Preview

• To examine the two modern business cycle theories—the real business cycle model and the new Keynesian model—and compare them with earlier Keynesian models
• To understand how the modern business cycle theories provide answers to key questions of policy and practice in macroeconomics
• To adapt the standard aggregate demand and supply to include financial frictions, and apply this modified model to the financial disruptions that occurred in 2007-2009
Real Business Cycle Model

• Originally developed by Edward Prescott and Finn Kydland, the **real business cycle model** assumes that:
  - **Real shocks**—shocks to productivity or the willingness of workers to work—cause fluctuations in potential output and long-run aggregate supply
  - All wages and prices are completely flexible, so that the short-run and long-run aggregate supply curves are the same, namely *LRAS*; and thus aggregate output always equals potential output
The Real Business Cycle Model

**Step 1.** Positive productivity shock shifts the long-run aggregate supply curve to the right.

**Step 2.** Leading to a rise in output and a fall in inflation.

**Step 3.** Negative productivity shock shifts the long-run aggregate supply curve to the left.

**Step 4.** Leading to a fall in output and a rise in inflation.

- Inflation Rate, $\pi$
- Aggregate Output, $Y$
- $LRAS_1$, $LRAS_2$, $LRAS_3$
- $Y^p_1$, $Y^p_2$, $Y^p_3$
Productivity Shocks and Business Cycle Fluctuations

- The key equation in real business cycle models is the aggregate production function:

\[ Y^P = F(K, L) = AK_t^{0.3} L_t^{0.7} \]

where

\( A \) = total factor productivity
\( K \) = capital stock
\( L \) = labor
Productivity Shocks and Business Cycle Fluctuations (cont’d)

- Real business cycle theorists see shocks to productivity, $A$, as the primary source of shocks to potential output and long-run aggregate supply:
  - A positive productivity shock, e.g., a new invention or government policy that makes the economy more efficient, causes the LRAS to shift to the right (while the AD curve remains the same), thus an increase in aggregate output $Y^p$ and a decrease in the inflation rate $\pi$.
  - A negative supply shock, e.g., permanent increases in the price of energy or strict government environmental regulations that cause production to fall, causes the LRAS to shift to the left (while the AD curve remains the same), thus a decrease in aggregate output $Y^p$ and an increase in the inflation rate $\pi$. 
Solow Residuals and Business Cycle Fluctuations

- **Solow residuals**, named after Robert Solow, are estimates of productivity in the aggregate production function:

  \[
  \hat{A} = \frac{Y_t}{K_t^{0.3} L_t^{0.7}}
  \]

- Real business cycle theorists view the positive co-movement of the growth rate of the Solow residual and output growth as confirmation that productivity shocks are the primary source of business fluctuations.
Employment and Unemployment in the Real Business Cycle Model

- The real business cycle model explains fluctuations in employment and unemployment with **intertemporal substitution**—the willingness to shift work effort over time as real wages and real interest rates change.

- An increase (decrease) in productivity raises (lowers) the real wage today, so that workers are willing to work more (less), thus both employment and output will rise (fall) while unemployment will fall (rise).

- The economy is always at full employment and all unemployment is voluntary because it arises out of choices workers make to maximize their well being, as implied by intertemporal substitution.
Objections to the Real Business Cycle Model

- Criticisms of real business cycle analysis focus on:
  1. Solow residuals and productivity shocks
  2. Negative productivity shocks
  3. Procyclical inflation and employment
  4. Market-clearing assumption
Objections to the Real Business Cycle Model (cont’d)

- Criticisms of real business cycle analysis focus on:
  1. Solow residuals and productivity shocks
     - If the economy slows down, labor hoarding—workers sitting idly for a chunk of their workday but are still counted as “employed”—and idle capital gives the appearance of a productivity shock when none exists
  2. Negative productivity shocks
  3. Procyclical inflation and employment
  4. Market-clearing assumption
Objections to the Real Business Cycle Model (cont’d)

• Criticisms of real business cycle analysis focus on:
  1. Solow residuals and productivity shocks
  2. Negative productivity shocks
     – Critics of real business cycles question whether productivity shocks, such as the development of the Internet, can ever be negative
  3. Procyclical inflation and employment
  4. Market-clearing assumption
Objections to the Real Business Cycle Model (cont’d)

• Criticisms of real business cycle analysis focus on:
  1. Solow residuals and productivity shocks
  2. Negative productivity shocks
  3. Procyclical inflation and employment
     – The real business cycle model implies that increases in aggregate output are associated with declines in inflation and vice versa, but the data shows that inflation is procyclical (rises during business cycle booms and falls in recessions)
  4. Market-clearing assumption
Objections to the Real Business Cycle Model (cont’d)

• Criticisms of real business cycle analysis focus on:
  1. Solow residuals and productivity shocks
  2. Negative productivity shocks
  3. Procyclical inflation and employment
  4. Market-clearing assumption
     – Many economists are skeptical of the market-clearing assumption in the real business cycle model, particularly in the labor market, as empirical evidence shows that wages and prices are far from flexible
New Keynesian Model

• The new Keynesian model is based on similar microeconomic foundations as in real business cycle models, but embeds wage and price stickiness into the analysis.

• The models are also referred to as dynamic, stochastic, general equilibrium (DSGE) models because they allow the economy to grow over time (dynamic), be subject to shocks (stochastic), and are based on general equilibrium principles.
Building Blocks of the New Keynesian Model

- There are three building blocks in the new Keynesian model:
  1. Aggregate production
  2. A new Keynesian short-run aggregate supply (Phillips) curve
  3. A new Keynesian aggregate demand (\textit{IS}) curve
Building Blocks of the New Keynesian Model (cont’d)

- There are three building blocks in the new Keynesian model:
  1. Aggregate production
     - The aggregate production function is similar to that in the real business cycle framework:
     \[ Y^P = F(K, L) = AK_t^{0.3}L_t^{0.7} \]
     and shocks to productivity, \( A \), are an important source of fluctuations in potential output and in LRAS
  2. A new Keynesian short-run aggregate supply (Phillips) curve
  3. A new Keynesian aggregate demand (IS) curve
Building Blocks of the New Keynesian Model (cont’d)

• There three building blocks in the new Keynesian model are:
  1. Aggregate production
     - Prices are sticky due to staggered (Calvo) prices and inflation depends on expected inflation tomorrow, the output gap and price shocks (markup shocks):

\[
\pi_t = \beta E_t \pi_{t+1} + \gamma (Y_t - Y^P_t) + \rho_t
\]

where

- \( \beta \) = a parameter that indicates how expectations of future inflation affect current inflation
- \( E_t \pi_{t+1} \) = the inflation rate next period that is expected today
- \( (Y_t - Y^P_t) \) = the output gap
- \( \gamma \) = a parameter describing the sensitivity of inflation to the output gap
- \( \rho_t \) = the price shock term

3. A new Keynesian aggregate demand (IS) curve
Building Blocks of the New Keynesian Model (cont’d)

- There are three building blocks in the new Keynesian model:
  1. Aggregate production
    - Through some algebraic manipulation, the new Keynesian short-run aggregate supply (Phillips) curve becomes:
      \[
      \pi_t = \sum_{j=0}^{\infty} \beta^j [\gamma (Y_{t+j} - Y_{t+j}^P) + \rho_{t+j}]
      \]
      meaning that it slopes upward at a given level of expected inflation rate
  3. A new Keynesian aggregate demand (IS) curve
Building Blocks of the New Keynesian Model (cont’d)

- There three building blocks in the new Keynesian model are:
  1. Aggregate production
  2. A new Keynesian short-run aggregate supply (Phillips) curve
  3. A new Keynesian aggregate demand (IS) curve
     - The new Keynesian IS curve incorporate expectations of future output and the real interest rate today:

\[
Y_t = \beta E_t Y_{t+1} - \delta r_t + d_t
\]

where

- \( \beta \) = a parameter that indicates how future expectations of output affect current output
- \( \delta \) = how sensitive output is to the real interest rate
- \( d_t \) = a demand shock
There three building blocks in the new Keynesian model are:
1. Aggregate production
2. A new Keynesian short-run aggregate supply (Phillips) curve
3. A new Keynesian aggregate demand (IS) curve
   - Through some algebraic manipulation, the (dynamic) IS curve becomes:

\[ Y_t = \sum_{j=0}^{\infty} \beta^j (-\delta_{t+j} r_{t+j} + d_{t+j}) \]

which implies that it is downward sloping, and aggregate output depends not only on today’s real interest rate and demand shock, but also on expectations of future monetary policy and demand shocks
Business Cycle Fluctuations in the New Keynesian Model

• Effects of shocks to aggregate supply
  – A positive productivity shock shifts the LRAS to the right so that \( Y < Y^p \) and so the slack in the economy causes the short-run AS curve to shift down and to the right, resulting in an increase in aggregate output and a decrease in inflation
The New Keynesian Model

Step 1. Rise in productivity shifts aggregate supply curves to $LRAS_2$ and $AS_2$...

Step 2. Shifting the economy to point 2, where output rises and inflation falls.

Step 3. Eventually, the short-run aggregate supply curve shifts down to $AS_3$...

Step 4. And the economy moves to point 3, where output rises and inflation falls further.

Aggregate Output, $Y$
Business Cycle Fluctuations in the New Keynesian Model (cont’d)

- Effects of shocks to aggregate demand
  1. Unanticipated shocks
     - A positive demand shock shifts the $AD$ curve to the right and, because it is unanticipated, expectations about future output and inflation remain unchanged, so the short-run $AS$ curve remains unchanged
  2. Anticipated shocks
     - Because the demand shock is anticipated, firms expect higher inflation the next period, so the short-run $AS$ curve shifts up, but the shift in the short-run $AS$ curve takes place only gradually because prices are sticky
     - *The new Keynesian model distinguishes between the effects of anticipated versus unanticipated aggregate demand shocks, with unanticipated shocks having a greater effect*
Shocks to Aggregate Demand in the New Keynesian Model

**Step 1.** Positive demand shock shifts AD to the right.

**Step 2.** If policy is unanticipated, AS doesn’t shift and economy moves to point 2, and inflation and output rise.

**Step 3.** If policy is anticipated, AS shifts up and economy moves to point 3...

**Step 4.** and inflation rises by more, but output by less.
Objections to the New Keynesian Model

- A key objection to the new Keynesian model is that prices are not all that sticky as assumed by the new Keynesian Phillips curve.
- Some empirical research finds that businesses change prices very frequently.
- Other research, however, point out that even if businesses change prices frequently, they may still adjust slowly to aggregate demand shocks, which are less worthwhile to pay attention to than shocks to demand for specific products they sell.
A Comparison of Business Cycle Models

• How Do the Models Differ?
  – In the traditional Keynesian model, expectations are not rational, but instead are adaptive or backward-looking; and prices are sticky and do not immediately adjust.
  – The real business cycle and new Keynesian models both assume that expectations are rational, but the real business cycle model is like a special case of a new Keynesian model in which prices become more and more flexible, so that the coefficient in the Phillips curve, $\gamma$, and thus the short-run AS curve gets steeper until it becomes the same as the LRAS curve.
Comparison of New Keynesian and Real Business Cycle Models

Step 1. As prices become more flexible, short-run AS rotates counterclockwise...

Step 2. until short-run AS becomes the same as LRAS and both models are identical.
A Comparison of Business Cycle Models (cont’d)

• How Do the Models Differ?
  – Both the new Keynesian model and the real business cycle model share the view that long-run supply shocks can shape the business cycle, but the new Keynesian model also suggests that demand shocks can also be important
A Comparison of Three Business Cycle Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Expectations</th>
<th>Price Flexibility</th>
<th>Are Long-Run Supply Shocks a Source of Business Cycle Fluctuations?</th>
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<tbody>
<tr>
<td>Real Business Cycle Model</td>
<td>Rational</td>
<td>Complete</td>
<td>Yes, and are the only source of business cycle fluctuations</td>
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<tr>
<td>New Keynesian Model</td>
<td>Rational</td>
<td>Sticky</td>
<td>Yes, but demand shocks are important too</td>
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<tr>
<td>Traditional Keynesian Model</td>
<td>Adaptive</td>
<td>Sticky</td>
<td>No</td>
</tr>
</tbody>
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Short-Run Output and Price Responses: Implications for Stabilization Policy

• Suppose an expansionary policy, such as an easing of monetary policy or an increase in government spending, shifts the aggregate demand curve:
  – In the real business cycle model, expansionary policy only leads to inflation, but does not raise output
  – The traditional Keynesian model does not distinguish between the effects of anticipated and unanticipated policy: Both have the same effect on output and inflation
  – In the new Keynesian model, anticipated policy has a smaller effect on output than when policy is unanticipated. On the other hand, in the new Keynesian model, anticipated policy has a larger effect on inflation than unanticipated policy
# Response to Policy in the Three Business Cycle Models

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</thead>
<tbody>
<tr>
<td>Real Business Cycle Model</td>
<td>$Y$ unchanged, $\pi \uparrow$</td>
<td>$Y$ unchanged, $\pi \uparrow$</td>
<td>No</td>
<td>$Y$ unchanged, $\pi \downarrow$</td>
<td>$Y$ unchanged, $\pi \downarrow$</td>
<td>No</td>
</tr>
<tr>
<td>Traditional Keynesian Model</td>
<td>$Y \uparrow, \pi \uparrow$</td>
<td>$Y \uparrow, \pi \uparrow$ by same amount as when policy is unanticipated</td>
<td>Yes</td>
<td>$Y \downarrow, \pi \downarrow$</td>
<td>$Y \downarrow, \pi \downarrow$ by same amount as when policy is unanticipated</td>
<td>No</td>
</tr>
<tr>
<td>New Keynesian Model</td>
<td>$Y \uparrow, \pi \uparrow$</td>
<td>$Y \uparrow$ by less than when policy is unanticipated, $\pi \uparrow$ by more than when policy is unanticipated</td>
<td>Yes, but designing a beneficial policy is difficult</td>
<td>$Y \downarrow, \pi \downarrow$</td>
<td>$Y \downarrow$ by less than when policy is unanticipated, $\pi \downarrow$ by more than when policy is unanticipated</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Comparison of the Short-Run Response to Expansionary Policy in the Three Models (a)

(a) Real Business Cycle Model

Step 1. Expansionary policy shifts the $AD$ curve to the right...

Step 2. Moving the economy to point 2...

Step 3. Where output is unchanged but inflation rises.

Inflation Rate, $\pi$

$Y_1 = Y^p$

Aggregate Output, $Y$
Comparison of the Short-Run Response to Expansionary Policy in the Three Models (b)

Step 1. Expansionary policy shifts the $AD$ curve to the right...

Step 2. Moving the economy to point $1'$...

Step 3. Where output and inflation rise.

Aggregate output, $Y$
Comparison of the Short-Run Response to Expansionary Policy in the Three Models (c)

(c) New Keynesian Model

Step 1. Expansionary policy shifts the AD curve to the right.

Step 2. If the policy is unanticipated, the economy moves to point 1'... 

Step 3. where output and inflation rise.

Step 4. If the policy is anticipated, the economy moves to point 2'...

Step 5. where output rises by less, but inflation by more.
Short-Run Output and Price Responses: Implications for Stabilization Policy (cont’d)

- The importance of expectations in policy decisions under the new Keynesian model suggests that policymakers must consider both the setting of policy instruments and the management of expectations—communication with the public and the markets to influence their expectations about what policy actions will be taken in the future.
Policy and Practice: Management of Expectations and Nonconventional Monetary Policy

- The Federal Reserve has used management of expectations twice since the 2001 recession:
  - In the aftermath of the 2001 recession, the Fed decided to stimulate aggregate demand through management of expectations about future monetary policy by making an explicit commitment to keep the federal funds rate low for a “considerable period” of time.
  - During the 2007-2009 financial crisis, the federal funds rate hit the zero-lower bound and the Fed again turned to management of expectations by committing to keep interest rates low for “an extended period” in addition to acquiring private debt securities.
Anti-Inflation Policy

• Suppose policymakers try to reduce inflation by applying contractionary policy:
  – The real business cycle implies that reductions in inflation have no cost in terms of lower output
  – In the traditional Keynesian model, reducing inflation is costly, because achieving lower inflation requires a reduction in output
  – In the new Keynesian model, anti-inflation policy is costly in terms of lost output
  – However, the cost is lower when the anti-inflation policy is anticipated
Anti-Inflation Policy in the Three Models (a)

(a) Real Business Cycle Model

Step 1. Autonomous monetary tightening shifts the $AD$ curve to the left...

Step 2. Moving the economy to point 2...

Step 3. Where output is unchanged but inflation falls to 2%.

Inflation Rate, $\pi$

$\pi_1 = 10\%$

$\pi_2 = 2\%$

Aggregate Output, $Y$
Anti-Inflation Policy in the Three Models (b)

(b) Traditional Keynesian Model

Step 1. Autonomous monetary tightening shifts the $AD$ curve to the left...

Inflation Rate, $\pi$

$\pi_1 = 10\%$

$\pi_2 = 2\%$

Step 2. Moving the economy to point 2'

Step 3. Where output falls and inflation falls, but not to 2%.

LRAS

$AD_1$

$AS_1$

Step 4. Eventually economy moves to point 2 where inflation falls to 2%.

$AD_2$

$AS_2$

Aggregate Output, $Y$
Anti-Inflation Policy in the Three Models (c)

**Step 1.** Autonomous monetary tightening shifts the $AD$ curve to the left...

**Step 2.** Moving the economy to point 2', if the policy is unanticipated, where output falls and inflation falls, but not to 2%...

**Step 3.** Moving the economy to point 2'', if the policy is anticipated, where output falls by less and inflation by more.

**Step 4.** Eventually economy moves to point 2 where inflation falls to 2%.

Inflation Rate, $\pi$

$\pi_1 = 10\%$

$\pi_2$

$\pi_2''$

$\pi_2 = 2\%$

Aggregate Output, $Y$

(c) New Keynesian Model
Business Cycle Models with Financial Frictions

• Financial frictions are impairments to the efficient functioning of financial markets

• One example of financial frictions is an increase in asymmetric information, which has two effects that leads to an inward shift of the IS curve:
  1. The real interest rate that firms and households have to pay to finance their investments rises, causing spending by households and businesses to fall
  2. Moral hazard and adverse selection problems in credit markets increase, leading to a cutback in lending by banks and other financial institutions
Shift in the IS Curve

- One example of financial frictions is an increase in asymmetric information, which has two effects that leads to an inward shift of the IS curve:
  1. The real interest rate that firms and households have to pay to finance their investments rises, causing spending by households and businesses to fall
  2. Moral hazard and adverse selection problems in credit markets increase, leading to a cutback in lending by banks and other financial institutions
Aggregate Demand and Supply Analysis with Financial Frictions

(a) MP Curve

Step 4. Lower inflation leads to a lower real interest rate set by monetary policy...

(b) IS Curve

Step 5. An increase in financial frictions shifts the IS curve to left...

Step 1. Increase in financial frictions shifts the IS curve to left...

Step 2. Shifting the AD curve to left...

Step 3. Lowering output and inflation.

Step 4. Lower inflation leads to a lower real interest rate set by monetary policy...

(c) AD/AS Diagram

Step 5. A lower real interest rate at point 2 in both panels (a) and (b).
Shift in the Aggregate Demand Curve and the Effect on Output and Inflation

- As the IS curve shifts to the left, the AD curve also shifts to the left as well, so that both output and inflation fall.
Effect on Real Interest Rates

- The decline in inflation implies that the increase in financial frictions leads to a decline in the real interest rate set by monetary policy.

- The increase in asymmetric information is likely to have led to such a large increase in credit spreads that the fall in the interest rate set by monetary policy is more than offset by the increase in credit spreads: Interest rates faced by households and businesses will likely rise.
The Role of Financial Frictions in Business Cycles

• An increase in financial frictions results in a decline in output and inflation, a decline in the real interest rate set by monetary policy, but a rise in the real interest rates faced by households and businesses
Application: Financial Frictions and the 2007-2009 Recession

- Our aggregate demand and supply analysis explains how the financial frictions created by the financial crisis of 2007-2009 eventually led to the 2007-2009 recession.
- Credit spreads jumped sharply so that borrowing costs for households and businesses rose.
- The leftward shift in the IS (and AD) curve due to falling consumption expenditure and investment led to a fall in inflation and real GDP.
- However, the sharp increase in credit spreads meant that real interest rates faced by households and businesses (e.g., the Baa corporate bond rate) did not fall even when the real federal funds rate fell to -2%.
Real Interest Rates in the 2007-2009 Financial Crisis