Fall Semester '04-'05
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Lecture 5: The Phillips Curve

I. OVERVIEW

- Over the last few lectures we first developed, then worked with a simple model of the macroeconomy: the AD-IA model. One component of the AD-IA model that we did not really spend much time on was the process by which the IA curve shifts - both in the short run and over time.
- In today's class, we will go over the Phillips Curve, a topic which you learned about in Economics 202. The Phillips curve describes the dynamics of inflation, i.e. tells a more detailed story about how the IA curve shifts over time.
- We will first review key concepts of the Phillips Curve that should be familiar with and then think about two different scenarios faced by a monetary policy maker: i) trying to bring unemployment down and calculating the "cost" in terms of higher inflation and ii) trying to bring inflation down and calculating the "cost" in terms of higher unemployment.

II. THE PHILLIPS CURVE

- First, let's digress a little to look at another important macroeconomic variable that we have not discussed very much in the class, namely, unemployment.
- In order to be counted as unemployed, a worker has to be in the labor force looking for a job but unable to find one. The unemployment rate can be written as $u = \frac{U}{L}$ where L is the size of the labor force, and U is the number of unemployed workers. The labor force is essentially the number of people, 16 years of age or over, who are either working or looking for work.
- When $Y = Y^*$, unemployment is said to be at its natural rate $u = u^n$. In general the natural rate of unemployment is not zero b/c people will always be losing jobs for some reason technology, trade etc. The natural rate is high when the job losing rate is high and when the job finding rate is low.
- Countries can have different natural rates of unemployment. For example, European countries, which have low job-finding rates, will have high natural rates, while Japan, which has low job-losing rates, has a low natural rate of unemployment.
- In the AD/IA model if $Y > Y^*$ then inflation would rise. If $Y < Y^*$ then inflation would fall. We can transform this into a relationship between inflation and unemployment by using what is known as Okun's law. Okun's law essentially says that the % deviation of Y from Y^* is negatively related to deviations of u from u^n. So if $u < u^n$ then inflation would rise. If $u > u^n$ then inflation would fall.
- In the long run, inflation would neither rise nor fall but remain study at a level that is determined by expected inflation and by inflation shocks.

- The following mathematical relationship captures the Phillips Curve:

$$\pi_{t+1} = \pi^e_{t+1} - \lambda(u_t - u^n) + \epsilon_{t+1}$$

- In the above,π_{t+1} is the percent change in price from time t to time $t+1$;π^e_{t+1}, sometimes written as $E_t\pi_{t+1}$, is the expected inflation rate, i.e. what we think (at time t) the percent change in price from time t to time $t+1$ will be; ϵ_{t+1} captures supply shocks to inflation (such as oil price shocks) that take place between time t and time $t+1$ and $(u_t - u^n)$ is the difference between the current unemployment rate and the natural rate. In the above relationship λ is a parameter that measures the sensitivity of inflation to movements in unemployment.

- This version of the Phillips Curve, developed by Milton Friedman and Edmund Phelps in the 1960's is what is referred to as the "modern Phillips Curve" (Expectations Augmented Phillips Curve).

- It essentially relates inflation from this period to the next to three things: the state of the economy this period, this period's expectations of inflation between now and the next period and supply shocks that could hit the economy between now and the next period.

- These 3 components of inflation have more formal names:

    1. The π^e term is called "expected inflation". This is the rate of inflation that can exist even when the economy is at full employment.
    2. The $-\lambda(u - u^n)$ term is called "demand-pull inflation". This is the more traditional inflation that results from the strength or weakness of the economy. When unemployment dips below the natural rate (output is above potential) then there is inflation in the economy because demand is greater than what the economy can produce over the long run.
    3. The ϵ term is known as "cost-push inflation": this term captures all other shocks to inflation unrelated to expectations and to labor markets. A fall in the price of oil can be interpreted as a negative ϵ while a rise in the price of oil can be interpreted as a positive ϵ.

- We can also lag the equation back one period and write it in a more familiar form as

$$\pi_t = \pi^e_t - \lambda(u_{t-1} - u^n) + \epsilon_t$$

- This simply states that the change in prices from last period to this period, depends on what we expected inflation to be this period, unexpected supply shocks that hit the economy this period and what the state of the economy was last period.

- How are expectations formed? We can think of three different types of expectations.

    1. Fixed expectations: agents in the economy form expectations about what inflation will be and they don't deviate from these expectations. While this helps us obtain a useful benchmark, this type of fixed expectations is clearly unrealistic.
    2. Adaptive expectations: depend only on the past history of the economy (e.g. $\pi^e_t = \pi_{t-1}$). In this case, once inflation enters the economy it becomes hard to get rid of. As Solow put it "When we expect inflation, we have inflation and when we have inflation we expect inflation".

3. Rational expectations: people form expectations based on all available information including the past history of the economy.

III. THE INFLATIONARY COST OF LOWER UNEMPLOYMENT

- We will first examine the cost (in terms of higher inflation) that a policy maker trying to reduce unemployment below the natural rate would have to bear.

Case 1: Fixed Expectations

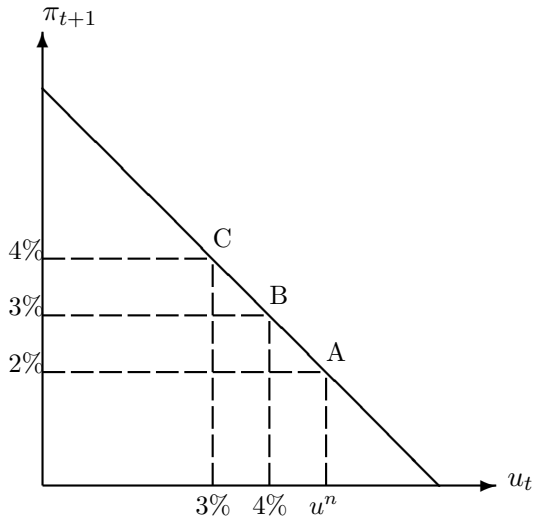
- In the short run, provided that expected inflation stays constant, a policy maker who controls aggregate demand can trade off inflation for unemployment.
- We can illustrate this best by thinking of a simple example. Consider a Phillips Curve of the form $\pi_{t+1} = \pi^e_{t+1} - \lambda(u_t - u^n) + \epsilon_{t+1}$ and let's suppose that $\lambda = 1$, the natural rate of unemployment is 5% and that expected inflation will ALWAYS stay constant at 2%. Then the Phillips Curve can be written as

$$\pi_{t+1} = 0.02 - 1(u_t - 0.05)$$

- A graph of this Phillips Curve is given below. Suppose also that the economy is currently at potential output so unemployment is at the natural rate. π_{t+1}, the rate of inflation between the current period and next period can then be found at point A on the graph; we can also calculate it mathematically as being

$$\pi_{t+1} = 0.02 - (0.05 - 0.05) = 0.02 \equiv 2\%$$

- Now suppose that the policymaker wants to reduce unemployment below the natural rate of unemployment to say 4%. Because expectations do not change she can do so by increasing inflation to $\pi_{t+1} = 0.02 - (0.04 - 0.05) = 0.03 \equiv 3\%$. This is represented as point B in the diagram below.
- Similarly, if she wants to reduce unemployment to 3%. This can be found either graphically or by looking at the Phillips Curve to see that $\pi_{t+1} = 0.02 - (0.03 - 0.05) \Rightarrow 0.04 \equiv 4\%$. This is represented as point C in the diagram below.



Case 2: Adaptive Expectations

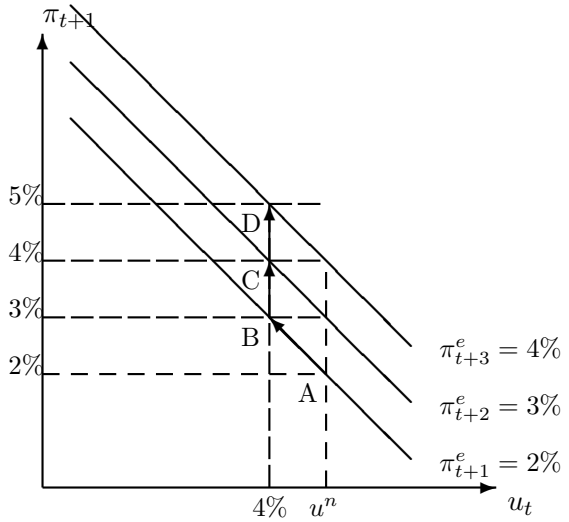
- When expectations are changing it becomes very difficult for a policy maker who controls aggregate demand to trade off inflation for unemployment in the long run.
- We can illustrate this best by thinking of a simple example like before. Suppose that expectations are adaptive. To keep things even more simple we further assume that the adaptive expectations are of the form $\pi^e_{t+1} = \pi_t$ Let's also suppose that $\lambda = 1$ and the natural rate of unemployment is 5%.
- The Phillips Curve for this economy is given by

$$\pi_{t+1} = \pi_t - (u_t - 0.05)$$

- Suppose that the inflation rate from last period to this period π_t was 2% and that unemployment is currently at the natural rate, $u_t = 5\%$. We can then calculate that the actual rate of inflation to be

$$\pi_{t+1} = 0.02 - (0.05 - 0.05) = 0.02 \equiv 2\%$$

- The Phillips Curve can be graphically displayed in the figure below,with the initial point represented as point A.

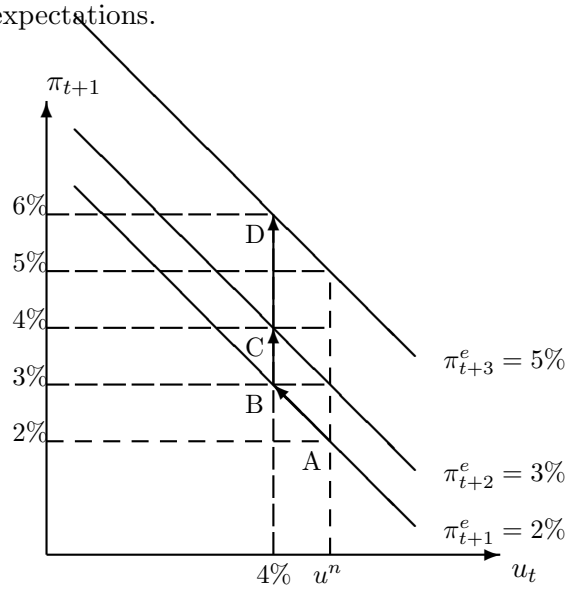


- Now suppose, as before, that the policymaker wants to reduce unemployment at time t to 4%. She can do so if she's willing to tolerate an increase in inflation to $\pi_{t+1} = 3\%$. [Point B on the graph]
- If expectations are adaptive, however, the expected value of inflation won't be constant. In the next period, since actual inflation turned out to be $\pi_{t+1} = 3\%$, people will revise their expectations $\pi^e_{t+2} = 3\%$. This causes the Phillips Curve to shift upwards. Why? When unemployment is at its natural rate, inflation is equal to expected inflation. However, expected inflation has now increased to 3% so the curve must have shift up.
- In period $t + 1$ the policy maker will have to be willing to tolerate an inflation rate of $\pi_{t+2} = 4\%$ just to keep unemployment at $u_{t+1} = 4\%$. [Point C on the graph]. The tradeoff has become more unfavorable (4% inflation for 4% unemployment instead of 3% inflation for 4% unemployment).
- The tradeoff will continue to become more unfavorable because in period $t + 2$ expected inflation will now be $\pi^e_{t+3} = 4\%$. This causes the Phillips curve to shift upwards again. The policymaker has to be willing to tolerate an inflation rate of $\pi_{t+3} = 5\%$ in order to keep unemployment at $u_{t+2} = 4\%$. [Point D on the graph].
- This shift up of the Phillips Curve will continue and make the long run tradeoff seem very unattractive since very high inflation rates are needed to keep unemployment below the natural rate.

Case 3: Rational Expectations

- If expectations were rational in the country described in the previous example, π^e will be formed on all the information available to the agents in the economy, not just the history of inflation.
- We can show that under rational expectations the tradeoff between inflation and unemployment will be even worse than in the previous case. Suppose that inflation had been constant at 2% for a while so that we start at point like A with $\pi^e_{t+1} = 2\%$ and therefore $\pi_{t+1} = 2\%$.

- As in the previous case, we move to point B when the government reduces unemployment to $u_t = 4\%$, resulting in an inflation rate of $\pi_{t+1} = 3\%$.
- In period t, people expected 2% inflation but the government gave them 3% inflation as a byproduct of their quest to reduce unemployment. Therefore, agents may revise their expectations upwards to $\pi^e_{t+2} = 3\%$ in the next period. If the government wants to keep the economy at 4% unemployment ($u_{t+1} = 4\%$), then inflation will rise to 4% ($\pi_{t+2} = 4\%$) [Point C].
- So far the analysis is similar to the adaptive expectations case. Period $t + 2$ is where things may start to diverge. In the adaptive expectations case people automatically revised their expectations upwards to $\pi^e_{t+3} = 4\%$, since actual inflation in period $t + 2$ was 4%. However, agents who are rational may not behave in the same manner. For example, they may think in the following way: "hmm, when I expected 2% inflation, the government gave me 3% and when I expected 3% inflation, they gave me 4%. So if I expect 4% they will most likely give me 5% so I should just make all my decisions with an expected inflation rate of 5%". In other words they may set $\pi^e_{t+3} = 5\%$
- This causes the Phillips Curve to shift upwards by more as expected inflation increases to 5% instead of 4%. Then the government needs to tolerate $\pi_{t+3} = 6\%$ to keep the economy at the current level of unemployment. [Point D on the graph]. In the next period, expected inflation may climb even higher and the tradeoff becomes untenable much more rapidly. One could even argue there is no tradeoff beyond more than a couple of periods under rational expectations.



IV. THE UNEMPLOYMENT COST OF LOWER INFLATION

- We can also turn the problem around and think about what the government has to do in order to reduce inflation. Let's consider an economy that has been at the natural rate of unemployment with high inflation of say 6% a year for the last few years. Suppose the task of the policy maker is to eventually reduce inflation to 3% a year.

- We consider disinflation under fixed expectations and changing expectations - both adaptive and rational. The analysis is essentially similar except that now, instead of trying to reduce unemployment and thinking of the inflation cost she must pay, the policy maker is trying to reduce inflation and thinking of the unemployment cost she must pay.

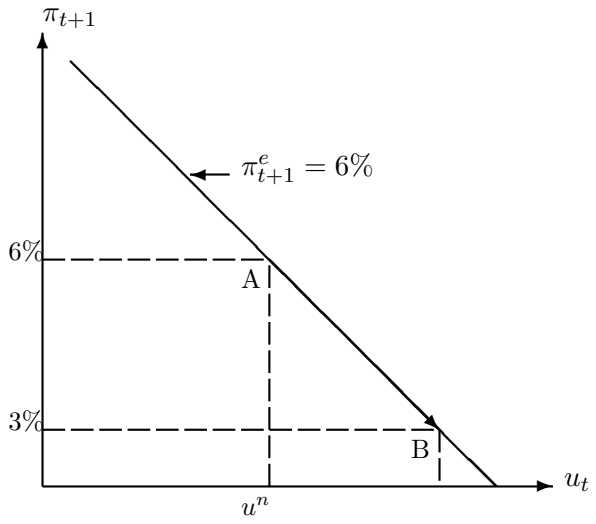
Case 1: Fixed Expectations

- Let's return to the Phillips Curve we considered in the last set of examples $\pi_{t+1} = \pi^e_{t+1} - (u_t - 5\%)$. Suppose that inflation has been 6% for the last few years and that expected inflation is therefore fixed at 6%.

- For convenience we assume the economy is at the natural rate, so that we can represent our starting position at point A on the figure below with $\pi^e_{t+1} = 6\%$ and therefore $\pi_{t+1} = 6\%$ as well.

- The policy maker is asked to permanently reduce inflation to $\pi_{t+1} = 3\%$. As you can see this would require that the unemployment rate be raised by 3 percentage points, from 5% to 8% [Point B on the graph]

- Furthermore, since expectations do not change, the only way to reduce inflation *permanently* is to raise unemployment *permanently* as well. The policymaker has a thankless job in this case.

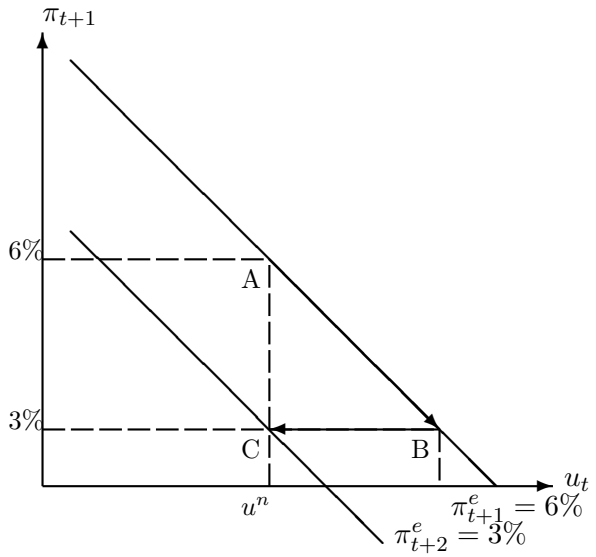


Case 2: Adaptive Expectations

- Now let's consider the same task, reducing inflation from 6% to 3% a year, with adaptive expectations. Once again, to keep things simple, we will assume that $\pi^e_{t+1} = \pi_t$ and that we start off at the natural rate of unemployment.
- Since the slope of the Phillips Curve is 1, in order to reduce inflation by 3 percentage points, unemployment has to be raised by 3 percentage points as well. Interestingly, the monetary policy maker can choose to raise unemployment by 3 percentage points in different ways, as we shall see below.

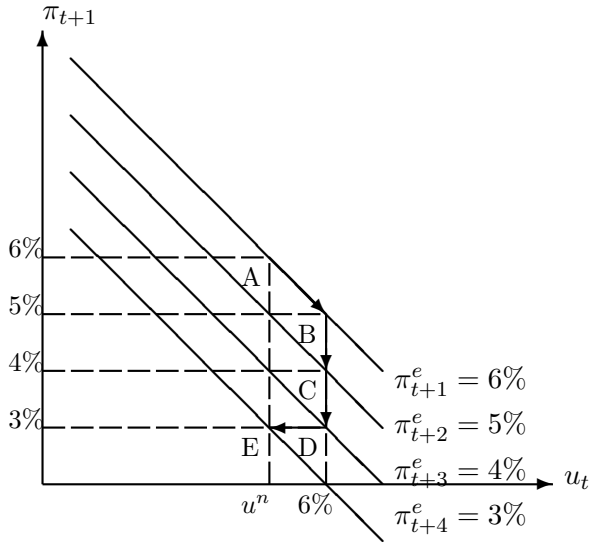
Example: A short, severe recession

- Let's do the same exercise as in the fixed expectations case, to see how having expectations that change impacts the policy maker's actions.
- We represent our starting position at point A on the figure below with $\pi^e_{t+1} = 6\%$ and therefore $\pi_{t+1} = 6\%$ as well.
- The policy maker is asked to permanently reduce inflation to 3%. As you can see this would require that the unemployment rate be raised by 3 percentage points, from 5% to 8% [Point B on the graph].
- In period $t+1$, since inflation was only $\pi_{t+1} = 3\%$, expected inflation will now be $\pi^e_{t+2} = 3\%$ as well - the Phillips Curve shifts down.
- As a result, we no longer need to stay at an unemployment rate of $u_{t+1} = 8\%$ and we move back to the natural rate [Point C].
- At Point C, inflation and expected inflation are both now at 3%, unemployment is at the natural rate and we haev permanently reduced inflation after a severe, yet short recession.
- This is a much better outcome than the case of fixed expectations, where the increase in unemployment was permanent.



Example: A long, mild recession

- It turns out we can accomplish the same task without putting as many people out of work. Suppose that instead of raising the unemployment rate by 3 percentage points, we instead raised it by 1 percentage point, from $u_t = 5\%$ to $u_t = 6\%$. This would lower inflation by 1 percentage point (given the slope of 1 on the Phillips Curve) from $\pi_{t+1} = 6\%$ to $\pi_{t+1} = 5\%$ [This would move us to Point B in the Figure below]
- Since actual inflation is only 5% instead of 6%, expected inflation for next year will also be $\pi^e_{t+2} = 5\%$. The Phillips Curve will shift down.
- Now, if the policy maker keeps unemployment at $u_{t+1} = 6\%$ then inflation will fall to $\pi_{t+2} = 4\%$. [Point C on the graph]. Furthermore, in the next period expected inflation will now be $\pi^e_{t+3} = 4\%$, the Phillips curve to shift down again.
- In period t+2, the policymaker can reduce inflation to $\pi_{t+3} = 3\%$ by continuing to keep unemployment at $u_{t+2} = 6\%$. [Point D on the graph]. As before expected inflation falls, this time to $\pi^e_{t+4} = 3\%$ and the Phillips Curve shifts down again.
- In period t+3 we no longer need to keep unemployment at $u_{t+3} = 6\%$, to reduce inflation to $\pi_{t+4} = 3\%$. Since expected inflation has come down to 3%, we can move the economy back to the natural rate [Point E on the graph] at which point the economy will remain at 3% inflation, since expected inflation and actual inflation now coincide again resulting in no further shifting of the Phillips Curve.



- So by increasing unemployment by 1 percentage point above the natural rate and keeping it there for 3 periods, we managed to reduce inflation by 3 percentage points. Compare that to the previous case where we raised unemployment by 3 percentage points (a sharper recession) but only kept it there fore 1 period (a shorter recession).
- When we have this simplest form of adaptive expectations we can easily come up with many different plans. Since reducing inflation by 3 percentage points required a total of 3 percentage points of unemployment, we could choose any combination of m extra points of unemployment and n periods where $m \times n = 3$.

- In other words raising unemployment by 3 percentage points for 1 period, raising unemployment by 1 percentage points for 3 periods, raising unemployment by 0.5 percentage points for 6 periods, by 1.5 percentage points for 2 periods all would be possible paths of disinflation.
- The policymaker gets to choose what she thinks is best for the economy.

Case 3: Rational Expectations

- Some economists believe that disinflation can be done painlessly and quickly under rational expectations. The pre-requisite for this is the policy maker's ability to convince the agents in the economy that she represents a clean break with the past.
- For example, under adaptive expectations, agents would always expect last period's inflation. However, someone who inherits the economy described in the previous section can reduce inflation immediately WITHOUT a recession if she can credibly convince people to reduce their inflation expectations to $\pi^e_{t+1} = 3\%$.
- Then, as can be seen in the graph below, we can immediately move from 6% inflation to 3% inflation as the Phillips Curve shifts down [go from Point A to Point B in the graph below].