

Advanced Macroeconomics

2. Analysing the IS-MP-PC Model

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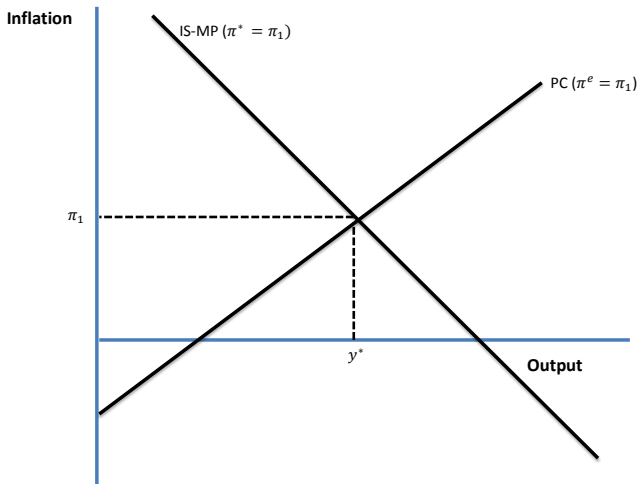
Part I

Inflation Expectations

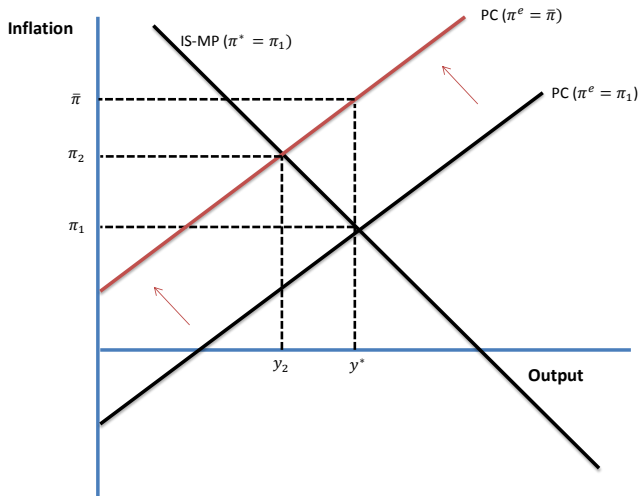
Changes in Inflation Expectations

- Last time we considered the simplest possible example: $\epsilon_t^\pi = \epsilon_t^y = 0$ and $\pi_t^e = \pi^*$
- This means no “shocks” and the public’s expectation of inflation equals the central bank’s inflation target, $\pi^* = \pi_1$.
- This generates an outcome where $\pi_t = \pi_1$ and $y_t = y_t^*$.
- Now consider a case where inflation expectations shift to being higher than the central bank’s target rate.
- In this case, $\pi_t^e = \bar{\pi} > \pi_1 = \pi^*$:
- After the increase in inflation expectations:
 - ▶ The PC curve shifts upwards.
 - ▶ Output ends up being lower than its natural rate
 - ▶ Inflation rises. It ends up taking a value between π_t^e and π^* .

Expected Inflation Equals the Inflation Target



Expected Inflation Exceeds the Inflation Target



Can We Learn More?

- The outcome here shows that inflation ends up between the public's inflation expectations and the central bank's inflation target.
- What determines this outcome? What determines how far from away target inflation will move when the public's inflation expectations change?
 - ▶ How much does it depend on the monetary policy rule?
 - ▶ How much does it depend on other aspects of the model, like the impact of real interest rates on output and the impact of output on inflation?
- It would be tricky to get these answers from a graph.
- However, using the equations underlying the model, we can fully answer all these questions.

Getting a Solution for the IS-MP-PC Model

- Let's repeat the equations describing our two curves.
- The PC curve is

$$\pi_t = \pi_t^e + \gamma(y_t - y_t^*) + \epsilon_t^\pi$$

- And the IS-MP curve is

$$y_t = y_t^* - \alpha(\beta_\pi - 1)(\pi_t - \pi^*) + \epsilon_t^y$$

- Taking all the other elements of the model as given, we can view this as two linear equations in the two variables π_t and y_t .
- These equations can be solved to give solutions that describe how these two variables depend on all the other elements of the model.

The IS-MP-PC Model Solution for Inflation

- The PC curve is

$$\pi_t = \pi_t^e + \gamma(y_t - y_t^*) + \epsilon_t^\pi$$

- And the IS-MP curve tells us that

$$y_t - y_t^* = -\alpha(\beta_\pi - 1)(\pi_t - \pi^*) + \epsilon_t^y$$

- Substituting this expression for the output gap into the Phillips curve and re-arranging we get

$$\pi_t = \left(\frac{1}{1 + \alpha\gamma(\beta_\pi - 1)} \right) \pi_t^e + \left(\frac{\alpha\gamma(\beta_\pi - 1)}{1 + \alpha\gamma(\beta_\pi - 1)} \right) \pi^* + \frac{\gamma\epsilon_t^y + \epsilon_t^\pi}{1 + \alpha\gamma(\beta_\pi - 1)}$$

- Letting

$$\theta = \frac{1}{1 + \alpha\gamma(\beta_\pi - 1)}$$

- We get

$$\pi_t = \theta\pi_t^e + (1 - \theta)\pi^* + \theta(\gamma\epsilon_t^y + \epsilon_t^\pi)$$

Interpreting the Solution for Inflation

- What's the meaning of our solution?

$$\pi_t = \theta \pi_t^e + (1 - \theta) \pi^* + \theta (\gamma \epsilon_t^y + \epsilon_t^\pi)$$

- If $\beta_\pi > 1$ as we've been assuming, then $0 < \theta < 1$. This means that inflation lies between the central bank's inflation target and the public's expectation of inflation.
- We can show that θ depends negatively on α , γ and β_π . This means that the central bank's inflation target plays more role in determining inflation when
 - 1 γ increases: This parameter determines how inflation changes when output changes.
 - 2 α increases: This parameter determines how output changes when real interest rates change.
 - 3 β_π increases: This parameter determines how the central bank responds to inflation.

The IS-MP-PC Model Solution for Output

- The IS-MP curve tells us that output depends on how far inflation is from the central bank's target

$$y_t - y_t^* = -\alpha (\beta_\pi - 1) (\pi_t - \pi^*) + \epsilon_t^y$$

- Re-arranging the solution for inflation, we get

$$\pi_t - \pi^* = \theta (\pi_t^e - \pi^* + \epsilon_t^\pi + \gamma \epsilon_t^y)$$

- This gives

$$y_t = y_t^* - \theta \alpha (\beta_\pi - 1) (\pi_t^e - \pi^* + \epsilon_t^\pi + \gamma \epsilon_t^y) + \epsilon_t^y$$

which can be simplified to

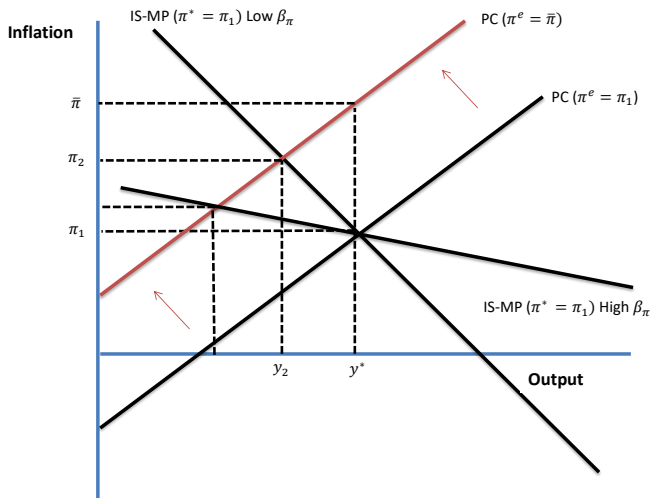
$$y_t = y_t^* - \theta \alpha (\beta_\pi - 1) (\pi_t^e - \pi^* + \epsilon_t^\pi) + (1 - \theta \alpha \gamma (\beta_\pi - 1)) \epsilon_t^y$$

- Output falls short of its natural rate if inflation expectations exceed the inflation target. The amount of the shortfall depends positively on α and β_π and negatively on γ . Think about why this is.

Soft versus Tough Central Banks

- The calculations here tell us that the more aggressive a central bank is in its response to inflation—the higher the value of β_π —then the smaller the rise in inflation will be and the larger the drop in output will be.
- We can illustrate this graphically by comparing the last figure with what would have happened if the IS-MP curve had been flatter: A higher value of β_π means a flatter IS-MP curve, meaning each unit increase in inflation is associated with a more aggressive policy response from the central bank and thus a larger fall in output.
- Look at the next page: We overlay a second, flatter, IS-MP curve on top of our previous figure.
- As with the original IS-MP curve, this curve generated by a higher β_π also intersects with the original curve so that $\pi_t = \pi^*$ and $y_t = y_t^*$.
- But after the Phillips curve shifts up, it generates a smaller increase in inflation and a larger decrease in output.

A Rise in Expected Inflation For Two Values Of $\beta\pi$



How Do Inflation Expectations Change?

- We have seen that after the public's inflation expectations rise, the result is a fall in output below its natural rate and an increase in inflation, though this increase is smaller than had been expected by the public.
- What happens next? How does the public's expectation of inflation change at this point?
- Milton Friedman's 1968 paper suggested that people gradually adapt their expectations based on past outcomes for inflation.
- Consider now a simple model of this idea of "adaptive expectations"

$$\pi_t^e = \pi_{t-1}$$

- Under this formulation of expectations, the Phillips curve becomes

$$\pi_t = \pi_{t-1} + \gamma(y_t - y_t^*) + \epsilon_t^\pi$$

- In other words, there should be a positive relationship between the *change* in inflation and the output gap. Alternatively, there should be a negative relationship between the change in inflation and the rate of unemployment.

The Failure of the Phillips Curve

US Inflation and Unemployment, 1955-2019

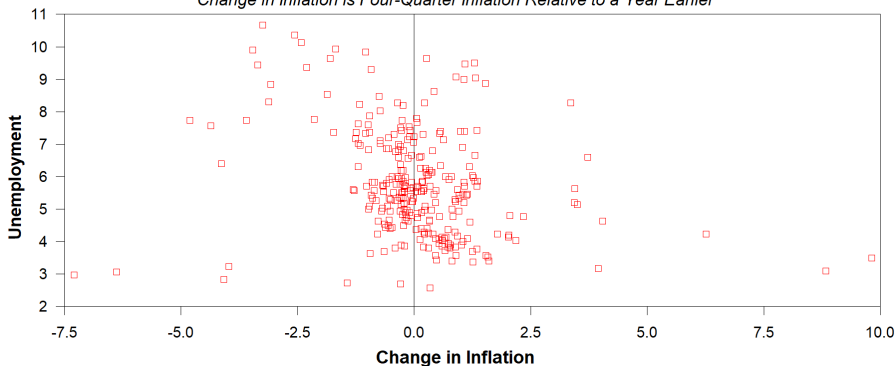
Inflation is the Four-Quarter Percentage Change in GDP Deflator



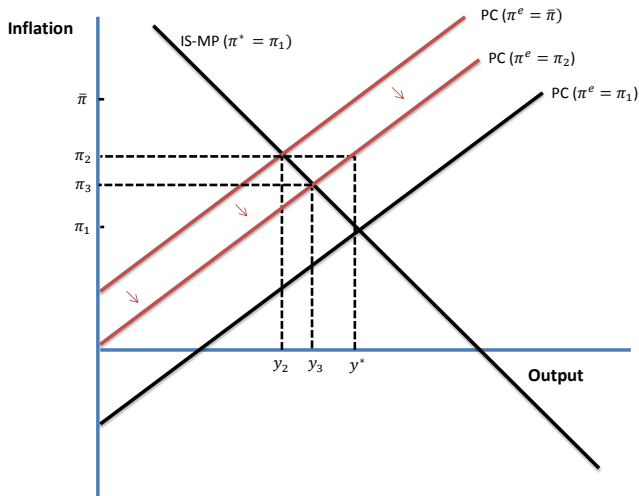
Evidence for Adaptive Inflation Expectations

Changes in US Inflation and Unemployment, 1955-2019

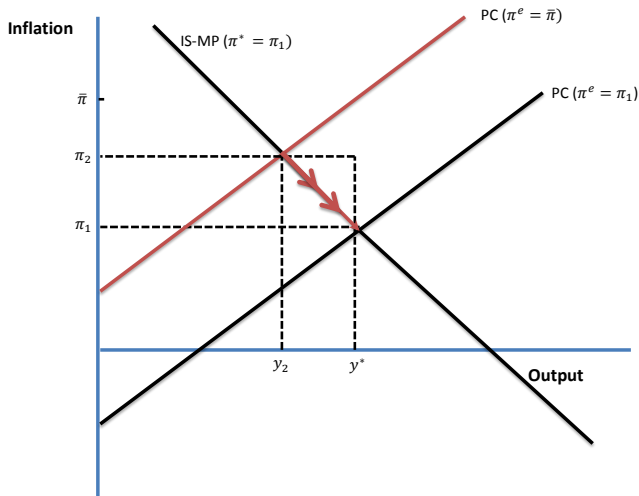
Change in Inflation is Four-Quarter Inflation Relative to a Year Earlier



Inflation Expectations Adjusting Back Downwards



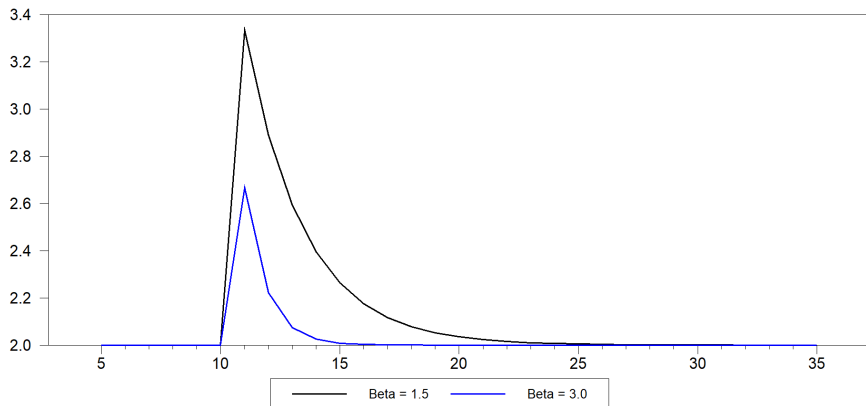
Inflation and Output Adjust Back to Starting Position



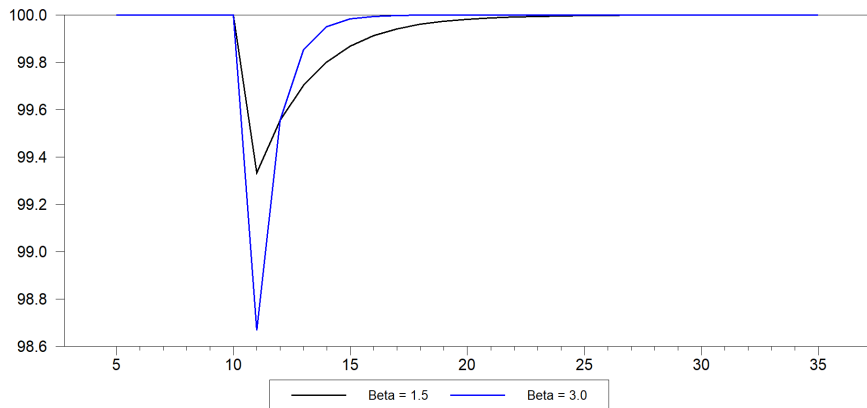
Economy Dynamics for Soft and Tough Central Banks

- Do we want a “soft” central bank that limits the increase in real interest rates when inflation rises to protect the economy?
- Or do we want a “tough” central bank that raises interest rates aggressively and is very concerned about getting inflation back to target?
- We can illustrate the differences between the two scenarios by simulating the model on a computer.
- The rise in inflation is smaller and disappears quicker when there is a tough central bank. And the tough central bank engineers a much larger recession but this ends much quicker.
- The total average value of output over the whole sample is the same for the two scenarios: A certain amount of cumulative output below its natural rate is required to lower the inflation rate back to the central bank's target.
- This suggests central banks face a choice when dealing with high inflation: They can go for the “cold turkey” option and have a sharp but short recession or they can take a softer approach which ends up taking more time to get output and inflation back to target.

Inflation Rises By Less and Falls Back Quicker With The Tough Central Bank



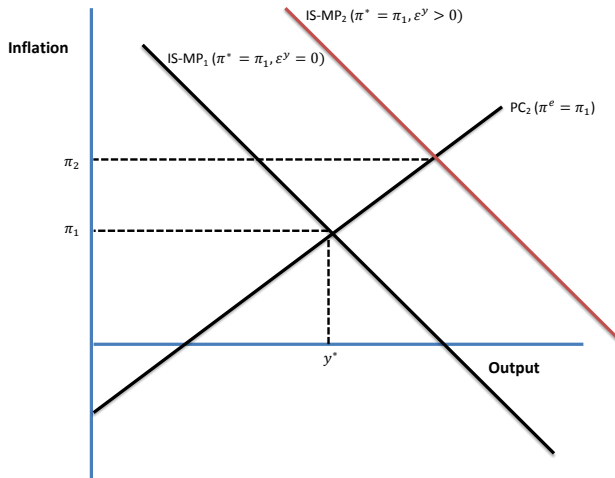
Sharper But Shorter Recession With The Tough Central Bank



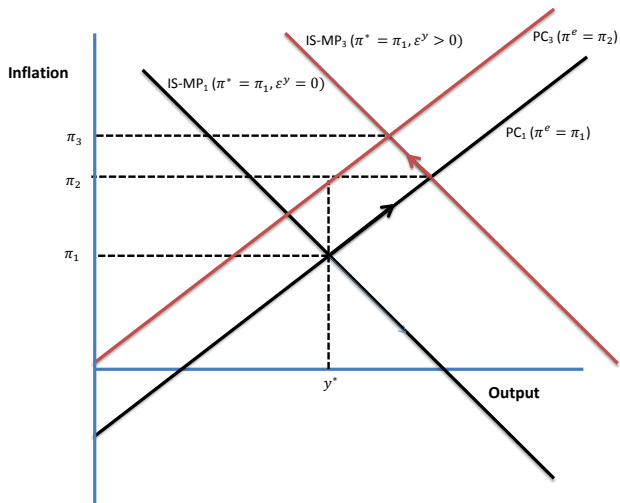
Part II

Temporary Demand Shocks

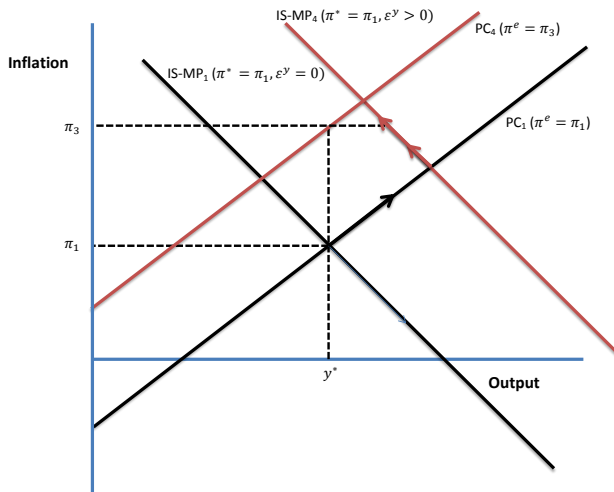
A Temporary Aggregate Demand Shock ($\epsilon_t^y > 0$)



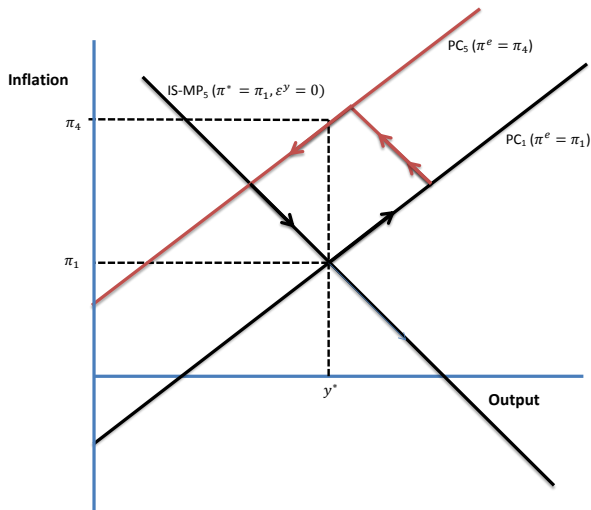
Inflation Expectations Adjust Upwards to π_2



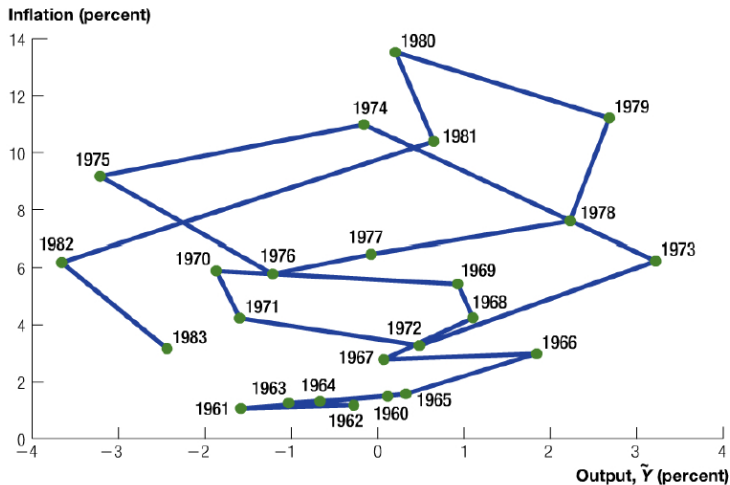
Inflation Expectations Adjust Upwards Further to π_3



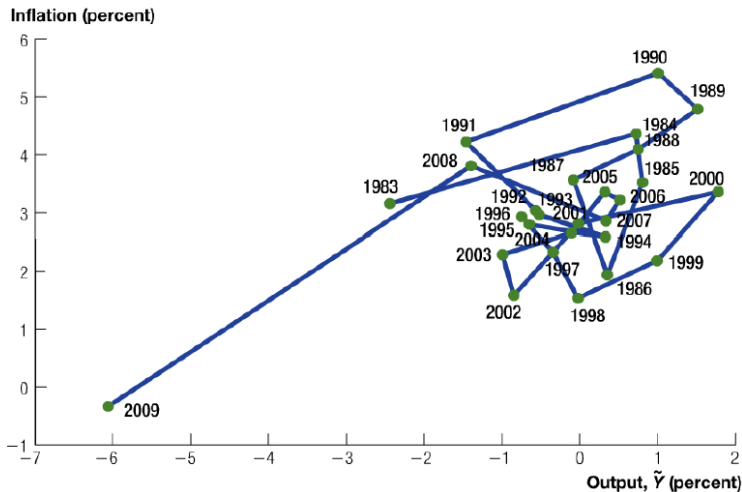
Reversal of Shock Leads to Recession With High Inflation



US Inflation-Output Loops 1960-1983



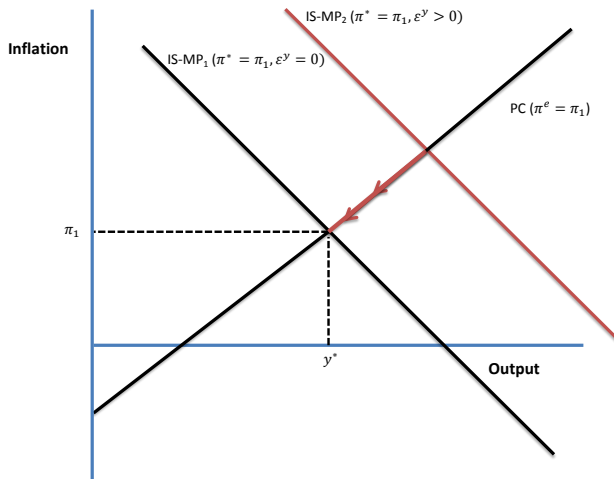
US Inflation-Output Loops 1983-2009



Part III

Soft Versus Tough Central Banks

Adjustment if Inflation Expectations Don't Change



Implications for Central Bank Institutional Design

- What kind of central bank do we want?
 - ▶ Do we want a “soft” central bank that limits the increase in real interest rates when inflation rises to protect the economy and which isn't too concerned about getting inflation back to target quickly?
 - ▶ Or do we want a “tough” central bank that raises interest rates aggressively and is very concerned about getting inflation back to target?
- Suppose we wish to avoid large recessions if possible. You might imagine the soft central bank would be more likely to deliver this.
- However, our model says the exact opposite.
 - ▶ Recessions are smaller and shorter and the economy less volatile when the central bank acts aggressively.
 - ▶ The more people believe that a central bank is maintaining its low inflation target, the less likely the economy is to go through boom-bust cycles.

Implications for Central Bank Institutional Design

A better outcome is obtained if the central bank can commit to a low inflation, and this commitment be believed by the public. This suggests the following ways of achieving the best outcome:

- 1 **Political Independence:** Central banks that plan for the long-term and don't worry about economic performance during election years are more likely to stick to a commitment to low inflation.
- 2 **Conservative Central Bankers:** If the central banker is known to really dislike inflation—and the public believes this, the economy gets closer to the ideal low inflation outcome even without commitment. The government may choose to appoint a central banker who is more inflation-averse than they are.
- 3 **Consequences for Bad Inflation Outcomes:** If bad things happen to central bankers when inflation is high, then the public are more likely to believe they will commit to a low inflation rate.

Influence of these Ideas

This research has had a considerable influence on the legal structure of central banks around the world:

- 1 **Political Independence:** There has been a substantial move around the world towards making central banks more independent. Close to home, the Bank of England was made independent in 1997 and the ECB/Eurosystem is highly independent from political control.
- 2 **Conservative Central Bankers:** All around the world, central bankers talk much more now about the evils of inflation and the benefits of price stability. Mainly, this is because they believe this to be the case. But there is also a marketing element. Perhaps they can face a better macroeconomic tradeoff if the public believes the central bank's commitment to low inflation.
- 3 **Consequences for Bad Inflation Outcomes:** Many central banks now have legally imposed inflation targets and bad things happen when the inflation target is not met. For instance, the Governor of the Bank of England has to write a letter to the Chancellor explaining why the target was not met.

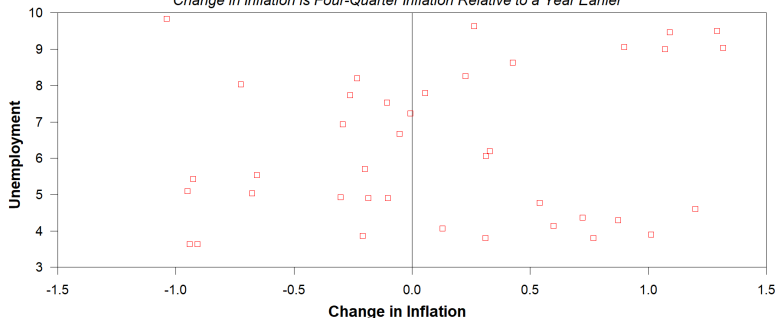
A Bad Decade for the Phillips Curve

- Inflation has been very low over the past decade in advanced economies despite many of them experiencing low rates of unemployment for extended periods of time.
- Check out the graph on the next page which shows that the “adaptive expectations” version of the Phillips curve has not worked over the past decade. The following page shows the correlation between the change in inflation and unemployment for rolling 10-year time windows. This Phillips correlation has been weakening since the early 1990s.
- Many now speculate that “the Phillips curve is dead” so central banks no longer need to worry about economies over-heating and generating higher inflation.
- One possibility is, with the increasingly globalised nature of economies, the relevant measure of “supply capacity” determining inflation is a global one rather than a national one and low inflation reflects the world economy still having plenty of spare capacity.
- Alternatively, what we are seeing could be the success of many years of central bank commitment to low inflation keeping inflation expectations anchored at low levels.

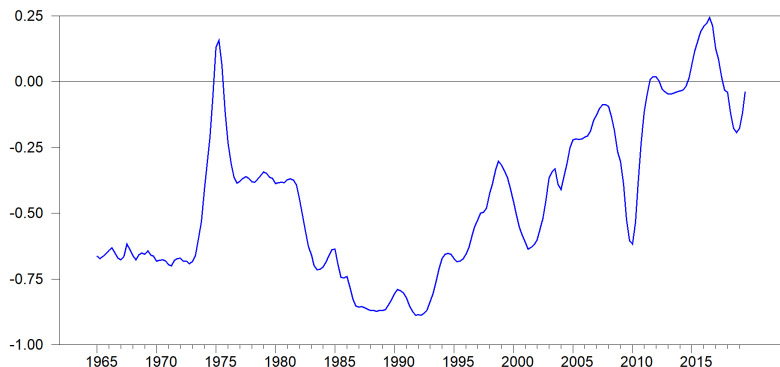
A Bad Decade for the Adaptive Expectations Phillips Curve

Changes in US Inflation and Unemployment, 2010-2019

Change in Inflation is Four-Quarter Inflation Relative to a Year Earlier



Rolling 10-Year Correlations Between Unemployment and the Change in Inflation



Things to Understand From This Topic

- 1 What happens when inflation expectations rise above the central bank's target.
- 2 The IS-MP-PC solution for inflation and how to derive it.
- 3 The IS-MP-PC solution for output and how to derive it.
- 4 Adaptive expectations.
- 5 Evidence for the adaptive expectations version of the Phillips curve.
- 6 Effects of a temporary demand shock under adaptive expectations.
- 7 Effects of a temporary demand shock when inflation expectations don't change.
- 8 Implications for central bank design and practice.