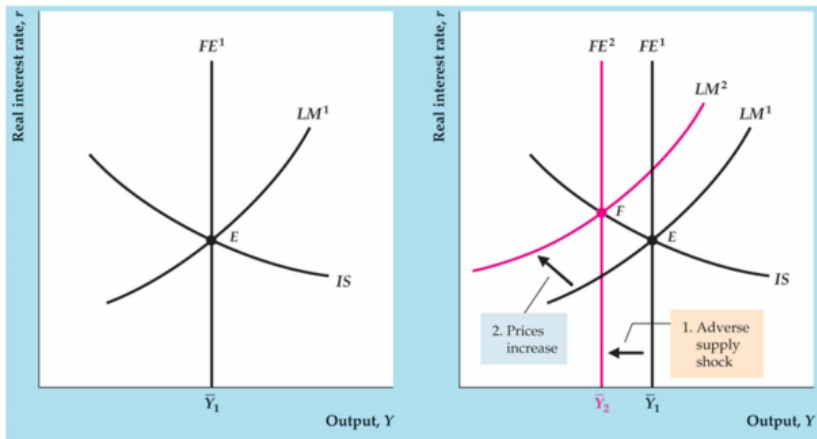
# General Equilibrium in the IS-LM Model



# Applying the IS-LM framework: A temporary adverse supply shock

- Suppose the productivity parameter in the production function falls temporarily due to some disease (SARS in China, 2003).
- The supply shock reduces the marginal productivity of labour, hence labour demand.
  - With lower labour demand, the equilibrium real wage and employment fall.
  - Lower employment and lower productivity both reduce the equilibrium level of output, thus shifting the  $FE$  line to the left.
- There's no effect of a temporary supply shock on the  $IS$  or  $LM$  curves.
- Since the  $FE$ ,  $IS$ , and  $LM$  curves don't intersect, the price level adjusts, shifting the  $LM$  curve until a general equilibrium is reached.
  - In this case the price level rises to shift the  $LM$  curve up and to the left to restore equilibrium.

# Effects of a temporary adverse supply shock



# Applying the IS-LM framework: A temporary adverse supply shock

- The inflation rate rises temporarily, not permanently.
- Summary: The real wage, employment, and output decline, while the real interest rate and price level are higher
  - There is a temporary burst of inflation as the price level moves to a higher level.
  - Since the real IR is higher and output is lower, consumption and investment must be lower.

## Application: Oil price shocks revisited (1 of 2)

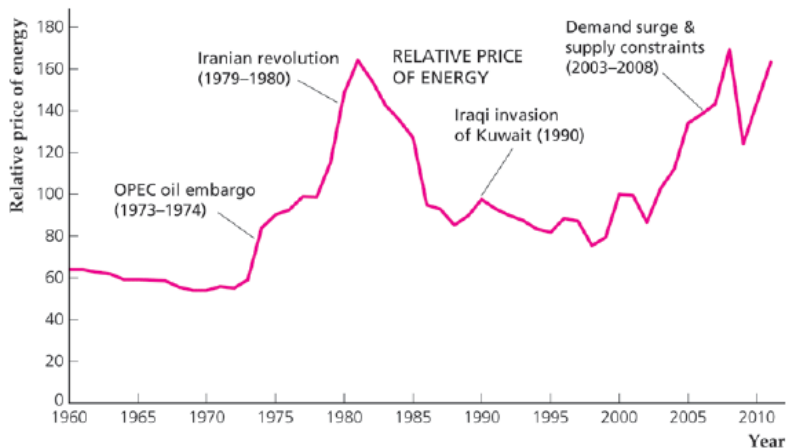
- Does the *IS* – *LM* model correctly predict the results of an adverse supply shock?
- The data from the 1973-1974 and 1979-1980 oil price shocks shows the followings:
  - As discussed in Topic 2, output, employment, and the real wage declined.
  - Consumption fell slightly and investment fell substantially.
  - Inflation surged temporarily.
  - All the above results are consistent with the theory.



## Application: Oil price shocks revisited (2 of 2)

- The real interest rate did not rise during the 1973-1974 oil price shock (though it did during the 1979-1980 shock):
  - It could be that people expected the 1973-1974 oil price shock to be permanent.
  - In that case the real interest rate would not necessarily rise.
  - If so, people's expectations were correct, since the 1973-1974 shock seems to have been permanent, while the 1979-1980 shock was reversed quickly.

# Oil price shocks



# In touch with data and research: Econometric models and macroeconomic forecasts

- Many models that are used for macroeconomic research and analysis are based on the *IS – LM* model.
- There are three major steps in using an economic model for forecasting:
  - An econometric model estimates the parameters of the model (slopes, intercepts, elasticities) through statistical analysis of the data.
  - Projections are made of exogenous variables (variables outside the model), like oil prices and changes in productivity.
  - The model is solved for the values of endogenous variables, such as output, employment, and interest rates.

# Econometric models and macroeconomic forecasts

- The Federal Reserve Board's FRB/US model, introduced in 1996, improves on the old model by better handling of expectations, improved modeling of reactions to shocks, and use of newer statistical techniques.
- The FRB/US model is the workhorse for policy analysis by the Fed's staff economists.
- Board of Governor's staff adjust the FRB/US forecasts with their judgment; the subsequent forecasts reported in the Greenbook have been found to be superior to private-sector forecasts.

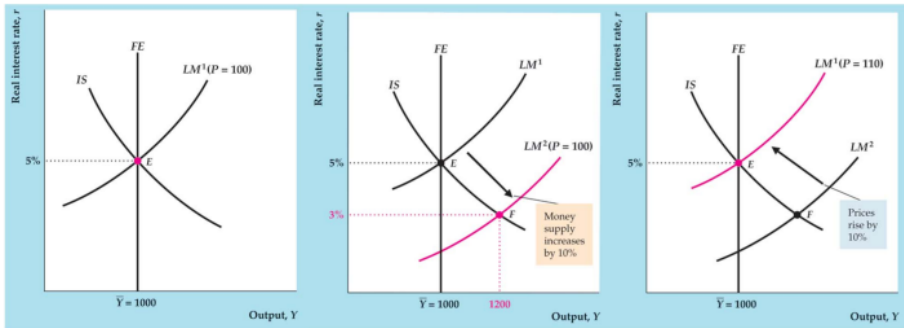
## The effects of a monetary expansion (1 of 2)

- An increase in money supply shifts the LM curve down and to the right.
- Because financial markets respond most quickly to changes in economic conditions, the asset market responds to the disequilibrium.
  - The FE line is slow to respond, because job matching and wage renegotiation take time.
  - The IS curve responds somewhat slowly.
  - We assume that the labour market is temporarily out of equilibrium, so there's a short-run equilibrium at the intersection of the *IS* and *LM* curves.
- The increase in the money supply causes people to try to get rid of excess money balances by buying assets, driving the real IR down:
  - The decline in the real IR causes consumption and investment to increase temporarily.
  - Output is assumed to increase temporarily to meet the extra demand.

## The effects of a monetary expansion (2 of 2)

- The adjustment of the price level
  - Since the demand for goods exceeds firms' desired supply of goods, firms raise prices.
  - The rise in the price level causes the  $LM$  curve to shift up.
  - The price level continues to rise until the  $LM$  curve intersects with the  $FE$  line and the  $IS$  curve at general equilibrium (next figure).
- The result is no change in employment, output, or the real IR.
- The price level is higher by the same proportion as the increase in the money supply.
- So all real variables (including the real wage) are unchanged, while nominal values (including the nominal wage) have risen proportionately with the change in the money supply.

# Effects of a monetary expansion



# Trend money growth and inflation

- This analysis also handles the case in which the money supply is growing continuously.
- If both the money supply and price level rise by the same proportion, there is no change in the real money supply, and the  $LM$  curve doesn't shift.
- If the money supply grew faster than the price level, the  $LM$  curve would shift down and to the right.
- Often, then, we'll discuss things in relative terms.
  - The examples can often be thought of as a change in  $M$  or  $P$  relative to the expected or trend growth of money and inflation.
  - Thus when we talk about “an increase in the money supply”, we have in mind an increase in the growth rate relative to the trend.
  - Similarly, a result that the price level declines can be interpreted as the price level declining relative to a trend; for example, inflation may fall from 7% to 4%.



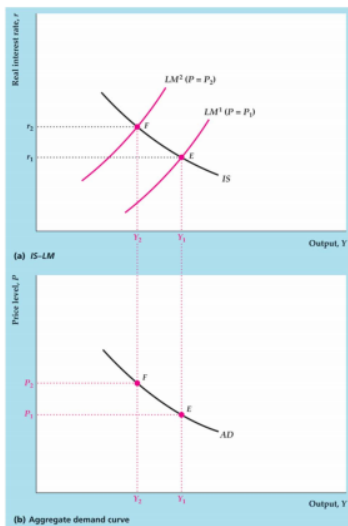
# Classical versus Keynesian versions of the IS-LM model

- There are two key questions in the debate between classical and Keynesian approaches:
  - How rapidly does the economy reach general equilibrium?
  - What are the effects of monetary policy on the economy?
- Price adjustment and the self-correcting economy.
  - The economy is brought into general equilibrium by adjustment of the price level.
  - The speed at which this adjustment occurs is much debated.

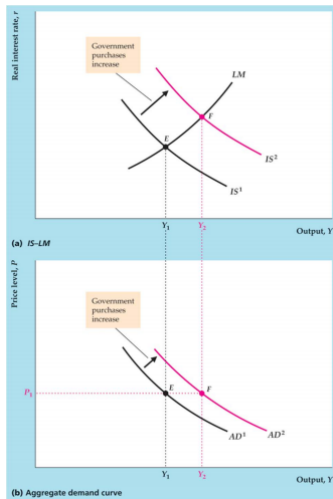
# Use the IS-LM model to develop the AD-AS model

- The two models are equivalent.
- Depending on the issue, one model or the other may prove more useful:
  - *IS – LM* relates the real interest rate to output.
  - *AD – AS* relates the price level to output.
- The *AD* curve:
  - The *AD* curve shows the relationship between the quantity of goods demanded and the price level when the goods market and asset market are in equilibrium.
  - So the *AD* curve represents the price level and output level at which the *IS* and *LM* curves intersect (next figure).
  - The *AD* curve is unlike other demand curves, which relate the quantity demanded of a good to its relative price; the *AD* curve relates the total quantity of goods demanded to the general price level, not a relative price.
  - The *AD* curve slopes downward because a higher price level is associated with lower real money supply, shifting the *LM* curve up, raising the real interest rate, and decreasing output demanded.

# Derivation of the aggregate demand curve



# The effect of an increase in government purchases on the aggregate demand curve



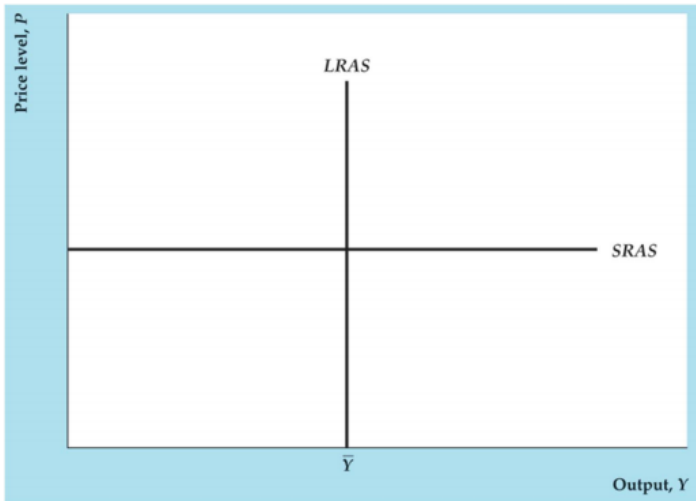
## Factors that shift the AD curve

- Any factor that causes the intersection of the *IS* and *LM* curves to shift to the left causes the *AD* curve to shift down and to the left; any factor causing the *IS* – *LM* intersection to shift to the right causes the *AD* curve to shift up and to the right.
- For example, a temporary increase in government purchases shifts the *IS* curve up and to the right, so it shifts the *AD* curve up and to the right as well (above figure).
- Factors that shift the *IS* curve up and to the right and thus the *AD* curve up and to the right as well:
  - Increases in future output, wealth, government purchases, or the expected future marginal productivity of capital.
  - Decreases in taxes if Ricardian equivalence doesn't hold, or the effective tax rate on capital.
- Factors that shift the *LM* curve down and to the right and thus the *AD* curve up and to the right as well:
  - Increases in the nominal money supply or in expected inflation.
  - Decreases in the nominal interest rate on money.

# The aggregate supply curve

- The aggregate supply curve shows the relationship between the price level and the aggregate amount of output that firms supply.
- In the short run, prices remain fixed, so firms supply whatever output is demanded:
  - The short-run aggregate supply curve is horizontal (next figure).
- Full-employment output isn't affected by the price level, so the long-run aggregate supply curve (*LRAS*) is a vertical line.

# The short-run and long-run aggregate supply curves



# Factors that shift the aggregate supply curves

- The *SRAS* curve shifts whenever firms change their prices in the short run.
  - Factors like increased costs of producing goods lead firms to increase prices, shifting *SRAS* up.
  - Factors leading to reduced prices shift *SRAS* down.
- Anything that increases full-employment output shifts the *LRAS* curve right; anything that decreases full-employment output shifts *LRAS* curve left.
- Examples include changes in the labour force or productivity changes that affect labour demand.



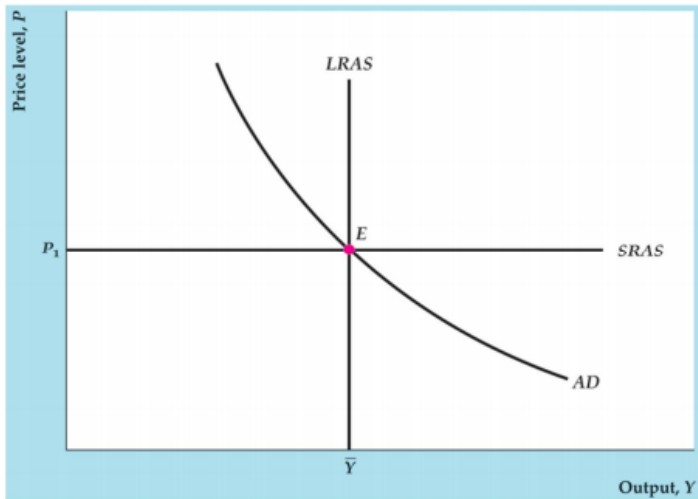
# Aggregate supply shocks

- Classicals view *AS* shocks as the main cause of fluctuations in output.
- An *AS* shock is a shift of the long-run *AS* curve.
- Factors that cause *AS* shocks are things like changes in productivity or labour supply.
- Example: a negative *AS* shock
  - Aggregate supply shock reduces full-employment output, causing long-run *AS* curve to shift left.
  - New equilibrium has lower output and higher price level.
  - So recession is accompanied by higher price level.
- Keynesians also recognize the importance of supply shocks.

# Equilibrium in the AD-AS model

- Short-run equilibrium:  $AD$  intersects  $SRAS$ .
- Long-run equilibrium:  $AD$  intersects  $LRAS$ .
  - Also called general equilibrium.
  - $AD$ ,  $LRAS$ , and  $SRAS$  all intersect at same point (next figure).
- If the economy isn't in general equilibrium, economic forces work to restore general equilibrium both in AD-AS diagram and IS-LM diagram.

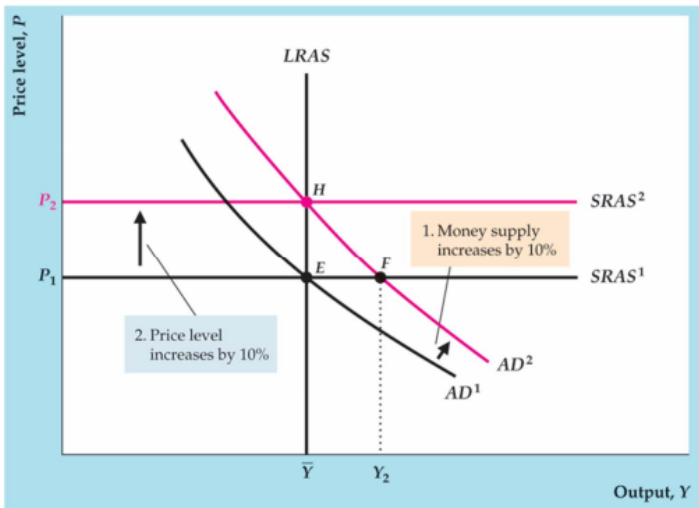
# Equilibrium in the AD-AS model



## Monetary neutrality in the AD-AS model

- Suppose the economy begins in general equilibrium, but then the money supply is increased by 10%.
- This shifts the  $AD$  curve upward by 10% because to maintain the aggregate quantity demanded at a given level, the price level would have to rise by 10% so that real money supply wouldn't change and would remain equal to real money demand.
- In the short run, with the price level fixed, equilibrium occurs where  $AD^2$  intersects  $SRAS^1$ , with a higher level of output.
- Since output exceeds full-employment output, over time firms raise prices and the short-run aggregate supply curve shifts up to  $SRAS^2$ , restoring long-run equilibrium.
- The result is a higher price level – higher by 10%.
- Money is neutral in the long run, as output is unchanged.
- The key question is: How long does it take to get from the short run to the long run?
- The answer to this question is what separates classicals from Keynesians.

# Monetary neutrality in the AD-AS framework



# Monetary neutrality

- The results in long run:
  - No change in employment, real output, real interest rate.
  - Price is higher by the same proportion as the increase in  $M$ .
  - All real variables (including the real wage) are unchanged.
  - Nominal values (including the nominal wage) have risen proportionately with the change in  $M$ .
- Money is neutral in the long run!
- Money is neutral if a change in the nominal money supply changes the price level proportionately but has **NO** effect on real variables.

# Price adjustment

## ● Classical

- Rapid adjustment of the price level
  - The economy returns quickly to full employment after a shock.
  - If firms change prices instead of output in response to a change in demand, the adjustment process is almost immediate.

## ● Keynesian

- Slow adjustment of the price level
  - It may be several years before prices and wages adjust fully.
  - When not in general equilibrium, output is determined by  $AD$  (the intersection of  $IS$  and  $LM$  curves), and the labour market is not in equilibrium.

# Monetary policy

- **Classical**

- A monetary expansion affects prices quickly.
- Monetary neutrality holds even in the short run.

- **Keynesian**

- The economy may spend a long time in disequilibrium, so a monetary expansion increases output and employment and causes the real interest rate to fall.
- Monetary neutrality in the long run but not in the short run.