LECTURE 24
INFLATION AND THE RETURN OF OUTPUT TO POTENTIAL
April 21, 2016

I. KEY IDEAS

II. THE BEHAVIOR OF INFLATION
   A. Nominal rigidities and the behavior of inflation in the short run
   B. How inflation changes over time
      1. When $Y = Y^*$, inflation tends to remain the same
      2. When $Y > Y^*$, inflation will gradually rise.
      3. When $Y < Y^*$, inflation will gradually fall

III. HOW MONETARY POLICY RESPONDS TO INFLATION
   A. How monetary policy affects the real interest rate
   B. The Fed’s reaction function

IV. HOW OUTPUT RETURNS TO POTENTIAL
   A. Moving toward potential
   B. Long-run equilibrium
   C. Saving, investment, and the real interest rate in the long run

V. APPLICATION #1: A TAX CUT
   A. The experiment
   B. The short run
   C. Returning to potential output
   D. The long-run effects

VI. APPLICATION #2: THE FED REDUCES INFLATION
   A. A shift of the Fed’s reaction function
   B. The experiment
   C. The short run
   D. Returning to potential output
   E. The long-run effects
LECTURE 24
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Announcements

• **Reminder:** The only reading for today is p. 674 of the textbook.

• **We have handed out Problem Set 6:**
  • It is due at the start of lecture on Thursday, April 28\textsuperscript{th}.
  • Problem set work session Tuesday, April 26\textsuperscript{th}, 5–7 p.m., in 648 Evans.
I. **Key Ideas**
Key Idea #1: Inflation doesn’t change in the short run, but over time, it responds to the difference between actual and potential output.

In the absence of other shocks:

- When $Y > Y^*$, inflation rises.
- When $Y < Y^*$, inflation falls.
- When $Y = Y^*$, inflation holds steady.
Key Idea #2: Monetary policy responds to inflation.

- When inflation rises, the Fed raises nominal and real interest rates.
- When inflation falls, the Fed lowers nominal and real interest rates.
- When inflation is steady, the Fed holds nominal and real interest rates steady.
Key Idea #3: The Fed’s response to inflation feeds back to the economy.

- Changes in r change planned aggregate expenditure (the PAE line).
- The shifts of the PAE line change output.
Key Idea #4: The economy is in long-run equilibrium when output is equal to potential.

• If $Y$ is not equal to $Y^*$, inflation is changing, and so $r$ is changing, and so $Y$ is changing: the economy is not in long-run equilibrium.

• If $Y$ is equal to $Y^*$, inflation is steady, and so $r$ is steady, and so $Y$ is steady: the economy is in long-run equilibrium.
Key Idea #5: The r in the long-run equilibrium we have just described is the same as the r* from our long-run saving and investment diagram.
II. The Behavior of Inflation
Inflation in the Short Run

• Recall: there are “nominal rigidities.” That is, inflation doesn’t change substantially in the short run.

• Due to limited information, menu costs, long-term contracts, or other factors.
When $Y = Y^*$, inflation tends to remain the same.

• Firms do not want to see the prices they charge either rise or fall relative to other firms’ prices.

• So, they raise prices to keep up with expected inflation.

• And past inflation is a crucial determinant of inflation expectations.

• Wage inflation and contracts also play important roles.
Inflation and Output, 1994–1997

Source: Bureau of Economic Analysis.
When $Y > Y^*$, inflation will gradually rise.

- Contracts expire, menus wear out, uncertainty is resolved, etc.

- With $Y > Y^*$, firms are operating above their comfortable capacity, and so want to raise their prices relative to other firms’.

- They therefore raise their prices by more than past inflation.

- With many firms doing this, inflation rises.
Inflation and Output, 1962–1970

Source: Bureau of Economic Analysis.
When $Y < Y^*$, inflation will gradually fall.

- The same forces that cause inflation to rise when $Y > Y^*$ work in the opposite direction.
Inflation and Output, 1979–1987

Source: Bureau of Economic Analysis.
III. HOW MONETARY POLICY Responds TO INFLATION
The Fed buys bonds (and so increases the money supply).
How the Fed Moves the Real Interest Rate

Recall:

• The nominal interest rate is determined in the market for money (which we are thinking of as currency).

• By changing the money supply, the Fed can change the nominal interest rate, i.

• The real interest rate, r, equals $i - \pi$ (or $r = i - \pi^e$), and there is inflation inertia (inflation only changes slowly).

• So: When the Fed changes i, it changes r.
The Central Bank’s Reaction Function

• The reaction function describes how the central bank’s choice of the real interest rate depends on economic variables.

• The Fed’s reaction function: It raises the real interest rate when inflation rises, and reduces the real interest rate when inflation falls.

• The motivation for the reaction function is to keep inflation from getting too low or too high.
The Fed’s Reaction Function
Inflation and the Federal Funds Rate, 2002–2006

Source: FRED.
The Fed’s Reaction Function and Changes in the Real Interest Rate

- The steepness of the reaction function (a change in \( r \) in response to a change in \( \pi \)): Reflects how aggressively the Fed fights inflation.

- A shift in the reaction function (a change in \( r \) at a given level of \( \pi \)): Reflects concerns other than inflation, or a change in the Fed’s target rate of inflation.
Different Possible Fed Responses to Inflation

The Fed fights $\pi$ aggressively

The Fed fights $\pi$ mildly

Reaction function

Reaction function
An Upward Shift of the Reaction Function

\[ r \]

\[ \pi \]

Reaction function\(_1\)

Reaction function\(_2\)
IV. How Output Returns to Potential
An Initial Situation

\[ Y = PAE \]

Y = PAE

PAE₁

Y₁

Y∗
What Happens over Time?

- If $Y_1$ is not equal to $Y^*$, after a while inflation starts to change.
- In our example, $Y_1 < Y^*$, so inflation falls.
- As inflation falls, the Fed, following its reaction function, lowers $r$.
- The reductions in $r$ increase $C$ at a given $Y$ and increase $I^p$, and so shift the PAE line up and raise $Y$. 
As the Fed lowers $r$ as inflation falls, the PAE line shifts up.
Reaching Long-Run Equilibrium

• As long as $Y \neq Y^*$, inflation continues to change, so the Fed continues to change $r$, and so $Y$ continues to change: the economy is not in long-run equilibrium.

• In our example, $Y < Y^*$, so inflation continues to fall, so the Fed continues to lower $r$, so the PAE continues to shift up, so $Y$ continues to rise.

• The process continues until $Y = Y^*$. That is when the economy is in long-run equilibrium.

• Note: For simplicity, we ignore the fact the $Y^*$ is growing during this process.
The economy is in long-run equilibrium when the PAE line intersects the 45 degree line at $Y=Y^*$. 
Long-Run Equilibrium

• When $Y = Y^*$, there is no force acting to change inflation, and so $\pi$, $r$, the PAE line, and $Y$ all stay the same—until some shock hits the economy.

• Notice that in the adjustment process, the PAE line moves (because of movements in inflation changing the Fed’s choice of the real interest rate) until it crosses the 45 degree line at $Y^*$. 
The Timing of the Return to Potential

• The short run (little noticeable change in inflation): perhaps 6 months to a year.

• The time it takes to get essentially all the way back to potential:
  • Usually 3–5 years.
  • But, sometimes substantially longer.
S, I, and r in Long-Run Equilibrium

• Recall from the saving and investment lecture: The economy’s normal or long-run real interest rate, $r^*$, is the real interest rate at which $Y^* - C^* - G = I^*$, where $C^*$ is consumption when $Y = Y^*$ and $I^*$ is normal or long-run investment.

• In the long-run equilibrium we’ve just described (where PAE crosses the 45 degree line at $Y = Y^*$), $Y^* = C^* + I^* + G$, or $Y^* - C^* - G = I^*$. $C^*$ and $I^*$ depend on $r$. Thus, the $r$ at the long-run equilibrium we’ve just described is the real interest rate at which $Y^* - C^* - G = I^*$.

• Conclusion: The real interest rate at the long-run equilibrium we have just described is the same as the $r^*$ from our long-run saving and investment diagram.
Saving, Investment, and the Real Interest Rate in Long-Run Equilibrium
Since the Fed has no choice about $r$ in the long run, when it chooses its reaction function, it is (implicitly or explicitly) choosing what inflation will be in the long run.
V. APPLICATION #1: A TAX CUT
The Experiment

• The economy starts in long-run equilibrium.

• There is then a permanent cut in taxes, $T$.

• As always when we change $T$ (unless we explicitly say otherwise), we are holding $G$ fixed.
The Short Run

\[ Y = \text{PAE} \]

Graph showing two lines labeled \( \text{PAE}_1 \) and \( \text{PAE}_2 \) in the \( \text{PAE} - Y \) plane with points \( Y^* \) and \( Y_2 \).
The Short-Run Effects

• The PAE line shifts up.

• Y rises (by more than the amount of the upward shift in PAE, because of the multiplier).

• Inflation does not change (nominal rigidity).

• So r does not change.
Returning to Potential Output

- $Y > Y^*$, so after a while inflation starts to rise.
- As inflation rises, the Fed, following its reaction function, raises $r$.
- The increases in $r$ shift the PAE line down and lower $Y$.
- The process continues until we are back at $Y^*$.
Returning to Potential Output

\[ Y = \text{PAE} \]

\[ \text{PAE}_2, \text{PAE}_1, \text{PAE}_{LR} \]
The Long-Run Effects

• Y is back at $Y^*$. 

• r is higher. 

• Since I is a decreasing function of r, I is lower. 

• Since $Y = C + I + G$, and Y and G are unchanged and I is lower, C is higher. 

• So: The tax cut has changed the composition of output.
Note that this approach gives us the same answer: The tax cut raises $r$ and lowers $I$ in the long run.
VI. APPLICATION #2: THE FED REDUCES INFLATION
The Experiment

• The economy starts in long-run equilibrium.

• There is then a permanent upward shift of the reaction function—at a given rate of inflation, the Fed sets a higher real interest rate than before.
An Upward Shift of the Reaction Function

Reaction function$_1$

Reaction function$_2$
The Short Run

\[ Y = \text{PAE} \]

- \( \text{PAE}_1 \)
- \( \text{PAE}_2 \)

Points:
- \( Y_2 \)
- \( Y^* \)
The Short-Run Effects

• The PAE line shifts down.

• Y falls (by more than the amount of the downward shift in PAE, because of the multiplier).

• Inflation does not change (nominal rigidity).

• r does change (because of the shift of the reaction function).
Returning to Potential Output

- $Y < Y^*$, so after a while inflation starts to fall.
- As inflation falls, the Fed, following its reaction function, lowers $r$.
- The decreases in $r$ shift the PAE line up and raise $Y$.
- The process continues until we are back at $Y^*$.
Returning to Potential Output

\[ Y = \text{PAE} \]

Y

\[ \text{PAE}_1, \text{PAE}_{LR}, \text{PAE}_2 \]

\[ Y_2, Y^* \]
The Long-Run Effects

- Y is back at Y*.

- Inflation is lower (it was falling the whole time Y was below Y*, and there was never a period when Y was above Y*).

- What about r and I? r rose sharply when the Fed adopted its new reaction function, then fell gradually. So the overall effect isn’t obvious.

- But: Recall that the Fed has no choice about r in the long run. So, r must return to its initial level.
$S, I, \text{ and } r \text{ in the Long Run}$

Diagram showing the relationship between $r^*$ and $S^*, I^*$.

- $S_1, S_2$
- $I_1, I_2$
- $r_1^*, r_2^*$
- $I_1^*, I_2^*$
- $S^*, I^*$

The diagram illustrates the equilibrium point where $r^*$ intersects with the intersection of $S_1, S_2$ and $I_1, I_2$.
When the Fed chooses a new reaction function, it is (implicitly or explicitly) choosing a new inflation target.
The nominal interest rate, unemployment, and inflation, Sept. 1979–Dec. 1985

Source: FRED.