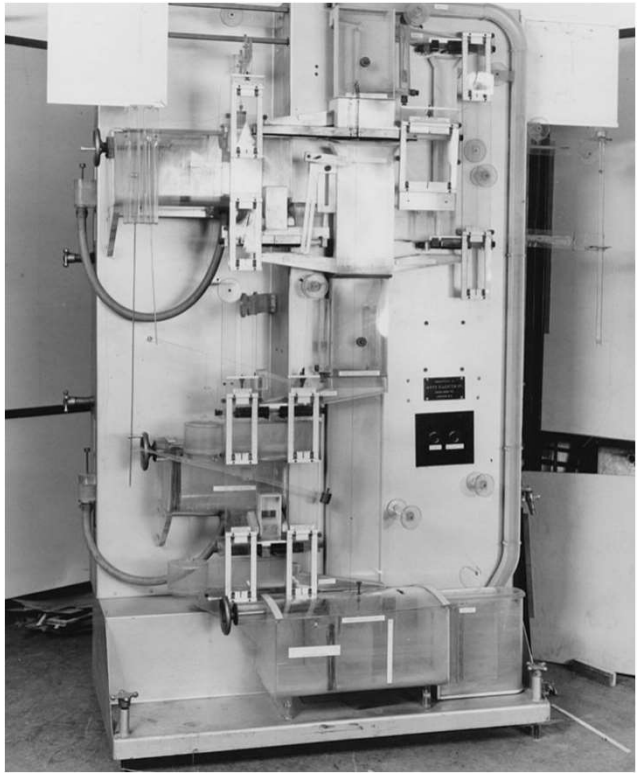
ECON3123
Macroeconomic Theory I

Tutorial #8: The Phillips Curve

Today's tutorial

- The Phillips Curve(s)
  - How they relate to the wage setting and price setting equations
  - The original and accelerationist versions
  - How expectations are formed
  - The role of central bank credibility

Bill Phillips and the Phillips machine



- The Phillips Curve is named after Bill Phillips, who worked at the LSE but who was originally an engineer
- He thought of an economy as a series of tanks in which output could be represented as a liquid, with its rate of growth controlled by pumps
- He built a machine to demonstrate his idea of how an economy works
  - The Phillips machine
- It's now kept at the LSE in London

Source: LSE

The Phillips Curve

- Introducing the supply side of the economy
  - Allowing prices to be flexible
- Wage setting: $W_t = AP_t^e\ (1 - \alpha u_t + z)$
- Price setting: $P_t = \frac{(1+m)}{A} W_t$
- Phillips curve: $\pi_t = \pi_t^e + (m + z) - \alpha u_t$
- Interpretation (<u>always through the wage and price setting equations</u>):
  - π_t^e: higher π_t^e ⇒ higher P_t^e ⇒ higher W_t ⇒ higher P_t ⇒ higher π_t
  - m: higher m => higher P_t ⇒ higher π_t
  - z: higher z ⇒ higher P_t ⇒ higher π_t
  - A: higher A ⇒ lower P_t ⇒ lower π_t
  - α: higher α ⇒ lower W_t ⇒ lower P_t ⇒ lower π_t
  - u_t: higher u_t ⇒ lower W_t ⇒ lower P_t ⇒ lower π_t

Telling the story of the Phillips Curve

- Intuitive explanations are important in understanding the relationships 'inside' the Phillips Curve

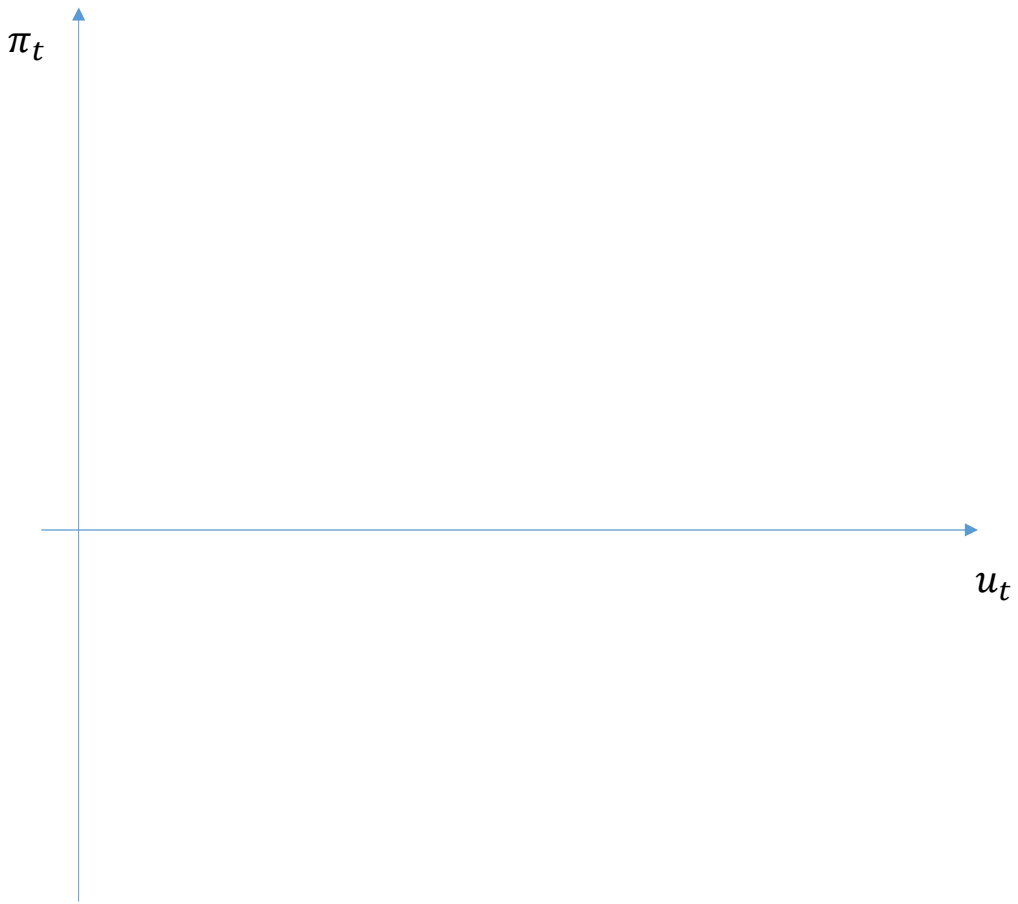
Variable	Impact on inflation (via the equations)	Intuition
u_t	Wage setting: $W_t = AP_t^e\ (1 - \alpha u_t + z)$ Price setting: $P_t = \frac{(1+m)}{A} W_t$ Phillips curve: $\pi_t = \pi_t^e + (m + z) - \alpha u_t$ The answer: higher u_t ⇒ lower W_t ⇒ lower P_t ⇒ lower π_t	• Higher unemployment means that there is a greater supply of workers available for every available job • Therefore, employers can offer lower wages to attract workers than if unemployment were not so high • Therefore, wages fall with higher unemployment • Therefore, firms can maintain their profitability with lower prices, and so prices fall • Therefore inflation falls

Telling the story of the Phillips Curve

- Intuitive explanations are important in understanding the relationships 'inside' the Phillips Curve

Variable	Impact on inflation (via the equations)	Intuition
m	Wage setting: $W_t = AP_t^e\ (1 - \alpha u_t + z)$ Price setting: $P_t = \frac{(1+m)}{A} W_t$ Phillips curve: $\pi_t = \pi_t^e + (m + z) - \alpha u_t$ The answer: higher m => higher P_t ⇒ higher π_t	

The original Phillips Curve



- The original Phillips Curve: an era of stable inflation
  - $\pi_t^e = \overline{\Pi}$
  - $\pi_t = \overline{\Pi} + (m + z) - \alpha u_t$
  - In this version, inflation expectations are fixed
  - With $\overline{\Pi}$, m and z fixed, we can draw this
  - A relationship like this worked from 1950 to 1970

The Accelerationist Phillips Curve

- The Accelerationist Phillips Curve: allowing inflation expectations to change
  - $\pi_t^e = \pi_{-1}$
  - $\pi_t = \pi_{-1} + (m + z) - \alpha u_t$
- In this version, inflation expectations change every period
- We cannot draw a stable relationship (the equation changes every period)
- Note: there are many ways to model inflation expectations. In this version, inflation expectations are given by the previous period's actual inflation rate
  - So inflation expectations are completely backward-looking in this version

The Phillips Curve and the Natural Rate of Unemployment

- Blanchard Ch.8 Q.3
- Re-write the Phillips Curve $\pi_t = \pi_t^e + (m + z) - \alpha u_t$ as a relation between the deviation of the unemployment rate from the natural rate, inflation and expected inflation

The Phillips Curve and the Natural Rate of Unemployment

- When we derived the natural rate of unemployment previously, what condition on the price level and the expected price level was imposed in that derivation?

- How does it relate to the condition imposed on the Phillips Curve?

- So now we have a version of the Phillips Curve that relates inflation to inflation expectations and the 'unemployment gap':

$$\pi_t = \pi_t^e - \alpha(u_t - u_n)$$

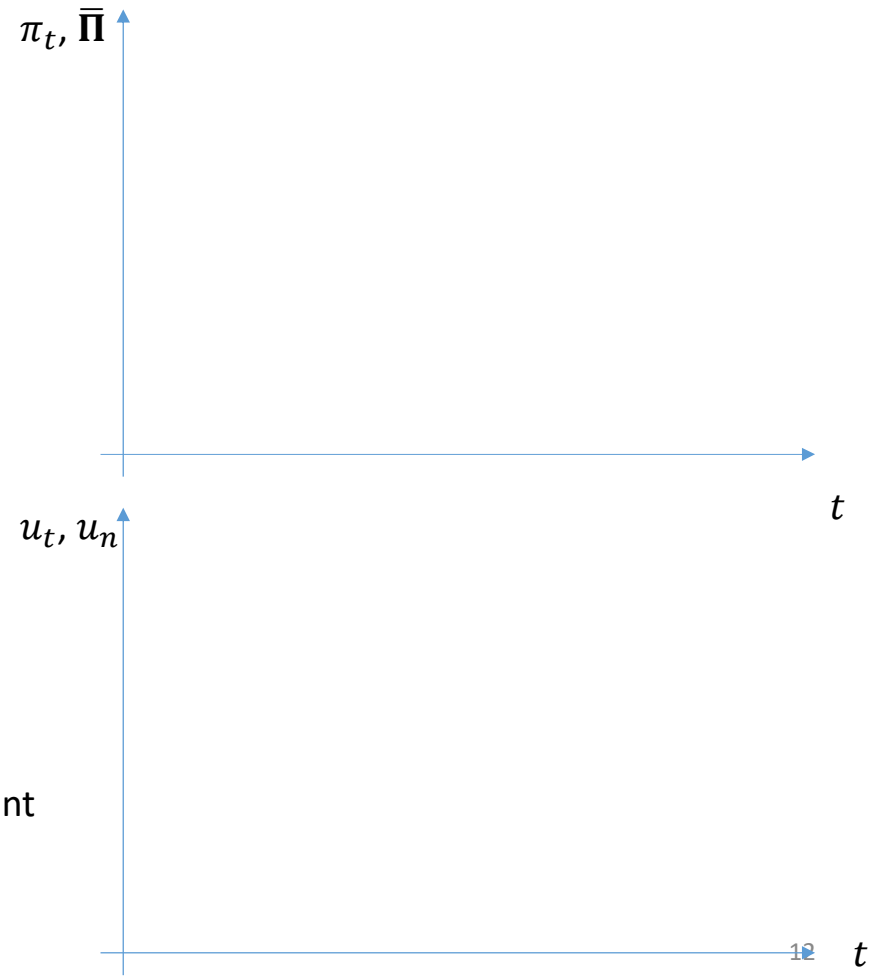
Exercise: Inflation under the original and accelerationist versions of the Phillips Curve

- We have two ways that inflation expectations are formed:
  - $\pi_t^e = \overline{\Pi}$
  - $\pi_t^e = \pi_{-1}$
- What are the implications for inflation of each when unemployment changes?
- Assume that the natural rate of unemployment is $u_n = 5\%$, and that at time $t = 0$, unemployment is $u_0 = 5\%$ and that inflation expectations are $\pi_0^e = 5\%$
- Assume that at $t = 1$, unemployment falls to $u_1 = 2.5\%$
- Assume two versions of the Phillips Curve:
  - Original: $\pi_t = \overline{\Pi} - (u_t - u_n)$
  - Accelerationist: $\pi_t = \pi_{-1} - (u_t - u_n)$
- What happens to inflation over time under the two versions?

Exercise: Inflation under the original and accelerationist versions of the Phillips Curve

Original Phillips curve: $\pi_t = \bar{\Pi} - (u_t - u_n)$

time	$\pi_t^e = \bar{\Pi}$	u_t	u_n	π_t
0	5%	5%	5%	5%
1	5%	2.5%	5%	7.5%
2	5%	2.5%	5%	7.5%
3	5%	2.5%	5%	7.5%
4	5%	2.5%	5%	7.5%



- There is a one-off increase in inflation caused by reduction in unemployment
- For t=1 onwards, inflation doesn't change
- There is no persistence of the effect of the fall in unemployment on inflation

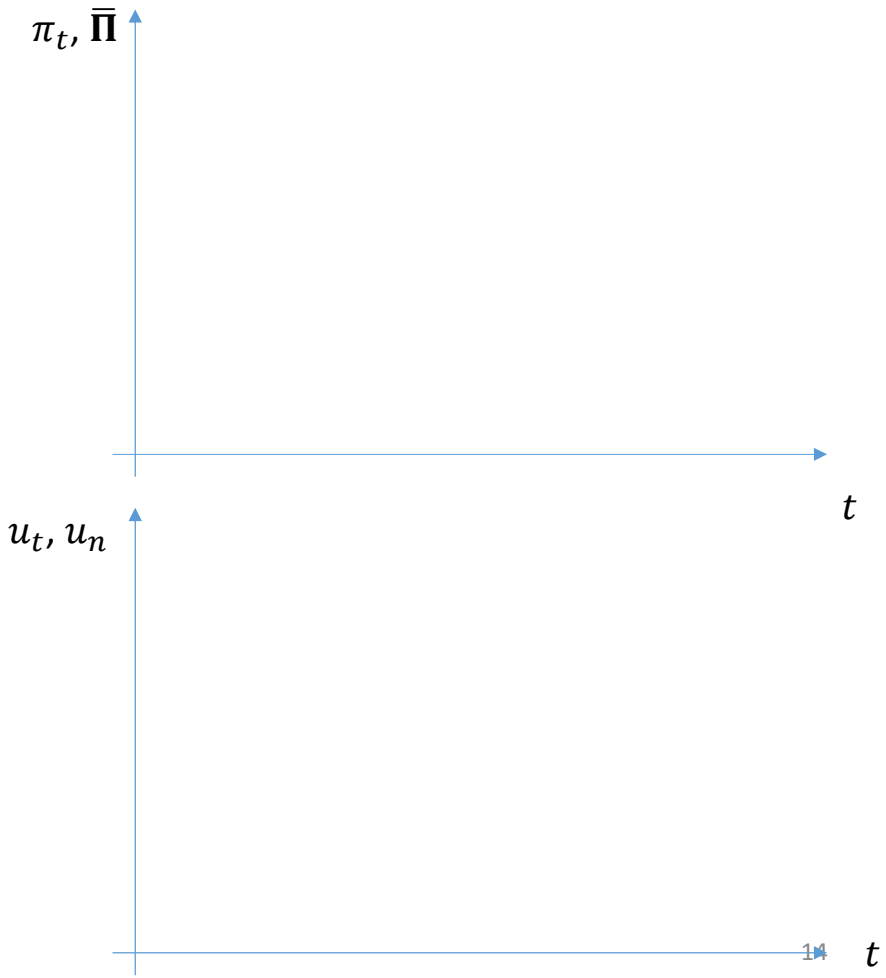
Exercise: Inflation under the original and accelerationist versions of the Phillips Curve

- Original Phillips curve: $\pi_t = \overline{\Pi} - (u_t - u_n)$
- What's the intuition for the lack of persistence of the fall in unemployment on inflation?
- Wage setting: $W_t = AP_t^e\ (1 - \alpha u_t + z)$
- Price setting: $P_t = \frac{(1+m)}{A} W_t$
- At t=1:
  - The fall in unemployment causes wages to rise via the wage setting equation:
    - Lower unemployment means that employers have to offer higher wages to attract workers
  - Higher wages feed into higher prices via the price setting equation:
    - To maintain their profitability, firms increase prices
    - Prices and inflation increase
- At t=2 and after:
  - Unemployment remains at the same level as at t=1
  - Inflation expectations stay at the same level as at t=0 and t=1
  - Therefore, employers can offer the same wages as at t=1
  - Prices and inflation stay unchanged

Exercise: Inflation under the original and accelerationist versions of the Phillips Curve

Accelerationist Phillips curve: $\pi_t = \pi_{-1} - (u_t - u_n)$

time	$\pi_t^e = \pi_{-1}$	u_t	u_n	π_t
0	5%	5%	5%	5%
1	5%	2.5%	5%	7.5%
2	7.5%	2.5%	5%	10%
3	10%	2.5%	5%	12.5%
4	12.5%	2.5%	5%	15%



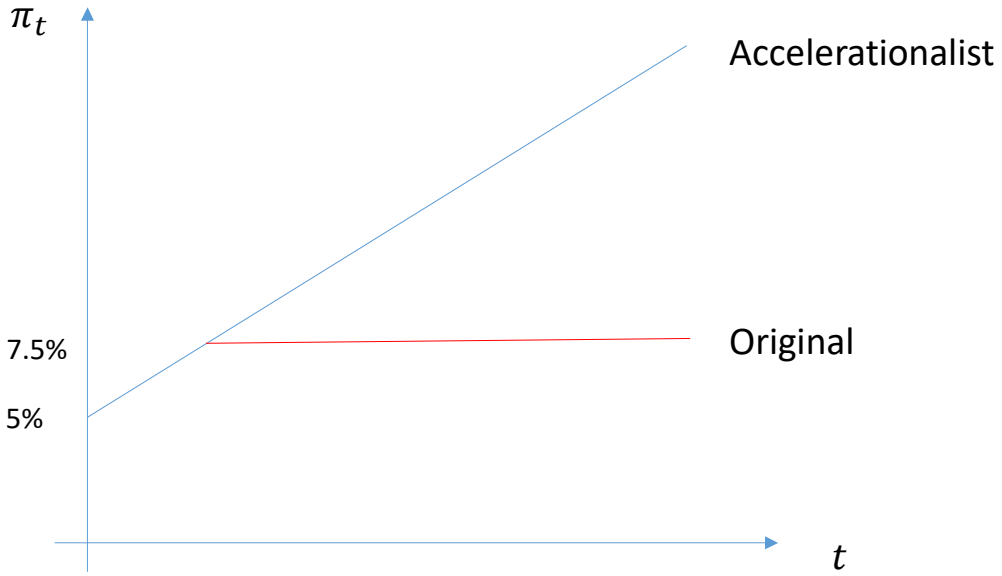
- The one-off reduction in unemployment causes inflation to increase forever
- There is total persistence of the effect of the fall in unemployment on inflation

Exercise: Inflation under the original and accelerationist versions of the Phillips Curve

- Accelerationist Phillips curve: $\pi_t = \pi_{-1} - (u_t - u_n)$
- What's the intuition for the persistence of the fall in unemployment on inflation?
- Wage setting: $W_t = AP_t^e\ (1 - \alpha u_t + z)$
- Price setting: $P_t = \frac{(1+m)}{A} W_t$
- At t=1:
  - The fall in unemployment causes wages to rise via the wage setting equation:
    - Lower unemployment means that employers have to offer higher wages to attract workers
  - Higher wages feed into higher prices via the price setting equation:
    - To maintain their profitability, firms increase prices
    - Prices and inflation increase
- At t=2 and after:
  - Unemployment remains at the same level as at t=1
  - Inflation expectations increase to the higher rate of actual inflation at t-1
  - Workers demand and are paid higher wages
  - Higher wages feed into higher prices and inflation increases every period

Economic policy and the Phillips Curve

- Question (1): which Phillips Curve would policy makers prefer to be in place in their economy?
  - Original: $\pi_t = \overline{\Pi} - \alpha(u_t - u_n)$
  - Accelerationist: $\pi_t = \pi_{-1} - (u_t - u_n)$



Economic policy and the Phillips Curve

- Question (2): According to the Phillips Curve, if inflation does increase in an economy, what can policy makers do to bring it under control?
  - Original: $\pi_t = \overline{\Pi} - \alpha(u_t - u_n)$
  - Accelerationist: $\pi_t = \pi_{-1} - \alpha(u_t - u_n)$
- Four options:
  - 1) Increase unemployment (ie u_t rises)
  - 2) Reduce the natural rate of unemployment (ie u_n falls)
  - 3) Reduce the sensitivity of inflation to unemployment (ie α falls)
  - 4) Find a way to reduce inflation expectations (ie $\overline{\Pi}$ or π_{-1} fall)
- 2) and 3) are important policy options, but take a long time to become effective
- We'll focus on 1) and 4)

Controlling inflation through rising unemployment

- By how much would unemployment have to increase by in order bring inflation back to its starting level of 5%?
- Assume that unemployment increases to 5% at t=2:

Original: $\pi_t = \bar{\Pi} - \alpha(u_t - u_n)$

time	$\pi_t^e = \bar{\Pi}$	u_t	u_n	π_t
0	5%	5%	5%	5%
1	5%	2.5%	5%	7.5%
2	5%	5%	5%	5%
3	5%	5%	5%	5%
4	5%	5%	5%	5%

- If inflation expectations are fixed, then a one-off increase in unemployment back to 5% immediately brings inflation back to 5%
- So stabilizing inflation is much easier if inflation expectations are fixed

Controlling inflation through rising unemployment

- By how much would unemployment have to increase by in order bring inflation back to its starting level of 5%?
- Assume that unemployment rises to 5% at t=2:

Accelerationist: $\pi_t = \pi_{-1} - (u_t - u_n)$

time	$\pi_t^e = \pi_{-1}$	u_t	u_n	π_t
0	5%	5%	5%	5%
1	5%	2.5%	5%	7.5%
2	7.5%	5%	5%	7.5%
3	7.5%	5%	5%	7.5%
4	7.5%	5%	5%	7.5%

- If inflation expectations are given by the previous period's inflation rate, then increasing unemployment to 5% stabilises inflation, but at a permanently higher level (7.5%)
- To reduce inflation back to 5% would require higher unemployment than its starting rate of 5%
- Stabilizing inflation has a greater cost in terms of unemployment with the accelerationist Phillips Curve

Controlling inflation through rising unemployment

- Creating a deeper recession and having unemployment at 7.5% in period 2 brings inflation to 5%, but then causes a deflationary spiral:

Accelerationist: $\pi_t = \pi_{-1} - (u_t - u_n)$

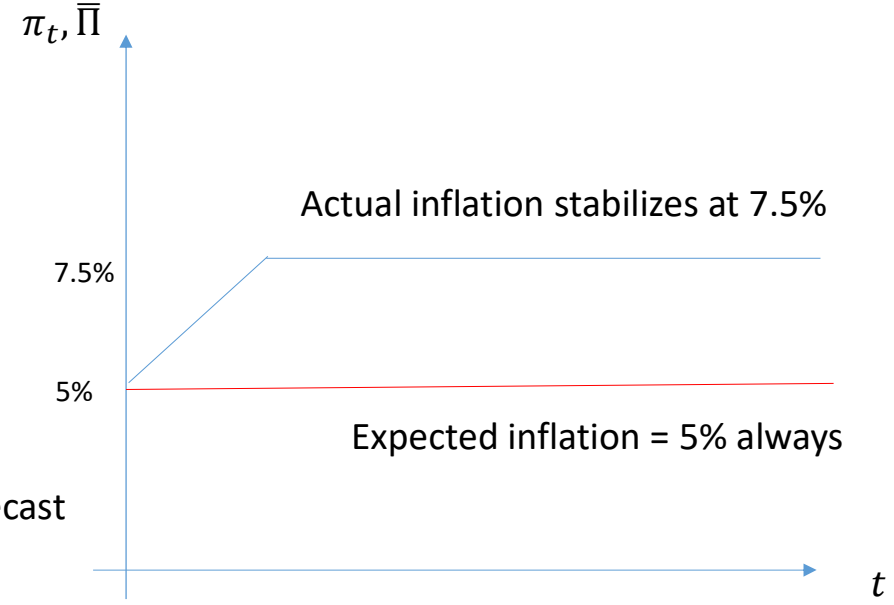
time	$\pi_t^e = \pi_{-1}$	u_t	u_n	π_t
0	5%	5%	5%	5%
1	5%	2.5%	5%	7.5%
2	7.5%	7.5%	5%	5%
3	5%	7.5%	5%	2.5%
4	2.5%	7.5%	5%	0%

- Permanent unemployment at 7.5% from t=2 onwards causes a permanent deflationary spiral
- To stabilize inflation at 5% permanently is theoretically possible, but in practice policy makers cannot implement policy with sufficient precision to achieve this
- More likely is a 'noisier' approach with costs in terms of social welfare

The importance of how inflation expectations are formed

- Consider again what happens to inflation when unemployment falls according to the original Phillips Curve:

time	$\pi_t^e = \bar{\Pi}$	u_t	u_n	π_t
0	5%	5%	5%	5%
1	5%	2.5%	5%	7.5%
2	5%	2.5%	5%	7.5%
3	5%	2.5%	5%	7.5%
4	5%	2.5%	5%	7.5%



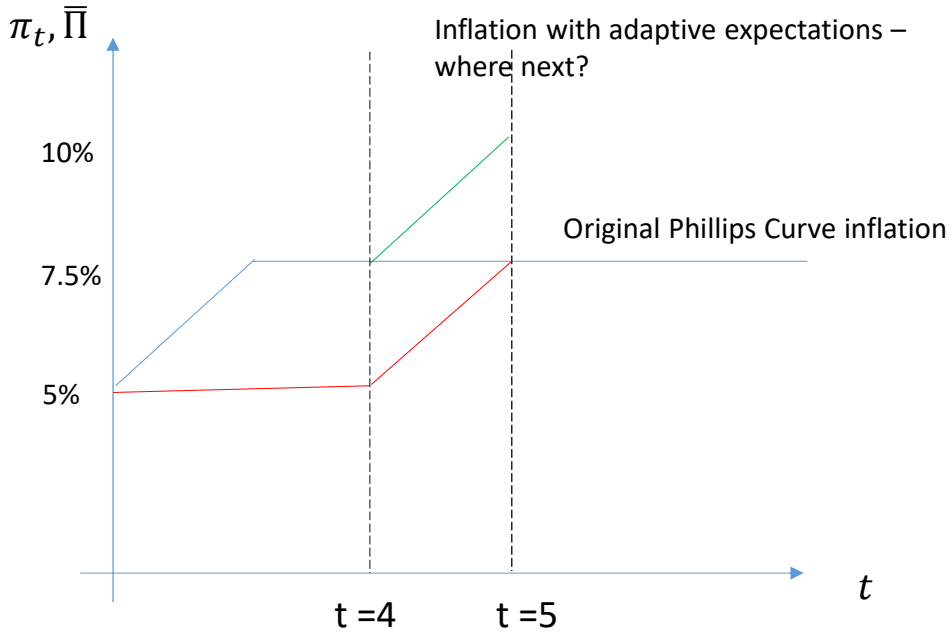
- Suppose that we are in period 5 and that you have to forecast inflation for the coming year
- What does the model forecast? What do you forecast?

The importance of how inflation expectations are formed

- What happens if inflation expectations rise to 7.5% in period 5?

time	π_t^e	u_t	u_n	π_t
5	7.5%	2.5%	5%	10%
6	?	2.5%	5%	?

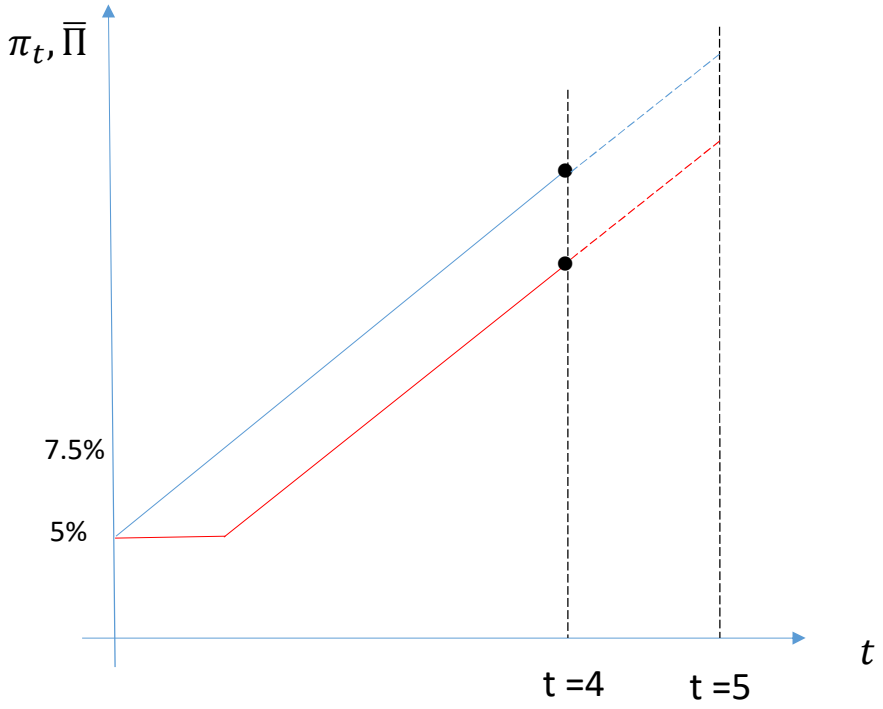
- Then what do you forecast in period 6 and onwards?
- Very easy to change from an Original to an Accelerationist Phillips Curve
- And so very easy to develop a 'wage-price spiral'



The importance of how inflation expectations are formed

- Now consider inflation expectations when unemployment falls under an Accelerationalist Phillips Curve:

time	$\pi_t^e = \pi_{-1}$	u_t	u_n	π_t
0	5%	5%	5%	5%
1	5%	2.5%	5%	7.5%
2	7.5%	2.5%	5%	10%
3	10%	2.5%	5%	12.5%
4	12.5%	2.5%	5%	15%
5	?	2.5%	5%	



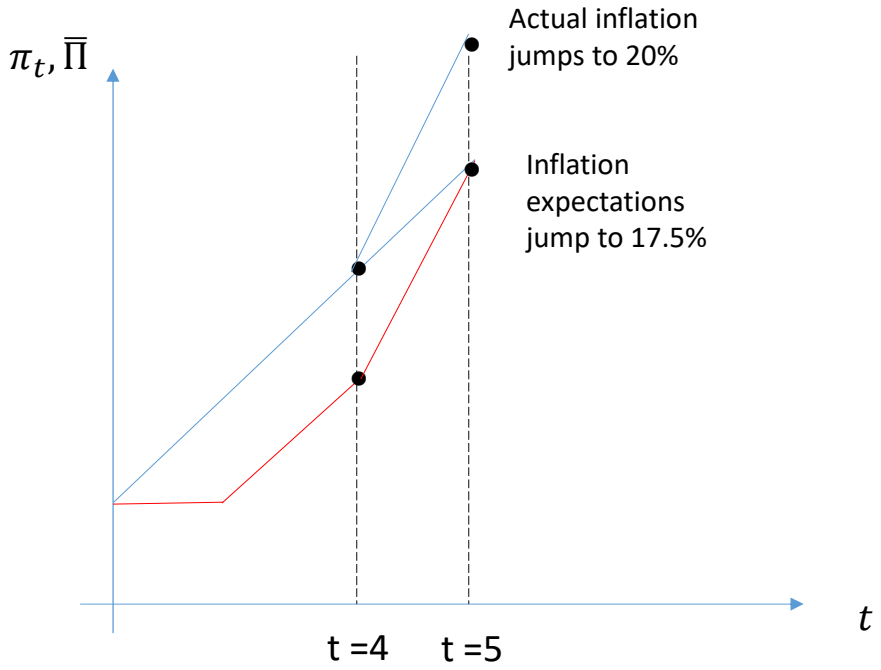
- Suppose that we are in period 5 and that you have to forecast inflation for the coming year
- What does the model forecast? What do you forecast?
- If actual inflation has been growing by 2.5% points per year, what is the most rational forecast that you could make?

The importance of how inflation expectations are formed

- If you forecast 17.5% inflation for period 5, what happens to actual inflation? And what happens in later periods?

time	$\pi_t^e = \pi_{-1}$	u_t	u_n	π_t
5	17.5%	2.5%	5%	20%
6	?			

- The assumption $\pi_t^e = \pi_{-1}$ systematically underestimates actual inflation
- Is this realistic, especially if inflation is well-established in an economy?
- More realistic assumptions can explain more serious 'wage-price spirals'



What can central banks do to manage inflation expectations?

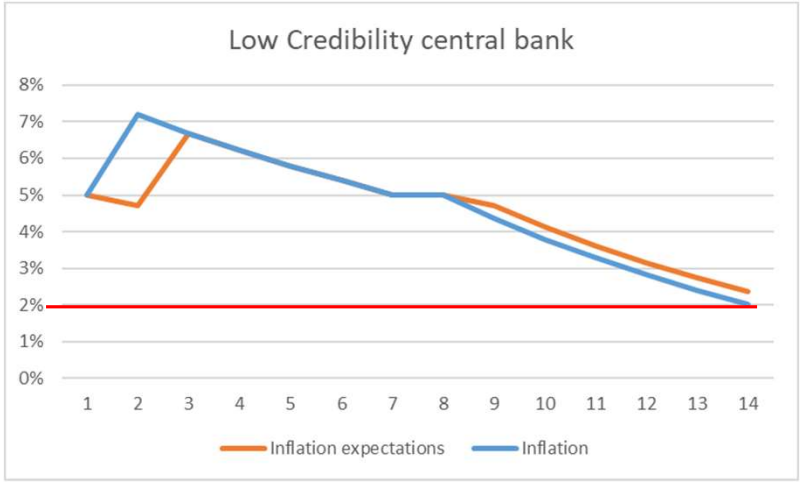
- We have seen that the costs of 'wage-price spirals can be significant in terms of higher unemployment
  - ie policy makers cause a recession to control inflation
- We have also seen that the cost are less when inflation expectations are fixed
- One solution: central banks can implement monetary policy with an explicit inflation target
- The objective is to achieve $\pi_t^e = \pi_{cb\ target}^e$
- Then we would have: $\pi_t = \pi_{cb\ target}^e - \alpha(u_t - u_n)$
- The costs of controlling inflation would be as in the fixed inflations expectations case, with no 'wage-price spiral' as inflation was brough under control and unemployment returned to its natural rate

The issue of central bank credibility

- A key issue is whether wage setters believe that the central bank will take necessary steps to bring inflation under control
  - ie the issue of central bank credibility
- With full credibility we would have $\pi_t = \pi^e_{cb\ target} - \alpha(u_t - u_n)$
- Consider two cases:
  - A central bank with a long record of inflation control and great credibility (eg the Bundesbank in Germany before the introduction of the Euro)
  - A central bank that has just introduced an inflation target after a long history of high and volatile inflation (eg the Bank of England in 1997)

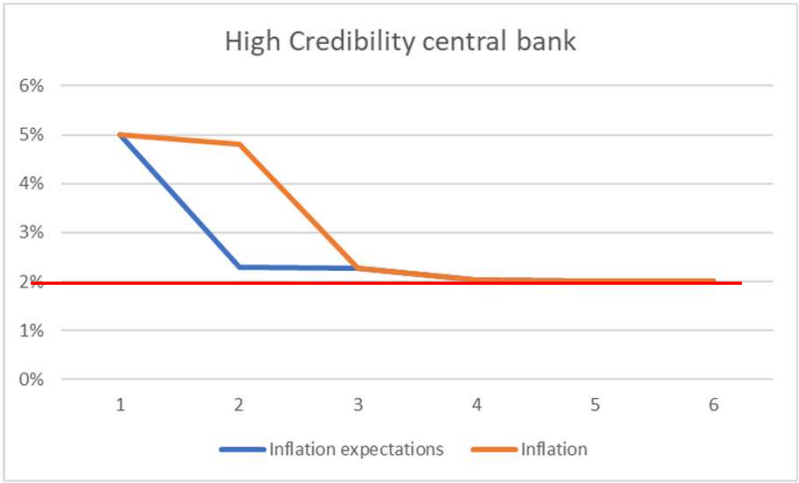
The issue of central bank credibility: example

- Assume an inflation target of 2% for both central banks, and that expected inflation at t=0 is 5%
- Assume that unemployment falls from 5% to 2.5% and that at t=2 the central banks cause unemployment to rise to 5%. How long does it take inflation to return to target?



Low credibility central bank: $\pi_t =$

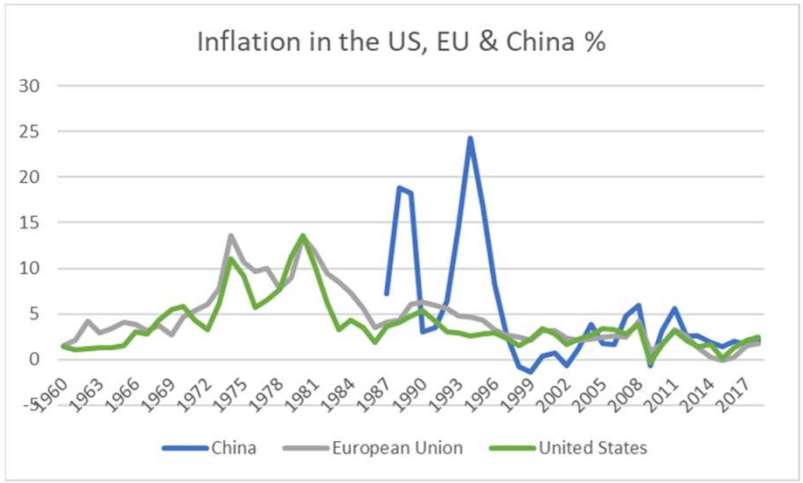
$0.9 \times \pi_{-1} + 0.1 \times \pi^e_{cb\ target} - (u_t - u_n)$



Credible central bank: $\pi_t =$

$0.1 \times \pi_{-1} + 0.9 \times \pi^e_{cb\ target} - (u_t - u_n)$

The Phillips Curve in context: inflation and inflation targeting



TARGETING INFLATION

Countries across the world have adopted inflation targeting irrespective of their income level.

COUNTRY	INFLATION TARGETING ADOPTION DATE	TARGET INFLATION RATE AT TIME OF ADOPTION	COUNTRY	INFLATION TARGETING ADOPTION DATE	TARGET INFLATION RATE AT TIME OF ADOPTION
New Zealand	1990	1–3	Philippines	2002	4 +/– 1
Canada	1991	2 +/– 1	Guatemala	2005	5 +/– 1
United Kingdom	1992	2 (point target)	Indonesia	2005	5 +/– 1
Australia	1993	2–3	Romania	2005	3 +/– 1
Sweden	1993	2 (point target)	Serbia, Republic of	2006	4–8
Czech Republic	1997	3 +/– 1	Turkey	2006	5.5 +/–2
Israel	1997	2 +/– 1	Armenia	2006	4.5 +/–1.5
Poland	1998	2.5 +/– 1	Ghana	2007	8.5 +/–2
Brazil	1999	4.5 +/– 2	Uruguay[1]	2007	3–7
Chile	1999	3 +/– 1	Albania	2009	3 +/– 1
Colombia	1999	2–4	Georgia	2009	3
South Africa	2000	3–6	Paraguay	2011	4.5
Thailand	2000	0.5–3	Uganda	2011	5
Hungary	2001	3 +/– 1	Dominican Republic	2012	3–5
Mexico	2001	3 +/– 1	Japan	2013	2
Iceland	2001	2.5 +/– 1.5	Moldova	2013	3.5–6.5
Korea, Republic of	2001	3 +/– 1	India	2015	2–6
Norway	2001	2.5 +/– 1	Kazakhstan	2015	4
Peru	2002	2 +/– 1	Russia	2015	4

Sources: Hammond 2011; Roger 2010; and IMF staff calculations.
Note: Countries are classified as inflation targeters based on the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) database.
[1]Adoption date is based on the starting point when the interest rate became the main monetary policy instrument.

- To avoid 'wage price' and 'boom bust' cycles, inflation-targeting has become a standard policy approach for central banks

Source: IMF