Chapter Outline

- The $FE$ Line: Equilibrium in the Labor Market
- The $IS$ Curve: Equilibrium in the Goods Market
- The $LM$ Curve: Asset Market Equilibrium
- General Equilibrium in the Complete $IS$-$LM$ Model
- Price Adjustment and the Attainment of General Equilibrium
- Aggregate Demand and Aggregate Supply
The FE Line: Equilibrium in the Labor Market

- Labor market in Chapter 3 showed how equilibrium in the labor market leads to employment at its full-employment level ($N$) and output at its full-employment level ($Y$).
- If we plot output against the real interest rate, we get a vertical line, since labor market equilibrium is unaffected by changes in the real interest rate (Fig. 9.1).
Figure 9.1 The $FE$ line
The FE Line

- 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 FE Line

- Summary Table 11 lists the factors that shift the full-employment line
  - The full-employment line shifts right because of
    - a beneficial supply shock
    - an increase in labor supply
    - an increase in the capital stock
  - The full-employment line shifts left when the opposite happens to the three factors above
### Factors That Shift the Full-Employment (FE) Line

<table>
<thead>
<tr>
<th>A(n)</th>
<th>Shifts the FE line</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beneficial supply shock</td>
<td>Right</td>
<td>1. More output can be produced for the same amount of capital and labor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. If the MPN rises, labor demand increases and raises employment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Full-employment output increases for both reasons.</td>
</tr>
<tr>
<td>Increase in labor supply</td>
<td>Right</td>
<td>Equilibrium employment rises, raising full-employment output.</td>
</tr>
<tr>
<td>Increase in the capital stock</td>
<td>Right</td>
<td>More output can be produced with the same amount of labor. In addition,</td>
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<tr>
<td></td>
<td></td>
<td>increased capital may increase the MPN, which increases labor demand</td>
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<tr>
<td></td>
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<td>and equilibrium employment.</td>
</tr>
</tbody>
</table>
The IS Curve: Equilibrium in the Goods Market

• The goods market clears when desired investment equals desired national saving
  – Adjustments in the real interest rate bring about equilibrium
  – 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 (Fig. 9.2)
Figure 9.2 Deriving the IS curve

(a) Saving curves, \( S(Y = 4000) \) and \( S(Y = 5000) \)

(b) Desired national saving, \( S^d \) and desired investment, \( I^d \)

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The IS Curve

• Key features
  – The saving curve slopes upward because a higher real interest rate increases saving
  – An increase in output shifts the saving curve to the right, because people save more when their income is higher
  – The investment curve slopes downward because a higher real interest rate reduces the desired capital stock, thus reducing investment
The IS Curve

- 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 interest rate, so the IS curve slopes downward
  - The IS curve shows the relationship between the real interest rate and output for which investment equals saving
The IS Curve

- 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 interest rates are associated with lower output, that is, the IS curve slopes downward
The IS Curve

- Factors that shift the IS curve
  - 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 (Fig. 9.3)
Figure 9.3 Effect on the IS curve of a temporary increase in government purchases
The IS Curve

• Factors that shift the IS curve
  – 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 interest rate must rise to reduce desired consumption and investment and restore equilibrium
The IS Curve

• Summary Table 12 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 12

**Factors That Shift the IS Curve**

<table>
<thead>
<tr>
<th>An increase in</th>
<th>Shifts the IS curve</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected future output</td>
<td>Up and to the right</td>
<td>Desired saving falls (desired consumption rises), raising the real interest rate that clears the goods market.</td>
</tr>
<tr>
<td>Wealth</td>
<td>Up and to the right</td>
<td>Desired saving falls (desired consumption rises), raising the real interest rate that clears the goods market.</td>
</tr>
<tr>
<td>Government purchases, $G$</td>
<td>Up and to the right</td>
<td>Desired saving falls (demand for goods rises), raising the real interest rate that clears the goods market.</td>
</tr>
<tr>
<td>Taxes, $T$</td>
<td>No change or down and to the left</td>
<td>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.</td>
</tr>
<tr>
<td>Expected future marginal product of capital, $MPK^I$</td>
<td>Up and to the right</td>
<td>Desired investment increases, raising the real interest rate that clears the goods market.</td>
</tr>
<tr>
<td>Effective tax rate on capital</td>
<td>Down and to the left</td>
<td>Desired investment falls, lowering the real interest rate that clears the goods market.</td>
</tr>
</tbody>
</table>
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 \((10,000 - 9615)/9615 = 0.04 = 4\%\)
    - If the price of the bond in the market were to fall to $9524, its yield would rise to 5%, since \((10,000 - 9524)/9524 = 0.05 = 5\%\)
  - For a given level of expected inflation, the price of a nonmonetary asset is inversely related to the real interest rate
The *LM* Curve: Asset Market Equilibrium

- 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
  - 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 interest rate rises
  - Real money demand rises as the level of output rises
  - The *LM* curve (Fig. 9.4) is derived by plotting real money demand for different levels of output and looking at the resulting equilibrium
Figure 9.4 Deriving the $LM$ curve
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 interest rate rises
  - As the interest rate rises, the demand for money declines until equilibrium is reached
The *LM* Curve

- The *LM* curve shows the combinations of the real interest rate and output that clear the asset market
  - Intuitively, for any given level of output, the *LM* curve shows the real interest rate necessary to equate real money demand and supply
  - Thus the *LM* curve slopes upward from left to right
The *LM* Curve

- Factors that shift the *LM* curve
  - 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 interest rate to rise
    - The rise in the real interest rate 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
The \textit{LM} Curve

- Summary Table 13 lists the factors that shift the \textit{LM} curve
  - The \textit{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 interest rate 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 \textit{LM} curve shifts up and to the left when the opposite happens to the eight factors listed above
Summary 13

<table>
<thead>
<tr>
<th>Factors That Shift the <em>LM</em> Curve</th>
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<tbody>
<tr>
<td><strong>An increase in</strong></td>
</tr>
<tr>
<td>Nominal money supply, <em>M</em></td>
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<tr>
<td>Price level, <em>P</em></td>
</tr>
<tr>
<td>Expected inflation, <em>π^e</em></td>
</tr>
<tr>
<td>Nominal interest rate on money, <em>i^m</em></td>
</tr>
</tbody>
</table>

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.
The *LM* Curve

- Changes in the real money supply
  - An increase in the real money supply shifts the *LM* curve down and to the right (Fig. 9.5)
Figure 9.5 An increase in the real money supply shifts the $LM$ curve down and to the right.

- In panel (a), the real money supply, $M/P$, and real money demand, $M^d/P$, are shown on the horizontal axis, with the real interest rate, $r$, on the vertical axis. The curve shifts from $MS^1$ to $MS^2$, indicating an increase in the real money supply.

- In panel (b), the $LM$ curve is shown with $M/F = 1200$ and $M/F = 1000$. The shift in the $LM$ curve from $A$ to $D$ illustrates the impact of an increase in the real money supply.
The $LM$ Curve

- Changes in the real money supply
  - 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
The *LM* Curve

- Changes in real money demand
  - An increase in real money demand shifts the *LM* curve up and to the left (Fig. 9.6)
  - Similarly, a drop in real money demand shifts the *LM* curve down and to the right
Figure 9.6 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
  – This occurs where the FE, IS, and LM curves intersect (Fig. 9.7)
Figure 9.7 General equilibrium in the IS-LM model
General Equilibrium

- Applying the IS-LM framework: A temporary adverse supply shock
  - Suppose the productivity parameter in the production function falls temporarily
  - The supply shock reduces the marginal productivity of labor, hence labor demand
    - With lower labor 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
General Equilibrium

• Applying the IS-LM framework: A temporary adverse supply shock
  – 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 (Fig. 9.8)
Figure 9.8 Effects of a temporary adverse supply shock
General Equilibrium

- 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 interest rate is higher and output is lower, consumption and investment must be lower
General Equilibrium

• Application: Oil price shocks revisited
  – 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 following
    • As discussed in Chapter 3, 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
General Equilibrium

• Application: Oil price shocks revisited
  – 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
General Equilibrium

• Box 9.1: 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
General Equilibrium

- Box 9.1: 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
Price Adjustment and the Attainment of General Equilibrium

• The effects of a monetary expansion
  – 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 labor market is temporarily out of equilibrium, so there’s a short-run equilibrium at the intersection of the $IS$ and $LM$ curves
Price Adjustment and the Attainment of General Equilibrium

• The effects of a monetary expansion
  – The increase in the money supply causes people to try to get rid of excess money balances by buying assets, driving the real interest rate down
    • The decline in the real interest rate causes consumption and investment to increase temporarily
    • Output is assumed to increase temporarily to meet the extra demand
Price Adjustment and the Attainment of General Equilibrium

• The effects of a monetary expansion
  – 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 (Fig. 9.9)
Figure 9.9 Effects of a monetary expansion
Price Adjustment and the Attainment of General Equilibrium

- The effects of a monetary expansion
  - The result is no change in employment, output, or the real interest rate
  - 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
Price Adjustment and the Attainment of General Equilibrium

- The 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
Price Adjustment and the Attainment of General Equilibrium

- The effects of a monetary expansion
  - Trend money growth and inflation
    - 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%
Price Adjustment and the Attainment of General Equilibrium

- 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 Attainment of General Equilibrium

- Classical versus Keynesian versions of the IS-LM model
  - 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
Price Adjustment and the Attainment of General Equilibrium

- Classical versus Keynesian versions of the IS-LM model
  - Classical economists see rapid adjustment of the price level
    - So 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
Price Adjustment and the Attainment of General Equilibrium

• Classical versus Keynesian versions of the IS-LM model
  – Keynesian economists see 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 aggregate demand at the intersection of the IS and LM curves, and the labor market is not in equilibrium
Price Adjustment and the Attainment of General Equilibrium

• Classical versus Keynesian versions of the IS-LM model
  – Monetary neutrality
    • Money is neutral if a change in the nominal money supply changes the price level proportionately but has no effect on real variables
    • The classical view is that a monetary expansion affects prices quickly with at most a transitory effect on real variables
Price Adjustment and the Attainment of General Equilibrium

- Classical versus Keynesian versions of the IS-LM model
  - Monetary neutrality
    - Keynesians think 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
    - Keynesians believe in monetary neutrality in the long run but not the short run, while classicals believe it holds even in the relatively short run
Aggregate Demand and Aggregate Supply

- 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
Aggregate Demand and Aggregate Supply

• The aggregate demand 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 (Fig. 9.10)
Figure 9.10 Derivation of the aggregate demand curve
Aggregate Demand and Aggregate Supply

• The aggregate demand curve
  – 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
Aggregate Demand and Aggregate Supply

• 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 (Fig. 9.11)
Figure 9.11 The effect of an increase in government purchases on the aggregate demand curve
Aggregate Demand and Aggregate Supply

• The aggregate demand curve
  – Summary Table 14: Factors that shift the \( AD \) curve
    • 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 or the real demand for money
## Factors That Shift the AD Curve

For a constant price level, any factor that shifts the intersection of the IS and LM curves to the right increases aggregate output demanded and shifts the AD curve up and to the right.

Factors that shift the IS curve up and to the right, and thus shift the AD curve up and to the right (see Summary table 12, p. 315) include:

- an increase in expected future output;
- an increase in wealth;
- an increase in government purchases, $G$;
- a reduction in taxes, $T$ (assuming no Ricardian equivalence so that consumers respond by raising desired consumption);
- an increase in the expected future $MPK$; and
- a reduction in the effective tax rate on capital.

Factors that shift the LM curve down and to the right, and thus shift the AD curve up and to the right (see Summary table 13, p. 321) include:

- an increase in the nominal money supply, $M$;
- a rise in expected inflation, $\pi^e$;
- a decrease in the nominal interest rate on money, $i^m$; and
- any other change that reduces the real demand for money.
Aggregate Demand and Aggregate Supply

• 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 (Fig. 9.12)
Figure 9.12 The short-run and long-run aggregate supply curves
Aggregate Demand and Aggregate Supply

• The aggregate supply curve
  – Full-employment output isn’t affected by the price level, so the long-run aggregate supply curve (LRAS) is a vertical line in Fig. 9.12
Aggregate Demand and Aggregate Supply

• The aggregate supply curve
  – 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 left
    • Examples include changes in the labor force or productivity changes that affect labor demand
Aggregate Demand and Aggregate Supply

- 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 (Fig. 9.13)
Figure 9.13 Equilibrium in the AD-AS model
Aggregate Demand and Aggregate Supply

- Equilibrium in the AD-AS model
  - If the economy isn’t in general equilibrium, economic forces work to restore general equilibrium both in AD-AS diagram and IS-LM diagram
Aggregate Demand and Aggregate Supply

- Equilibrium in the AD-AS model
  - Monetary neutrality in the AD-AS model (Fig. 9.14 and key diagram 7)
Figure 9.14 Monetary neutrality in the AD-AS framework

1. Money supply increases by 10%
2. Price level increases by 10%
Aggregate Demand and Aggregate Supply

• 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
Aggregate Demand and Aggregate Supply

• Monetary neutrality in the AD-AS model
  – 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
Aggregate Demand and Aggregate Supply

• Monetary neutrality in the AD-AS model
  – 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
Key Diagram 6 The IS-LM model
Key Diagram 7 The aggregate demand–aggregate supply model