Lesson: Inflation, Unemployment and the Phillips Curve

Lesson Developer : Neha Goel

College/ Department : Shyam Lal College, University of Delhi

- **Chapter : 1**

  Inflation, unemployment and the Phillips Curve

1. Learning Outcomes

After reading this chapter, you will be able to:

- Understand the relation between inflation and unemployment rate

- Discover the aggregate supply relation from Phillips curve
- Mutations of Phillips curve
- Look at the relation between inflation, unemployment and output
- Effects of growth of money on inflation, unemployment and output
- Understand the trade-off between inflation and unemployment
- Know the credibility of central banks and its affects

2. Introduction

The Phillips curve shows a negative relation between unemployment rate and inflation. In 1958, Phillips curve was drawn by A. W. Phillips, who plotted inflation rate against unemployment rate from the year 1861 to 1957 in the United Kingdom and found that inflation was low (even negative) if unemployment was high and inflation was high if unemployment was low, thus finding a negative relation between unemployment rate and inflation.

This Phillips curve was soon being used for formulating macroeconomic policies. A country could attain price stability (zero inflation) by tolerating higher unemployment rate or it could attain lower unemployment by tolerating higher inflation, thus choosing different combinations of inflation and unemployment rate.

However, this Phillips curve theory was broken down and contradicted when there was both high unemployment and high inflation in the United States and most organization for OECD countries in the 1970s. This curve reappeared as "**modified Phillips curve**" which showed relation between ***change*** **in inflation rate and unemployment rate**. Recent studies in United States show that high inflation doesn't lead to low inflation but to a decrease in inflation over time. Also, low unemployment rate leads not to high inflation, but to a rise in inflation over time.

3. Unemployment, inflation and expected inflation

The aggregate supply relation between the price level, the expected price level and the unemployment rate can be shown as:

$P = P^e(1+\mu)\, F(\mu, z)$

Where, p is the price level, P^e is the expected price level, u is the unemployment rate and z represents other factors that affect wage setting (wage setting relation is given by: W= P^eF(u,z)). Thus, F captures the effects on the wage of u and z. Specifically, F can be written as:

F(u,z)= 1-αu+z

Where α represents the strength of unemployment effect on the wage.

The equation above shows that the higher the unemployment rate 'u', lower will be the wages (negative relation) and the higher 'z' results in higher wages (positive relation).

Now substituting F in aggregate supply relation we get:

P = P^e(1+μ) (1-αu+z) ------(1)

Implies,

π = π^e + (μ+z) - αμ ------(2)

Deriving a relation between inflation (π_t), expected inflation ($\pi_t{}^e$) and unemployment (u) from the aggregate supply relation (i.e., eq. 2 from eq. 1):

P = P^e(1+μ) (1-αu+z) ------(1)

Introducing time indexes and dividing both sides by last year's price level i.e. P_{t-1}, we get:

$\frac{P}{P_{t-1}} = \frac{P^e}{P_{t-1}}$(1+μ) (1-α$u_t$+z) ------(1A)

Solving L.H.S,

$\frac{P}{P_{t-1}} = \frac{P-P_{t-1}+P_{t-1}}{P_{t-1}} = 1+\frac{P-P_{t-1}}{P_{t-1}} = 1+ \pi_t$ ----(i)

(as $\pi_t = \frac{P-P_{t-1}}{P_{t-1}}$)

Similarly, from R.H.S we can solve for $\frac{P^e}{P_{t-1}}$:

$\frac{P^e}{P_{t-1}} = \frac{P^e-P_{t-1}+P_{t-1}}{P_{t-1}} = 1+ \frac{P^e-P_{t-1}}{P_{t-1}} = 1+\pi_t{}^e$ ----(ii)

Substituting (i) and (ii) in the equation (1A) we get,

(1+ π_t) = (1+$\pi_t{}^e$) (1+μ) (1-αu_t+z)

This shows a relation between inflation (π_t), expected inflation ($\pi_t{}^e$) and unemployment (u_t).

Now dividing both sides by (1+$\pi_t{}^e$) (1+μ) we get:

$\frac{(1+\pi_t)}{(1+\pi_t{}^e)(1+\mu)}$ = (1-αu_t+z)

We can approximate the L.H.S of the above equation as (1+π_t-$\pi_t{}^e$- μ), provided that inflation, expected inflation and the mark-up are not too large.

Thus the above equation can be written as:

$\pi_t = \pi_t^e + (\mu+z) - \alpha u_t$

Dropping the time indexes we get:

$\pi = \pi^e + (\mu+z) - \alpha\mu$ ------(2)

3.1 Markup (μ), factors that affect wage determination (*z*) and inflation (π)

From equation 1 we can see that for a given expected price level, an increase in the markup (μ) or factors that affect wage determination (z) results in an increase in the actual price level. Restating this, for a given expected inflation, an increase in the markup (μ) or factors that affect wage determination (z) results in an increase in the actual inflation.

3.2 Unemployment rate (u) and inflation (π)

An increase in the unemployment rate results in a lower nominal wage, leading to a lower price level 'P', for a given expected price level 'P^e'. Restating this, for a given expected inflation, inflation decreases with an increase in unemployment rate.

3.3 Expected inflation (π^e) and inflation (π)

From equation 1 we can see that with an increase in the expected price level 'P^e', the actual price level 'P' also increases one to one. If a higher price level is expected by the wage setters, a higher nominal wage is set by them, thus leading to an increase in the price level. Given last year's price level, if this year's price level is also higher, the rate of increase in the price level from last period to this period will also be higher i.e. higher inflation. Restating this, given last year's price level, if this year's expected price level is also higher, the expected rate of increase in the price level from last period to this period will also be higher i.e. higher expected inflation. Thus, an increase in the expected price level results in an increase in the actual price level.

Thus, an increase in the expected inflation results in an increase in actual inflation.

Using time indexes in equation 2 we get,

$\pi_t = \pi_t^e + (\mu+z) - \alpha u_t$ ------(3)

Here μ and z are constants and we will study the movements in inflation, expected inflation and unemployment rate over time.

4. The Phillips Curve

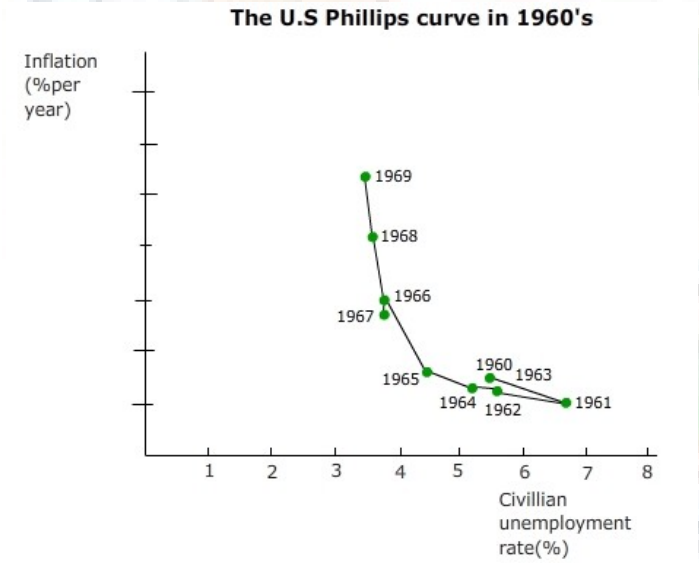
In 1960, Phillips, Solow and Samuelson stated a relation between inflation and unemployment rate.

4.1 Introduction

During much of the period of study of Phillips, Solow and Samuelson, average inflation was close to zero. Suppose in United States, inflation was positive in some years, while negative in others thus leading to a zero average inflation. However, this is not the case today in US. Thus, considering average inflation to be zero in the past, wage setters would expect that the average inflation rate would be zero in the next year too. Thus, assuming expected inflation to be zero, equation 3 can be modified as:

$\pi_t = (\mu+z) - \alpha u_t$ ------(4)

We get a negative relation between inflation and unemployment rate. Thus, the inverse relationship between inflation and unemployment rate is called the **"Phillips Curve"**.



Lower unemployment rate results in a higher nominal wage, for a given expected price level (i.e. last year's price level). This results in a higher price level. Thus, lower unemployment results in higher price level this year as compared to last year's price level, therefore a higher inflation rate. This process is known as **wage-price spiral**. Thus, we may sum it up as:

- A lower unemployment rate results in a higher nominal wage

- Firms increase their prices as nominal wage increases. Thus, price level increases
- Workers demand a higher nominal wage due to higher price level
- Firms increase their prices further as nominal wage increases again. Thus, price level increases further
- Workers demand for a further increase in nominal wage due to further increase in price level
- This results in steady wages and price inflation.

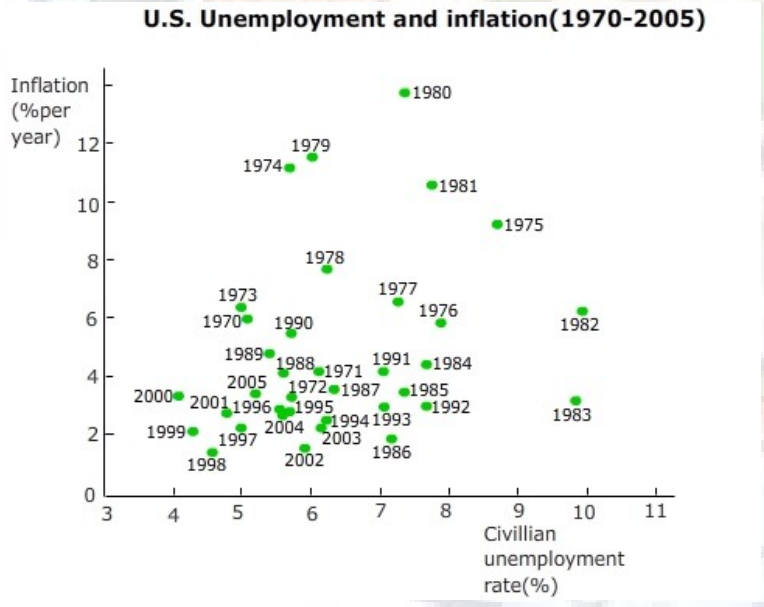
**** Test Yourself**

Is there a trade-off between inflation and unemployment rate?

4.2. Disappearance

In 1970s, the relationship between unemployment rate and inflation rate as shown in the figure above became inconsistent. The Phillips relation only lasted for 1960s in U.S.

The figure below shows the combination of unemployment rate and inflation rate in the U.S. since 1970. The diagram is scattered and the relation between unemployment rate and inflation rate disappears.



Reasons behind the failure of Phillips curve after 1970:

- The **expected inflation rate** varied considerably more in the 1970s than it did in the 1960s. The oil price shocks of 1973-74 and 1979-80 were most important. There was a large increase in the price of oil which forced the firms to increase their prices relative to wages they paid i.e. to increase the markup (μ). Even at a given unemployment rate, an increase in μ resulted in an increase in inflation rate.

- Monetary policy was also highly expansionary in the 1970s, leading to high and volatile **actual** and **expected inflation**.
- The ***natural rate of unemployment*** varied considerably more in the 1970s than it did in the 1960s. Also the composition of the labor force changed in the 1970s. There were also other structural changes in the economy.
- Change in expectation led to change in the nature of relation between inflation and unemployment. We can see from the above diagram that inflation rate became consistently positive rather than being sometimes positive and sometimes negative in the past years. Also the inflation rate became persistent overtime. Now, expecting zero average inflation became incorrect. People made mistakes and became foolish expecting this year's price level to be same as last year's price level due to persistent positive inflation. Thus, they took the presence and persistence of inflation into account.

  Now, let's assume expected inflation to be:

  $\pi_t^e = \theta\ \pi_{t-1}$ ------(5)

  From the above equation we can see that θ explains the effect of last year's inflation rate, π_{t-1}, on this year's expected inflation rate, π_t^e. With higher value of θ, as last year's inflation rises, the workers and firms revise their expectations of what inflation will be next year.

- The workers and the firms expected θ to be close to zero so long as the inflation was low and not very persistent. But as inflation turned out to be more persistent, the workers and the firms started assuming inflation to be high this year as it had been high last year as well. As a result θ increased. Thus, people assumed this year's inflation to be the same as last year's inflation i.e. θ was now equal to 1.

  Substituting equation 5 in equation 3 we get:

  $\pi_t = \theta\ \pi_{t-1} + (\mu+z) - \alpha u_t$

  - We get the original Phillips curve only when θ is equal to zero. So we get a relation between the unemployment and inflation rate as follows:

    $\pi_t = \theta\ \pi_{t-1} + (\mu+z) - \alpha u_t$

  - As θ turns out to be positive, both the unemployment rate and the last year's inflation rate affect the inflation rate.
  - When θ turns out to be 1, the equation becomes:

    $\pi_t = \pi_{t-1} + (\mu+z) - \alpha u_t$

    i.e. $\pi_t - \pi_{t-1} = (\mu+z) - \alpha u_t$ ------(6)

    L.H.S of the equation is the *change in the inflation rate.* An increase in unemployment rate results in decreasing inflation while, a decrease in unemployment rate results in increasing inflation. Thus, when θ is equal to 1, unemployment rate affects the change in inflation rate. Thus, the relation

between inflation rate and unemployment disappeared as θ increased from 0 1to 1. This can be seen in the figure above.

NOTE:

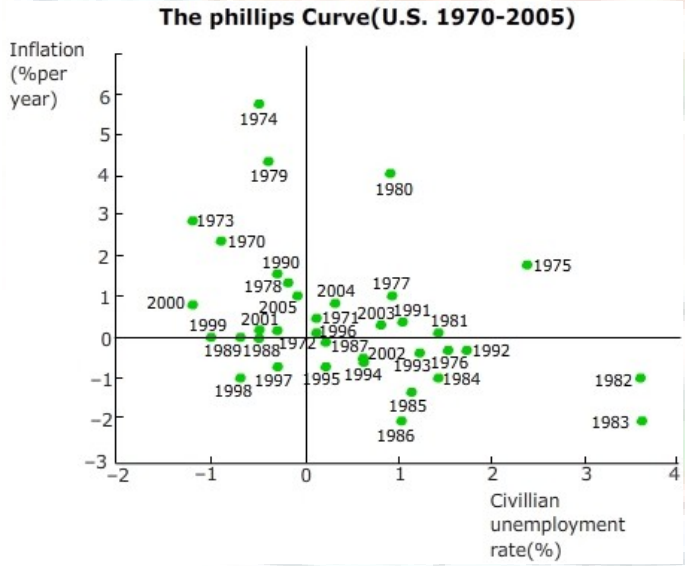
 In the 1960s in U.S., why did the Phillips curve hold?

• As long as expected inflation and the natural rate of unemployment are approximately constant, the relationship between inflation and unemployment holds.

– This was true in the United States in the 1960s, so the Phillips curve appeared to be stable.

4.3: Modified Phillips Curve

With the disappearance of the relation between the unemployment rate and the inflation rate, a new relationship emerged between the unemployment rate and the change in the inflation rate, as shown above in equation 6. The figure below shows the unemployment rate versus the change in inflation rate observed for each year since 1970. A negative relation is seen between the unemployment rate and the change in the inflation rate.



From the figure above we can see that for high unemployment rate, the change in inflation rate is negative while, the change in inflation rate is positive for low unemployment rate. We can see this relationship between the unemployment rate and the change in the inflation rate today. Equation 6 i.e.,

$\pi_t - \pi_{t-1} = (\mu+z) - \alpha u_t$

is the modified Phillips curve. It is also called the **accelerationist Phillips curve (**as price level accelerates due to increase in inflation rate because of low unemployment) or the **expectations-augmented Phillips curve** (π_{t-1} is the expected inflation).

• The ***expectations-augmented*** Phillips curve:
The inverse relationship between the ***cyclical*** unemployment rate and ***unanticipated*** inflation hypothesized by Friedman and Phelps is called the ***expectations-augmented*** Phillips curve.
 The ***expectations-augmented*** Phillips curve shows the inverse relationship between unemployment and inflation **for a given expected** rate of inflation and the natural rate of unemployment.
• $\pi = \pi^e - f(u - u)$
• The Phillips curve is drawn such that $\pi = \pi^e$ when $u = u$.
• $\pi - \pi_e = -f(u - u)$ or
$\pi = \pi_e - f(u - u)$
– When $u = u$, then $\pi = \pi^e$.
– When $u > u$, then $\pi < \pi^e$.
– When $u < u$, then $\pi > \pi^e$.

 This suggests the relationship between inflation and the unemployment rate is **NOT** stable.
 In the 1970s, both inflation and unemployment rose, which is inconsistent with the original Phillips Curve.
• The relationship between inflation and unemployment was quite unstable for the following three decades.
 But the expectations-augmented Phillips curve has been fairly stable since 1970.

4.4: Inflation versus Unemployment

Relation between high inflation and the Phillips curve:

We have already seen how wage setters, firms and institutions changed the ways they formed inflation expectations as inflation became more persistent in the 1970s.

Inflation becomes more variable as inflation rate turns high. Thus, firms and workers are less willing to enter into long term labor contracts (as they have to set nominal wages for a long time period). Real wages may plunge if inflation rate becomes higher than expected; making workers cut their living standards. Similarly, Real wages may rise high if inflation rate becomes lower than expected. Thus, firms may be unable to pay the high wages to the workers and may even get bankrupt. As a result, changes in the level of inflation, changes the terms of wage agreements, making **wage indexation** (a provision that automatically leads to a rise in wages in line with inflation) more prevalent. Thus, nominal wages are generally set for shorter period of time.

Thus, the above changes show a strong relationship between inflation and unemployment.

Relation between high deflation and the Phillips curve:

A situation when inflation is low, even negative, is known as deflation.

From the period 1934 to 1937 (years corresponding to great depression), there was high unemployment rate. Thus, we would have expected a large rate of deflation but during

those years, inflation was surprisingly high. Thus, given high unemployment rate, deflation was limited while, inflation was positive. This may have happened because:

- During the great depression, both actual unemployment rate and the natural unemployment rate increased. This seems unlikely.
- The Phillips curve relation breaks down as the economy faces deflation. It may be because the workers are reluctant to work for lower nominal wages. But as nominal wages increases more slowly than inflation, workers have to accept a cut in their real wages. An overcut in the nominal wages may lead to the same cut in the real wages and the workers may fight on this. Thus, the Phillips curve relation between the unemployment and inflation may become weak as economy comes close to zero inflation.

5. Relation between inflation, unemployment and output

- A relationship between growth in output and change in unemployment rate is called the Okun's law
- A relationship between inflation, expected inflation and unemployment rate is called the Phillips curve (as already discussed above).
- A relationship between inflation, money growth and output growth is called the aggregate demand relation.

5.1 Okun's Law:

It is a relationship between growth in output and change in unemployment rate. It was named after the economist "Arthur Okun". This relation holds under two assumptions: one is that output is equal to employment (Y=N i.e., change in output results in one to one change in employment). Another assumption is that the labor is constant. Thus, change in employment resulted in one to one opposite change in unemployment.

Thus, let's see how this output and change in unemployment relation works. Now, if output and employment moving together, a 1% rise in output results in a 1% rise in employment. If change in employment is opposite the change in unemployment, a 1% increase in employment results in a 1% fall in unemployment rate.

Let 'u_t' denote unemployment rate in year *t*. Similarly, u_{t-1} is the unemployment rate in the year (*t-1*) and g_{y^t} stands for the growth rate of output from year (*t-1*) to *t*. Thus, we get the following relation:

$u_t - u_{t-1} = - g_{y^t}$ ------(i)

Thus, change in the unemployment rate is equal to the negative of the growth rate of output. If output growth is 1%, then the unemployment rate should go down by 1%.

Comparing equation (i) with Okun's law:

$u_t - u_{t-1} = -0.4\ (g_{y^t} - 3\%)$ ------(ii)

Equation (ii) also shows a negative relation between output growth and change in unemployment rate. But it differs from equation (i) in following ways:

- To keep unemployment negative, the annual output growth has to be at least 3%. It is affected by the two factors: labor-productivity growth and labor-force growth. Employment must grow at the same rate as the labor force to maintain a constant unemployment rate. If labor productivity i.e. output per worker also increases in addition, then to maintain a constant unemployment rate, output growth is the summation of labor-productivity growth and labor-force growth.
- In equation (i), the coefficient on the right side is -1.0 as compared to -0.4 in equation (ii). This implies that growth in output 1% above normal results only in 0.4% reduction in the unemployment rate in equation (ii) as compared to 1% in equation (i). This may be because of the following 2 reasons:
  1) If output growth deviates from normal, in response, firms adjust employment less than one for one.
  2) As employment rate increases, it does not lead to a one-for-one decrease in the unemployment rate.

Rewriting equation (ii) in terms of letters, where normal growth rate is denoted by $\bar{g}_y$ (equals 3% in equation (ii)) and the effect of output growth above normal on the change in the unemployment rate is denoted by β (equals 0.4 in equation (ii)). Thus, the equation for Okun's Law may be written as:

$u_t - u_{t-1} = - \beta\ (g_{y^t} - \bar{g}_y)$ ------(iii)

Thus unemployment rate decreases as output growth is above normal and vice-versa.

5.2 The Aggregate Demand

A relationship between inflation, money growth and output growth is called the aggregate demand relation. Earlier in previous chapters we have already derived a relationship between the real money stock and the level of output, taxes and government spending i.e.

Y_t = Y ($\frac{M_t}{P_t}$, G_t, T_t)

We will just focus on the relation between output and real money stock. Thus, we can write the aggregate demand relation as:

Y_t = Y $\frac{M_t}{P_t}$ ------(iv)

From this equation we can see that demand for goods, and therefore output, is directly proportional to the real money stock (a relation between output, money and price level). From this equation we will go to the relation between growth rates- of output, money and inflation rate.

Let growth rate of output be denoted by g_{y^t}, growth rate of price level (inflation rate) be denoted by π_t, and nominal money growth rate be denoted by g_{mt}, i.e.

g_{y^t}= g_{mt} - π_t ------(v)

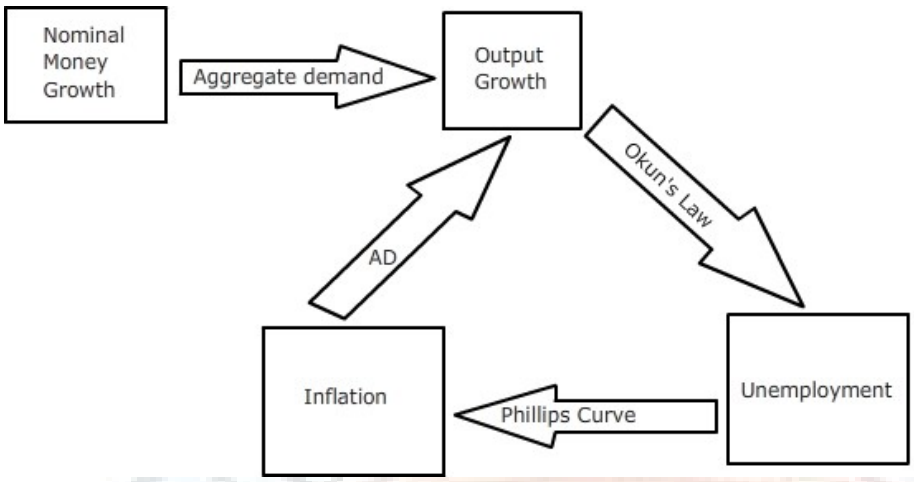
Real money growth and output growth are positive if nominal money growth exceeds inflation. Whereas, real money growth and output growth are negative if nominal money growth is less than inflation. Thus, expansionary monetary policy results in high output growth for a given inflation rate and contractionary monetary policy results in low output growth for a given inflation rate.

6. Nominal Money Growth

So far we have studied the relation between inflation, unemployment, output growth and nominal money growth.

- A relationship between growth in output and change in unemployment rate is called the Okun's law
- A relationship between inflation, expected inflation and unemployment rate is called the Phillips curve (as already discussed above).
- A relationship between inflation, money growth and output growth is called the aggregate demand relation.

This can be shown in the following diagram:



6.1 <u>Medium-run:</u>

If Central bank keeps a constant rate of growth of nominal money ($\bar{g}_m$); the unemployment rate must be constant in the medium run as unemployment cannot be increasing or decreasing forever. This means $u_t = u_{t-1}$. Substituting this in Okun's law we get, $g_{yt} = \bar{g}_y$. Thus, output grows at its normal growth rate '$\bar{g}_y$'. With constant rate of growth of nominal money ($\bar{g}_m$) and output growth equal to $\bar{g}_y$, the aggregate demand relation becomes:

$\bar{g}_y = \bar{g}_m - \pi$

This implies a constant inflation rate and we get:

$\pi = \bar{g}_m - \bar{g}_y$ ------(vi)

<u>Thus, inflation is equal to growth of nominal money minus the growth of normal output growth i.e. inflation equals **adjusted nominal money growth** in the medium run**.**</u>

A constant inflation means $\pi_t = \pi_{t-1}$ i.e. this year's inflation is same as last year's. Substituting it in Phillips curve equation we get, $u_t = u_n$.

<u>Thus, unemployment rate equals the natural rate of unemployment in the medium run.</u>

Thus money growth has no effect on either output or unemployment and is neutral in the medium run.

The change in money growth just reflects one for one change in the inflation rate. Thus, inflation is a monetary phenomenon.

6.2 Short-run:

Let us assume economy to be in its medium run equilibrium. Thus, the rate of inflation equals adjusted nominal money growth, output growth equals normal growth rate and unemployment equals the natural rate of unemployment.

Now, if the central bank decreases the growth of nominal money, inflation rate decreases and the output growth and unemployment remains unchanged in the medium run. To see its effect in the short run let's look at all the 3 relations that we studied:

1. Aggregate demand- lower growth in nominal money results in lower growth in real nominal money thus decreasing output growth, for a given rate of initial inflation rate.
2. Okun's Law- unemployment increases if growth in output is below the normal
3. Phillips curve- inflation decreases if unemployment is above the natural rate of unemployment

Thus, we see that contractionary monetary policy results in recession initially and then it lower inflation rate. As the growth of nominal money reduces, it decreases growth in output and increases the unemployment rate. Inflation decreases as a result of rise in unemployment.

Thus, in the short run we see that contractionary monetary policy results in slowdown in growth rate and an *increase in unemployment temporarily*. Whereas, in the medium run, growth in output comes back to normal, unemployment rate comes back to its natural rate and at this point, both *money growth and inflation are permanently lower*.

7. Disinflation

If the economy is in its medium run equilibrium, output growth equals normal growth rate, unemployment equals the natural rate of unemployment and the rate of inflation equals adjusted nominal money growth. With high nominal money growth, inflation rises too. The policy makers try to reduce this increasing inflation. Thus, deflation can be defined as a decrease in the inflation rate. Money growth needs to be reduced to reduce inflation and this may result in increase in unemployment for some time. The question arises that what pace should be adopted by the central bank to reduce inflation:

7.1 Using Phillips curve:

Let's look at Phillips curve. It says inflation can be reduced at the cost of rising unemployment.

$$\pi_t - \pi_{t-1} = -\alpha (u_t - u_n) \quad \text{------(vii)}$$

To keep the L.H.S of the equation negative, $(u_t - u_n)$ has to be positive. Thus, the rate of unemployment must exceed the NRU. To achieve quick disinflation, unemployment has to rise for few years. Whereas, a slow disinflation can be achieved with a smaller rise in unemployment spread over many years. The summation of total amount of unemployment over the years remains the same.

7.2 The Lucas Critique: credibility and expectations

From equation (vii) we can assume that the wage setters would expect the inflation rate in the future to be same as it was in the past years. This would imply that expectations of the wage setters would not change in response to a policy change. This is what Lucas argued about. According to him, if the central bank plans to reduce inflation, then the wage setters might well expect inflation to be lower in future than in the past. As a result, the actual inflation would decline with lower expected inflation as stated by Phillips curve:

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

Now, if the wage setters keep expecting inflation to be equal to previous year's inflation ($\pi_t^e = \pi_{t-1}$), then accepting higher unemployment for some time will be the only way to reduce inflation. We already studied the implications previously. But, if wage setters are convinced that inflation in future will be lower than in past, this would reduce the expectations of inflation thus reducing the actual inflation, without any change in unemployment rate.

Thus, growth of nominal money, inflation and expected inflation, all can be reduced without the need for recession. Thus, reduction in nominal money growth could be neutral in both medium run and short run.

Although, Lucas believed that some increase in unemployment would be there while reducing inflation, Sargent believed that this increase would be small. Credibility reduces the unemployment cost of disinflation. Credibility of monetary policy could be defined as the belief by wage setters that central bank was truly committed to reduce inflation. Only credibility would change ways the wage setters form their expectations. Thus, central bank should adopt fast inflation as it is more credible than slow inflation.

7.3 Nominal rigidities and contracts:

Nominal rigidities imply that in many modern countries for some time, many wages and prices are set in nominal terms and are typically not readjusted with change in policy. Stanley Fisher argued the presence of normal rigidities and a rapid decrease in nominal money growth would result in higher unemployment even if there is credibility. He suggested that disinflation policy should be announced before its implementation to allow wage setters to readjust while setting wages.

However, John Taylor stated that the wage contracts are staggered over time and are not all signed at the same time. Thus, even if central bank's commitment to inflation was fully credible, the staggering wages limited the fast proceeding of disinflation without triggering higher unemployment.

Thus, the central bank should adopt slow disinflation policy so that the wage setters get time to take the change in policy into account to decrease unemployment cost of disinflation.

- **Summary**

- The Phillips curve shows a negative relation between unemployment rate and inflation.
- Modified Phillips curve showed relation between *change* in inflation rate and unemployment rate.
- The aggregate supply relation between the price level, the expected price level and the unemployment rate can be shown as: **P = P^e(1+μ) F(μ, z)**
- For a given expected inflation, inflation decreases with an increase in unemployment rate.
- For a given expected inflation, an increase in the markup (μ) or factors that affect wage determination (z) results in an increase in the actual inflation.
- An increase in the expected inflation results in an increase in actual inflation.
- Phillips curve failed because: The **expected inflation rate** varied considerably more in the 1970s than it did in the 1960s. Monetary policy was also highly expansionary in the 1970s, leading to high and volatile **actual** and **expected inflation**. The ***natural rate of unemployment*** varied considerably more in the 1970s than it did in the 1960s.
- Modified Phillips curve is the relationship between the unemployment rate and the change in the inflation rate.

- A relationship between growth in output and change in unemployment rate is called the Okun's law
- A relationship between inflation, money growth and output growth is called the aggregate demand relation.
- Credibility of monetary policy could be defined as the belief by wage setters that central bank was truly committed to reduce inflation.

- **Exercise**

1. Define Phillips curve.
2. Give the reasons for failure of Phillips curve after 1970s.
3. Derive the Phillips curve relation mathematically.
4. Suppose Phillips curve equation is given by: $\pi_t = \pi_t^e + 0.1 - 2u_t$. Assume $\pi_t^e = \theta \pi_{t-1}$. Find NRU.
5. Taking equation in 4th question, suppose θ is zero and unemployment rate is equal to NRU. In year 't' unemployment rate is brought down to 3%, what will be inflation rate in years t, t+1, t+2 and t+5?
6. Define Okun's Law.
7. Derive the aggregate demand relation.
8. Define nominal money growth in the medium and short-run.
9. What is Lucas critique?
10. Give some views on credibility and nominal rigidities.

- **References**

1. Olivier Blanchard, Macroeconomics, Worth publishers, 4th edition
2. CLF Attfield, D. Denery & N.W. Duck (1991. 2nd edition)
3. Steven Sheffrin (1996, 2nd edition)

- **Quiz**

1. The negative relationship between the gap between actual *GDP* and its trend value and the difference between actual unemployment rate and its equilibrium value is called:
   a)The aggregate supply curve
   b)Phillips curve
   c)Okun's law
   d)The aggregate demand relation

Ans. **1) c)** Okun's Law

Feedback:

The aggregate supply curve combines Okun's Law and the augmented Phillips Curve together, the Phillips Curve is a relationship between the unemployment gap and the difference between actual and underlying inflation. The Battle of the Mark-ups is the story that combines underlying inflation, prices being marked up over costs and supply shocks.

2. The critical macroeconomic policy implication of a vertical long-run Phillips Curve is that
a) inflation is everywhere and always a monetary phenomenon.
b) big inflations will be stopped by big recession.
c) money illusion is the source of the unemployment in the long-run.
d) demand policies cannot move the actual unemployment rate permanently away from its equilibrium level.

Ans. **d)** ...demand policies cannot move the actual unemployment rate permanently away from its equilibrium level.

Feedback:

On the one hand the message tells us that aggregate demand policies will not succeed in a permanent reduction of the unemployment rate below its equilibrium level but it also gives us a ray of hope in combatting high inflation-if expectations of inflation can be reduced, a deep recession will not be required to bring down the rate of inflation. There is more than one way to reduce the underlying rate of inflation (though it is not as easy as a political leader giving us a speech, promising future price stability…the promise has to be believed!).

3. "It is better for an economy to have a 5% rate of inflation over a 5% rate of unemployment."
Without getting into a debate on the relative costs of unemployment and inflation yet, why do we know this statement is not helpful for policy makers, even if the prime minister says this explicitly?
a) The economy is dichotomized in the short-run because of the Taylor rule.
b) Wage-negotiations are subject to money illusion so that real wages would fall to an unsustainable level.

c) Even if we could reduce unemployment to 0% today at a cost of an increase in inflation of 5%, there is no guarantee that underlying inflation in the economy would remain unchanged.
d) The battle of the mark-ups determines wages and prices only so long as there is no supply shock.

Ans. 3. **d)** demand policies cannot move the actual unemployment rate permanently away from its equilibrium level.

Feedback:

On the one hand the message tells us that aggregate demand policies will not succeed in a permanent reduction of the unemployment rate below its equilibrium level but it also gives us a ray of hope in combatting high inflation-if expectations of inflation can be reduced, a deep recession will not be required to bring down the rate of inflation. There is more than one way to reduce the underlying rate of inflation (though it is not as easy as a political leader giving us a speech, promising future price stability…the promise has to be believed!).

4. If the Phillips Curve is vertical in the long run, then an increase in the money supply from year to year will _____ the unemployment rate and will _____inflation rate.

(a) increase; increase
(b) increase; not change
(c) not change; increase
(d) not change; not change

Ans. (c)

5. If inflationary expectations increase, the Phillips curve will

(a) shift to the right
(b) shift to the left
(c) become vertical
(d) become upward sloping

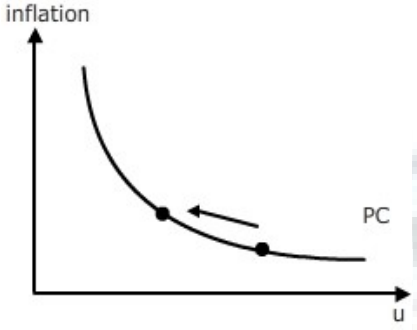
Ans. (a)

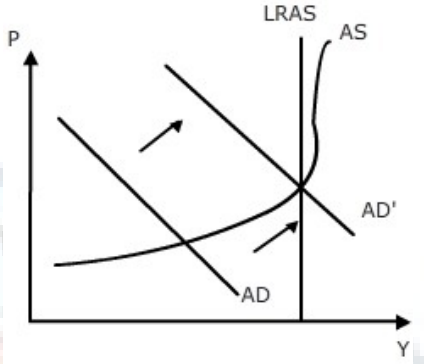
6. Illustrate graphically in both in a Phillips Curve and in an AD/AS diagram the following phenomena. Make sure you label all your graphs and axes. Mark clearly in which direction the variables are moving and/or the curves are shifting.

Note: each scenario is independent of each other.

1. The economy is below its long run equilibrium. Now the government starts an expansionary fiscal policy. Show the effects.

2. The economy is in its long run equilibrium. Now there is a discovery of a new technology for transforming orange juice into fuel at very cheap costs.
3. The economy is in its long run equilibrium. A cost shock in the form of higher oil prices together with an

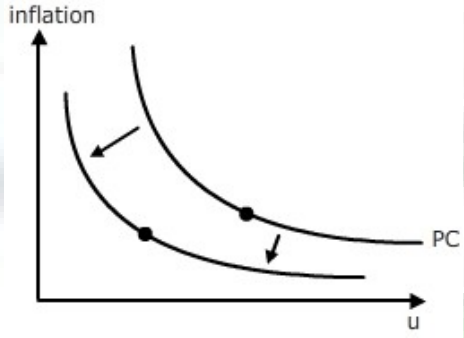


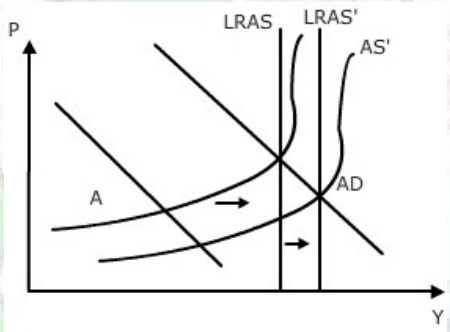


expansionary policy from the government to counteract the fall in output.

1.

2.





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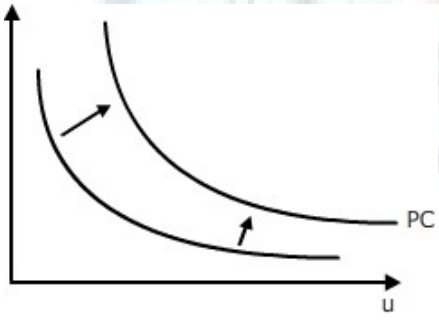

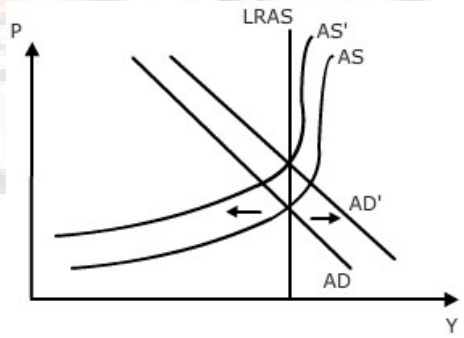

7. If inflationary expectations increase, the Phillips curve will

   a)Shift rightwards
   b)shift leftwards
   c)become vertical
   d)become upward sloping

   Ans. a) Shift rightwards

8. Which of the following changes will cause the expectations-augmented Phillips curve to shift down?
   a) an unanticipated decline in money supply
   b)a decline in expected inflation rate
   c)an increase in price level
   d)a decrease in unemployment rate

   Ans. b) a decline in the expected inflation rate.