Chapter 22

Modern Business Cycle Theory
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
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
FIGURE 22.1 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, $Y$

$Y^P_3$ $Y^P_1$ $Y^P_2$
Productivity Shocks and Business Cycle Fluctuations

• The key equation in real business cycle models is the aggregate production function (Ch. 3):

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

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 comovement of the growth rate of the Solow residual and output growth as confirmation that productivity shocks are the primary source of business fluctuations.
FIGURE 22.2 Growth Rate of Solow Residuals, 1960-2011

Source: Bureau of Economic Analysis, at www.bea.gov/national/nipaweb/SelectTable.asp?Selected=N, and Economic Report of the President at www.gpoaccess.gov/eop/tables10.html. The Solow residual is computed using the same procedure used to produce Figure 6.13 in Chapter 6.
Employment and Unemployment in the Real Business Cycle Model

- The real business cycle model explains fluctuations in employment and unemployment with \textbf{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.
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. Pro-cyclical 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
• 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 (IS) curve
There three building blocks in the new Keynesian model are:

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
  2. New Keynesian short-run AS (Phillips) curve
     - Prices are sticky due to *staggered prices* (Ch. 8), and inflation depends on expected inflation *tomorrow*, the output gap and price shocks (*markup shocks*):

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

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
- \( (Y_t - Y_t^P) \) = the output gap
- \( \gamma \) = a parameter describing the sensitivity of inflation to the output gap
- \( \rho_t \) = the price shock term

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

• There are three building blocks in the new Keynesian model are:
  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. New Keynesian short-run aggregate supply (Phillips) curve
  3. New Keynesian IS curve and aggregate demand 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 are three building blocks in the new Keynesian model:
  1. Aggregate production
  2. New Keynesian short-run aggregate supply (Phillips) curve
  3. New Keynesian IS curve and aggregate demand 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.
FIGURE 22.3  The New Keynesian Model

Step 1. Rise in productivity shifts aggregate supply curves to $LRAS_3$ 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.
• 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.*
FIGURE 22.4 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.** 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 (Ch. 12), 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.
FIGURE 22.5  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.
• 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
### SUMMARY TABLE 22.1  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>
</tr>
</thead>
<tbody>
<tr>
<td>Real Business Cycle Model</td>
<td>Rational</td>
<td>Complete</td>
<td>Yes, they are the only source of business cycle fluctuations</td>
</tr>
<tr>
<td>New Keynesian Model</td>
<td>Rational</td>
<td>Sticky</td>
<td>Yes, but demand shocks are important too</td>
</tr>
<tr>
<td>Traditional Keynesian</td>
<td>Adaptive</td>
<td>Sticky</td>
<td>No</td>
</tr>
<tr>
<td>Model</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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*
### SUMMARY TABLE 22.2  RESPONSE TO POLICY IN THE THREE BUSINESS CYCLE MODELS

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Business Cycle Model</td>
<td>( \gamma \uparrow ), ( \pi \uparrow )</td>
<td>( \gamma \uparrow ), ( \pi \uparrow )</td>
<td>No</td>
<td>( \gamma \uparrow ), ( \pi \downarrow )</td>
<td>( \gamma \uparrow ), ( \pi \downarrow )</td>
<td>No</td>
</tr>
<tr>
<td>Traditional Keynesian Model</td>
<td>( \gamma \uparrow ), ( \pi \uparrow )</td>
<td>( \gamma \uparrow ), ( \pi \uparrow ) by same amount as when policy is unanticipated</td>
<td>Yes</td>
<td>( \gamma \downarrow ), ( \pi \downarrow )</td>
<td>( \gamma \downarrow ), ( \pi \downarrow ) by same amount as when policy is unanticipated</td>
<td>No</td>
</tr>
<tr>
<td>New Keynesian Model</td>
<td>( \gamma \uparrow ), ( \pi \uparrow )</td>
<td>( \gamma \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>( \gamma \downarrow ), ( \pi \downarrow )</td>
<td>( \gamma \downarrow ) by less than when policy is unanticipated, ( \pi \downarrow ) by more than when policy is unanticipated</td>
<td>Yes</td>
</tr>
</tbody>
</table>
FIGURE 22.6 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, $\pi$

LRAS

$Y_1 = Y^P$

Aggregate Output, $Y$

$\pi_1$

$\pi_2$
FIGURE 22.6 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.

Diagram showing the comparison of short-run responses in three models with labeled steps and economic curves.
FIGURE 22.6 Comparison of the Short-Run Response to Expansionary Policy in the Three Models (c)

**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.
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.
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
FIGURE 22.7 Anti-Inflation Policy in the Three Models (a)

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%.
FIGURE 22.7 Anti-Inflation Policy in the Three Models (b)

Step 1. Autonomous monetary tightening shifts the \( AD \) curve to the left...

Step 2. Moving the economy to point \( 2' \)...

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

Step 4. Eventually economy moves to point 2 where inflation falls to 2%.
FIGURE 22.7 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%.
New Classical Phillips Curve and the Aggregate Supply Curve

- In the **new classical model**, flexible wages and prices imply that inflation rises at the same rate as expected inflation in the Phillips curve and the short-run AS curve.

- The short-run AS curve becomes:

\[
\pi_t = E_{t-1} \pi_t + \gamma (Y_t - Y^P)
\]

where

- \(\pi_t\) = Inflation at time \(t\), that is, the change in the price level from period \(t - 1\) to period \(t\).
- \(E_{t-1} \pi_t\) = Inflation from period \(t - 1\) to period \(t\), which is expected at time \(t - 1\) using rational expectations.
- \(Y_t\) = Aggregate output at time \(t\).
- \(Y^P\) = Potential output.
- \(\gamma\) = Sensitivity of inflation to the output gap.
FIGURE 22A1.1 Aggregate Supply in the New Classical Model
Misperceptions Theory

- The new classical model is consistent with a misperceptions theory as firms supply more due to their misperceptions about a rise in the general price level as higher relative prices for their goods.
- The short-run AS curve can be rewritten as:

\[ y_t - y^p = \frac{(\pi_t - E_{t-1}\pi_t)}{\gamma} \]
Effects of Expansionary Policy

• The effect of expansionary policy depends on whether the policy is anticipated or unanticipated
• Let’s first look at an unanticipated expansionary policy, such as a rise in government spending or an autonomous easing of monetary policy
FIGURE 22A1.2 Response to Expansionary Policy in the New Classical Model

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

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

Step 3. If the policy is anticipated, AS shifts up and the economy moves to point 2, and inflation rises by more, but output does not rise.
Effects of Expansionary Policy (cont’d)

- Now suppose that the expansionary policy is fully anticipated by the public
- The new classical model shows that aggregate output does not increase as a result of anticipated policy and that the economy immediately moves back to long-run equilibrium
- The box “Proof of the Policy Ineffectiveness Proposition” proves why the short-run shifts immediately and so aggregate output necessarily remains at its potential level
Policy Ineffectiveness Proposition

- The new classical model is associated with the theories of the classical economists of the 19th and early 20th centuries: Aggregate output remains at the potential level.

- The **policy ineffectiveness proposition**: anticipated policy has no effect on the business cycle; only unanticipated policy matters.
Box: Proof of the Policy Ineffectiveness Proposition

- In the new classical model, the expected inflation rate is where the short-run AS intersects the LRAS curve.
- In Fig. 22A1.2, the optimal forecast of inflation is where $AS_2$ intersects $AD_2$.
- If the short-run AS curve is above or below $AS_2$, the optimal forecast of inflation is not equal expected inflation, thus violating the rationality of expectations.
- $AS_2$ implies that aggregate output remains at $Y^p$ as a result of anticipated expansionary policy.
FIGURE 22A1.3 Uncertainty About Policy Outcomes

Step 1. AS shifts up to $AS_2$ because the public expects $AD$ to shift to $AD_2$.

Step 2. Expansionary policy shifts $AD$ to $AD_2'$, which is less than the expected $AD_2$.

Step 3. The economy moves to point $2'$, where output falls.
Uncertainty About Policy Outcomes

- The policy ineffectiveness proposition and the new classical model have 2 important implications for policy makers:
  - It illuminates the distinction between the effects of anticipated vs. unanticipated policy actions
  - It demonstrates that policy makers cannot know the outcome of their decisions without knowing the public’s expectations regarding them
Objections to the New Classical Model

• The strongest objection is that firms could easily get information about movements in the general price level, and so they cannot be fooled for very long.

• The new classical model is unable to address the persistence of business cycle movements.

• Those objections have led economists to develop new theories that are discussed in Ch. 22.