

Inflation, Unemployment and Monetary Policy

1 Introduction

Inflation and unemployment are both considered undesirable for an economy. Why is inflation bad? High inflation leads to decline in the purchasing power of nominal assets, such as money and wages. It is also argued that inflation brings with it a lot of uncertainty about future prices since not all the prices tend to rise at the same rate. Therefore firms are having hard time planning its future production and how the particular prices of its inputs and production evolve relative to other prices. Fortunately for the U.S., we did not experience very high inflation rates, as can be seen in Figure 1. Some countries were not as

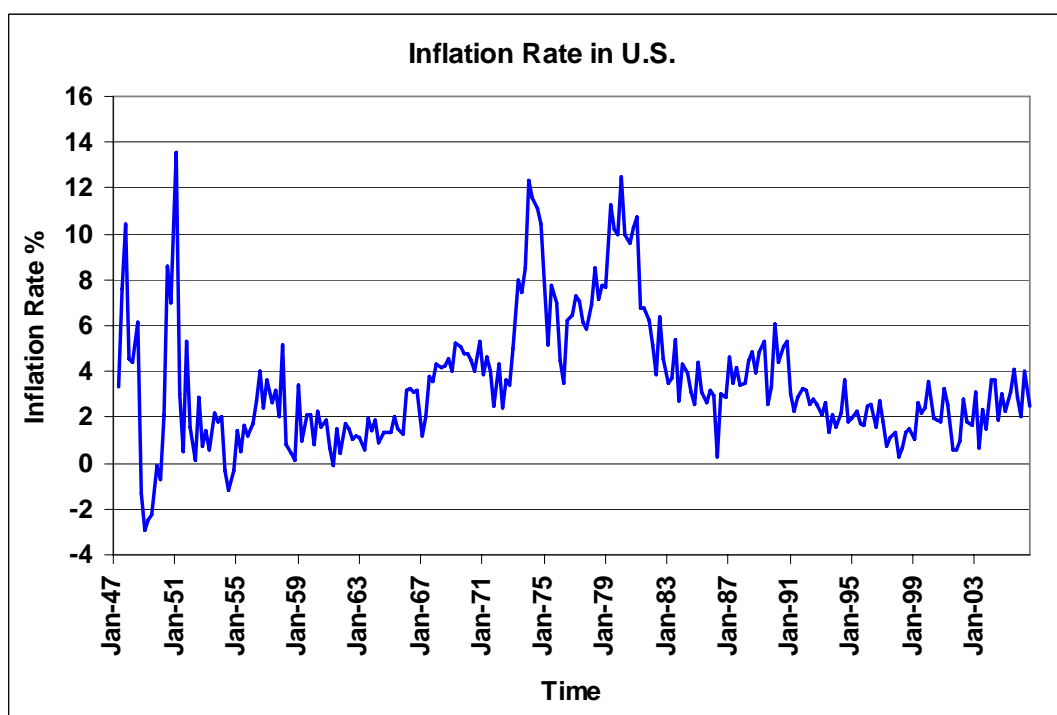


Figure 1: Inflation in the U.S.

fortunate however. For example, Austria in 1921-22 had 10,000% annual inflation rate, and Argentina during 1989-1999 had annual inflation rate of 20,000%. Can you imagine living in an economy where prices change by the minute.

High unemployment is also considered undesirable for a number of reasons. The most important reason is the waste of resources, since unemployed workers do not produce output. There is also emotional cost for those who lose their job or stay unemployed for long periods of time. Figure 2 shows the unemployment rate in the U.S. since 1948. Compared to other European countries during the same period, the unemployment rate in the U.S. is

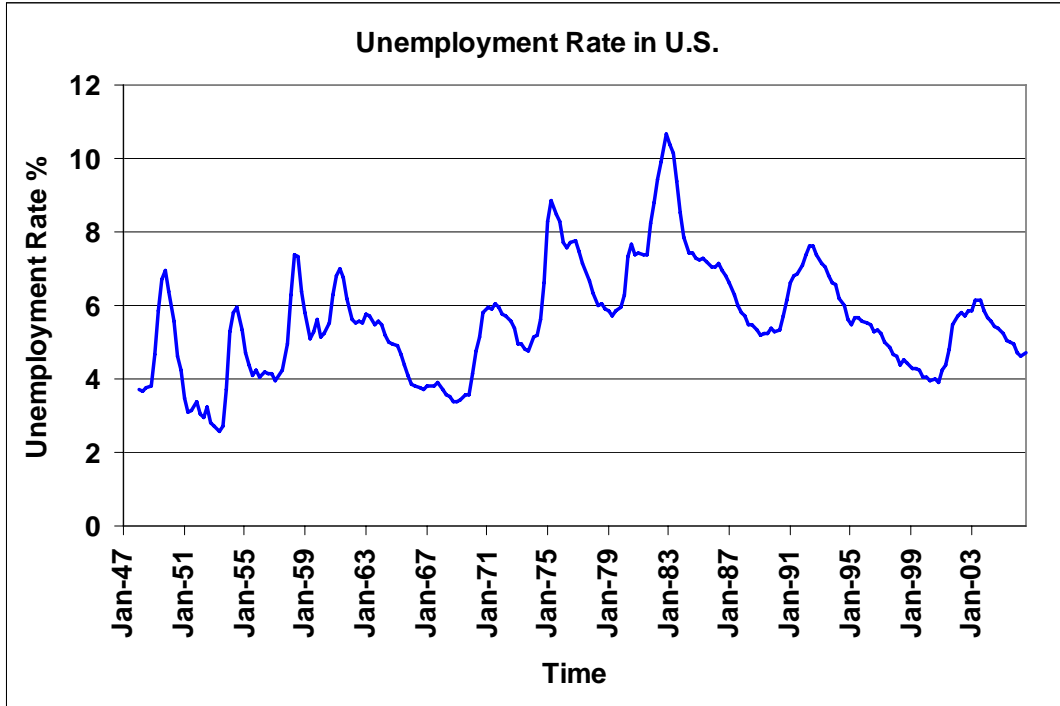


Figure 2: Unemployment rate in the U.S.

considered quite low. So both inflation and unemployment are undesirable. The search model of unemployment shed some light on the factors that determine the unemployment rate (e.g. separation rate, government policies about unemployment insurance benefits, etc.). We also mentioned cyclical unemployment, which varies with the business cycle. So far however we did not suggest that Inflation and Unemployment are related in any way.

2 Phillips Curve

The New Zealand-born economist A.W. Phillips, in his 1958 paper "The relationship between unemployment and the rate of change of money wages in the UK 1861-1957" published in *Economica*, observed an inverse relationship between money wage changes and unemployment in the British economy over the period examined. He concluded that government "demand" policies can move the economy along the curve, and thereby changing the level of unemployment in the economy. Today, what is known as "The Phillips Curve" is a graph that shows the relationship between inflation and unemployment over a particular period of time.

The negative relationship between inflation and unemployment was observed in other countries during different periods. Figure 3 shows the Phillips Curve in the U.S. during the 60's. We can see the during the 60's there a significant negative relationship between inflation and unemployment was observed in the U.S.

During other periods in the U.S., the negative relationship between inflation and unem-

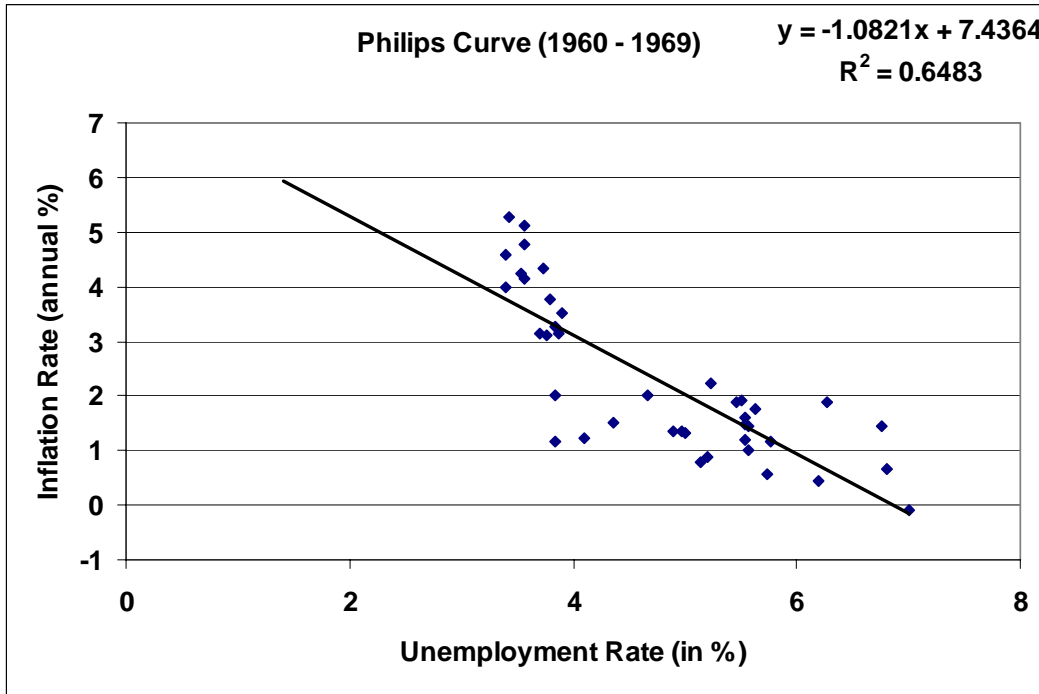
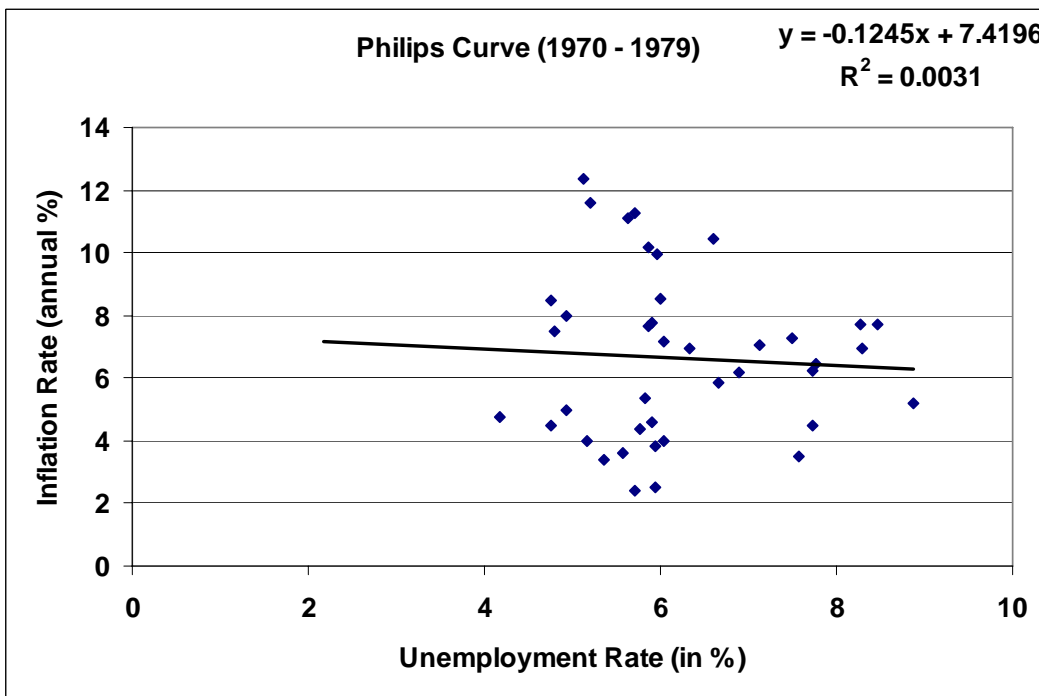
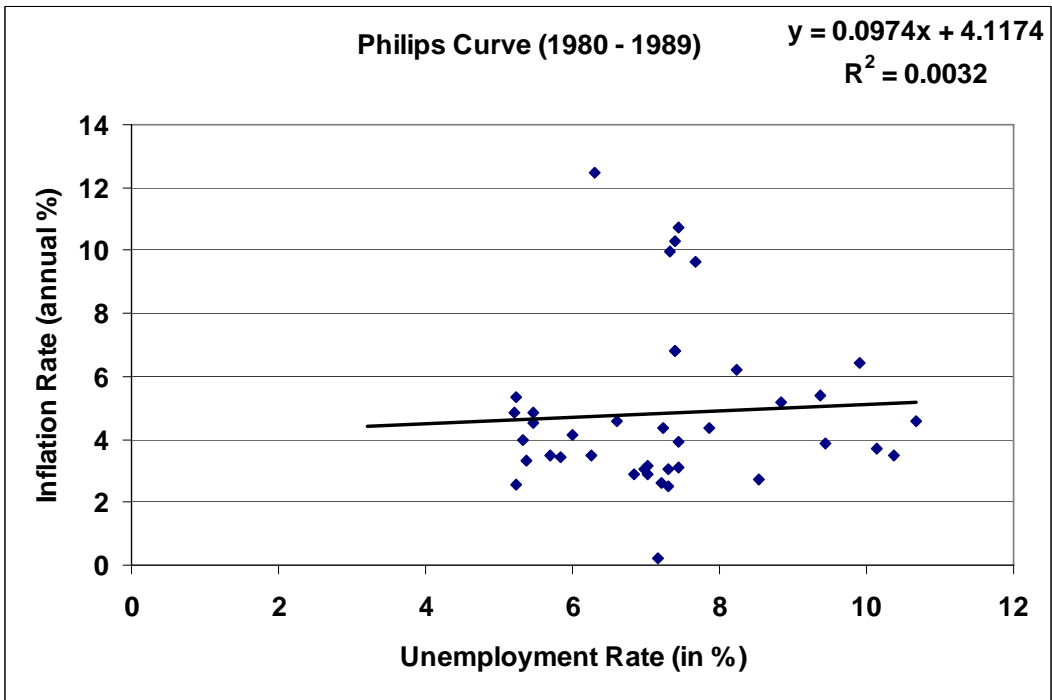
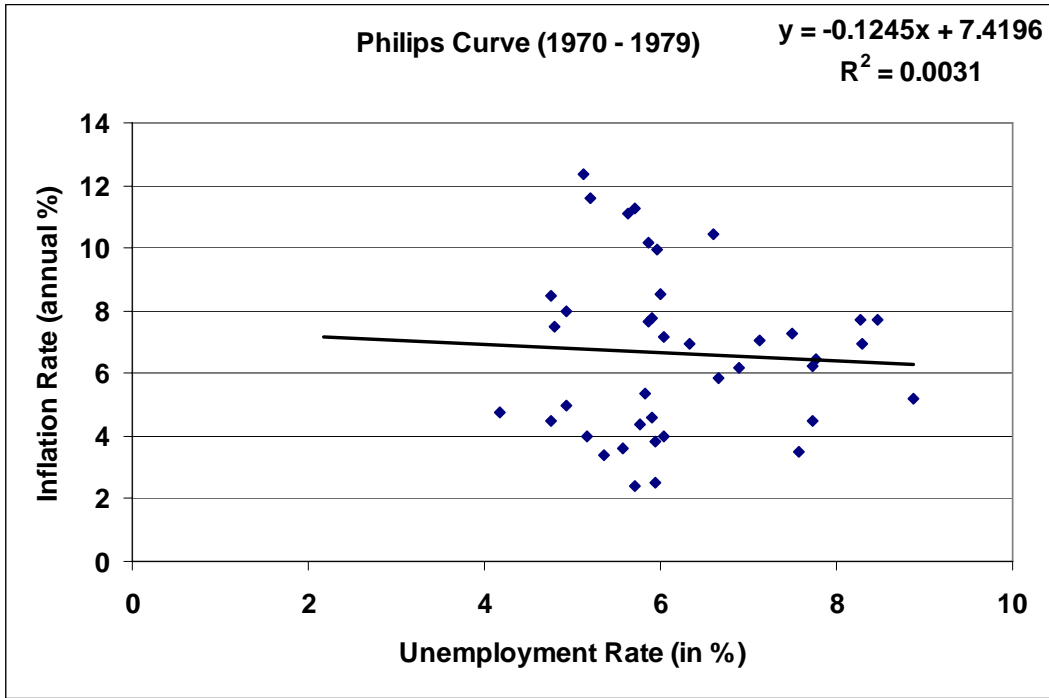
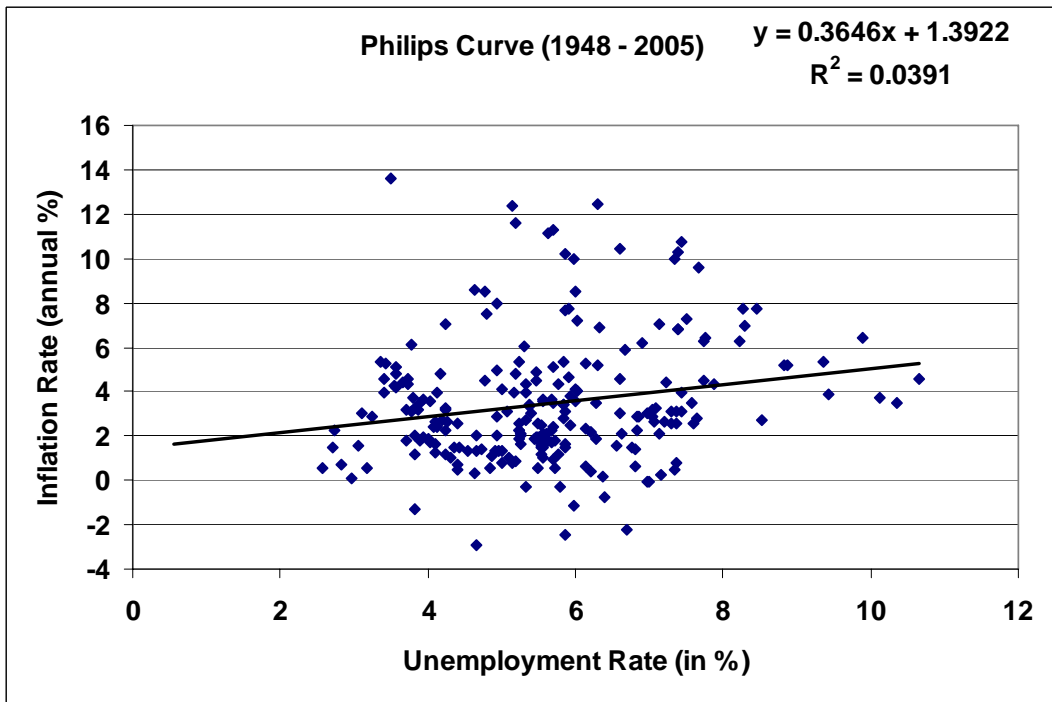
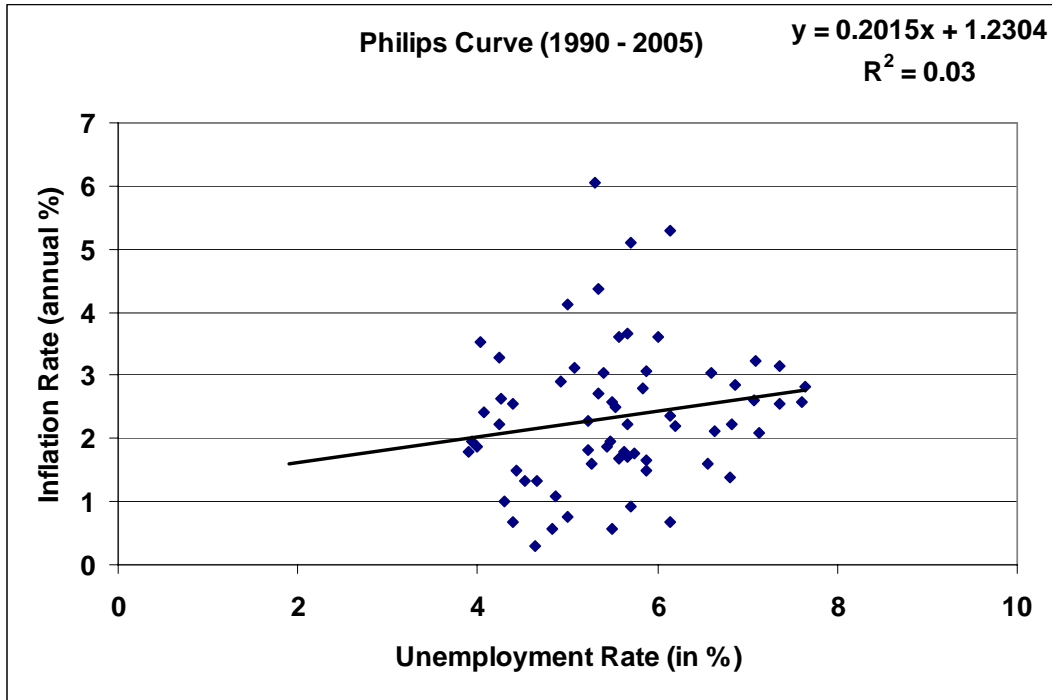


Figure 3: Phillips curve in the U.S., 1960's

employment rate seem to weaken and sometimes even a positive relationship was observed. The next figures show the Phillips curve in the U.S. for the 70's, 80's, 90-2005, and 1948-2005.



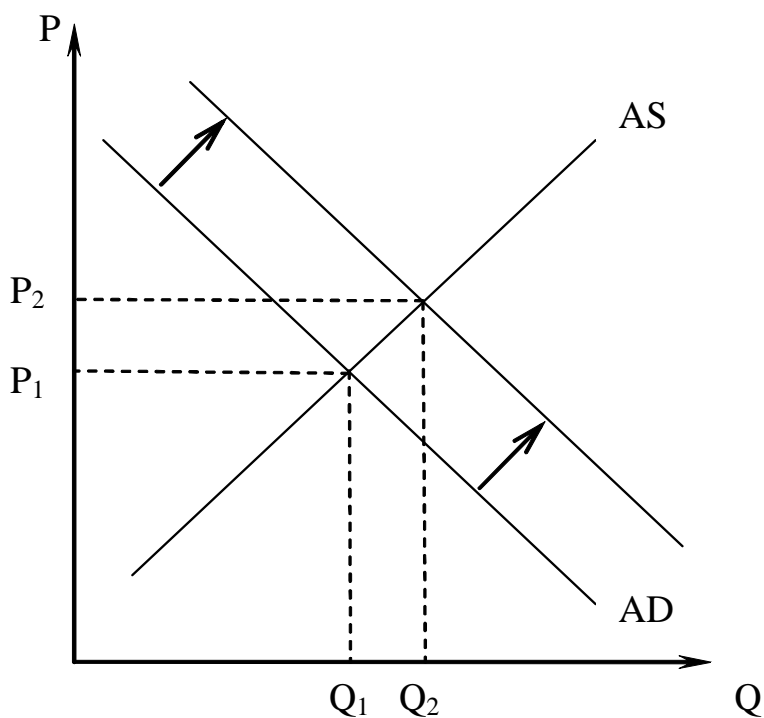




Observe that the negative relationship between inflation and unemployment that was observed during the 60's breaks down during the subsequent decades. Moreover, for the entire period of 1948-2005 (last figure), the observed relationship between inflation and unemployment is negative.

2.1 The impact of the Phillips curve on monetary policy

Phillips' article in 1958 and subsequent empirical work on the Phillips curve convinced many economists and policy makers that there exists a stable trade-off between inflation and unemployment. Some economists modified the standard Keynesian model so that it would predict a negative trade-off between inflation and unemployment. Some of you may have seen in your principle class the so called AD-AS (aggregate demand, aggregate supply) model, illustrated in the next figure.



In this model expansionary policies (fiscal or monetary) lead to an outward shift of the AD curve, and equilibrium output goes up, but at a cost of higher price level. The obvious implication of higher output is lower unemployment. Equipped with this model and the empirical evidence about the negative relationship between inflation and unemployment, some economists and policy makers concluded that it is possible to *exploit* the Phillips curve. In other words, they believed that there is a stable relationship between inflation and unemployment rate, and the policy makers have a choice of lowering unemployment at the cost of higher inflation, or having higher unemployment rate but with lower inflation. It was often argued that as long as inflation is not too high, it does not pose much danger to the economy, so it is better to suffer some inflation as long as this would lead to lower unemployment. Central banks of some countries (e.g. Israel) printed money with the hope that higher inflation would lower unemployment and thereby boost the economy.

In most cases, if not in all of them, the inflationary policies that attempted to lower unemployment resulted in higher inflation but without lowering unemployment. In some countries these policies led to hyper inflation, and the collapse of the local currency, banking system and ultimately led to high unemployment. Why did inflationary policies fail so

miserably? The key to answering this question is *expectations*, which is the topic of the next section.

3 Expectations-Augmented Phillips Curve (Edmund Phelps)

Edmund Phelps did most of his important work on Inflation and Unemployment during the late 60's, when the most compelling evidence that supported the downward sloping Phillips curve was becoming available (see figure 3). Contrary to the conventional wisdom that the downward sloping Phillips curve represents a stable and exploitable trade-off between inflation and unemployment, Phelps argued that this is *not the case in the long-run*. Phelps introduce an important notion of *expected inflation*, which plays a key role in his argument.

The expectation-augmented Phillips curve is given by:

$$\pi_t = \pi_t^e - \beta(u_t - u_n) \quad (1)$$

or

$$\pi_t - \pi_t^e = -\beta(u_t - u_n) \quad (2)$$

where π_t is the actual inflation in period t , π_t^e is the period $t - 1$ expectation of π_t (or formally, $\pi_t^e = E_{t-1}(\pi_t)$), u_t is the unemployment at time t and u_n is some *natural rate* of unemployment or NAIRU (Non-Accelerating Inflation Rate of Unemployment). According to the extended Keynesian model mentioned above, $\beta > 0$. Thus, if the monetary policy is such that the actual inflation is equal to the expected inflation, then the unemployment in that period is by definition equal to the natural rate. That is if $\pi_t = \pi_t^e$ then $u_t = u_n$. To motivate this formulation, think of workers and employers who set work contracts based on their expectations of future inflation. The contracts are set in such a way that when they perfectly anticipate the future inflation, the labor markets are cleared (the only unemployment is the natural one). If for some reason people made an error in predicting the future inflation, then the unemployment differs from the natural rate. Suppose that the realized inflation is greater than the expected one, i.e. $\pi_t > \pi_t^e$. In this case we can see that the realized unemployment rate will fall below the natural rate, i.e. $u_t < u_n$.

We need to make some assumption about the way people form their expectations about future inflation. The most simple assumption that we can make is *backward-looking* expectations. In words, this means that the expected inflation at time t is the realized inflation at time $t - 1$. Formally, backward-looking expectations mean that $\pi_t^e = \pi_{t-1}$. Phelps' argument that there is *no long-run trade-off between inflation and unemployment* can be easily illustrated with Figure 4. Suppose that initially the Phillips curve is the curve labeled $\pi^e = \pi_1$ and the actual inflation is initially π_1 . This curve represents the Phillips curve for expected inflation of π_1 . Since the actual inflation is equal to the expected inflation, the actual unemployment rate is equal to the natural rate. Thus, at the initial point the economy has inflation rate of π_1 and unemployment rate of u_n . Suppose now that the central bank decided to increase in the inflation to π_2 . In the short run people still expect the inflation to be π_1 (as it was in the last period), so the economy moves to the point labeled Short run, with higher inflation and lower unemployment. In the following period however, people's expectations will adjust and they will expect inflation to be π_2 . The Phillips curve will shift

up¹ and the new Phillips curve is the one labeled $\pi^e = \pi_2$. At the long-run equilibrium, the unemployment rate returns to the natural rate u_n but the inflation is higher π_2 . Thus, we

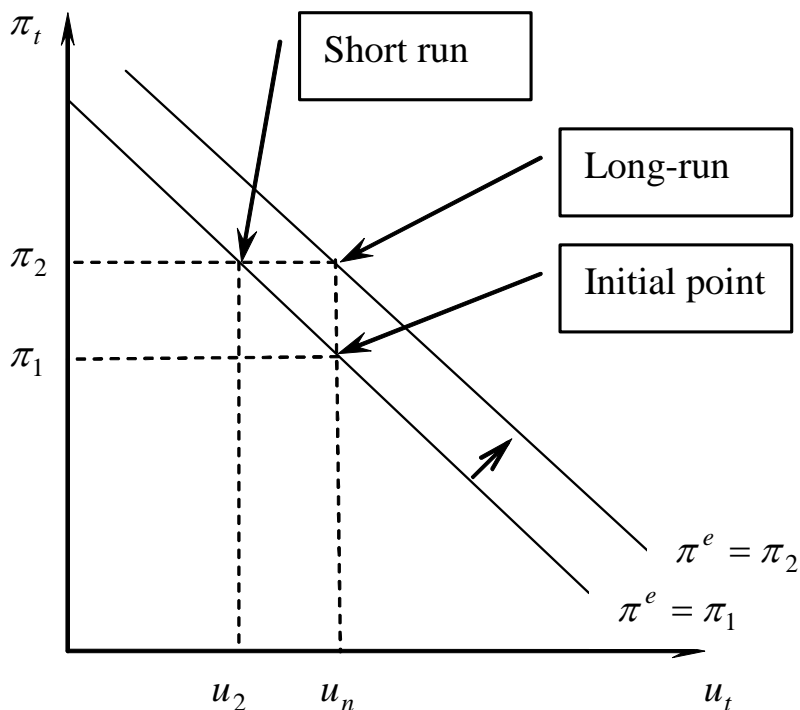


Figure 4: Phelps' Expectations-Augmented Philips curve

see that even when we make the very simplistic assumption that expectations are backward-looking, the result of this model is that there can be at best a short-run trade-off between inflation and unemployment, but not in the long run. As we will see below, with more reasonable assumptions of expectation formation, Phelps' result becomes even more robust.

3.1 The impact of the expectations-augmented Phillips curve on monetary policy

Phelps' insight and his emphasis of the expected inflation revolutionized the way monetary policy is conducted. He switched the discussion from the *permanent* trade-off between inflation and unemployment to discussion about *intertemporal* trade-off (between lowering unemployment now but suffering from high inflation in the future). The theoretical underpinnings for the policy of inflation targeting, which many central banks have adopted since the early 1990s, are to a large extent derived from the framework developed in Phelps' 1967 paper. He demonstrated that expansionary monetary policy can lower inflation only in the short run, in the best case scenario of backward looking expectations. We will see in what follows that if we make more reasonable assumptions about expectation formation, then

¹The Phillips curve shifts up because π^e is part of the intercept.

inflationary monetary policy becomes even less effective and can fail boosting the economy even in the short run.

4 Rational Expectation (Robert Lucas)

Rational Expectations theory assumes that people use all the information available to them to predict the future inflation. According to the backward-looking expectations, people's prediction of future inflation is current inflation. This is similar to predict tomorrow's weather to be exactly like today's weather. When meteorologists predict tomorrow's weather, they use a host of information other than yesterday's weather. Similarly, when people form expectations about future inflation they use the media, the FED announcements and all sorts of other information that is available.

What are the implications of the rational expectations assumption on monetary policy? Looking back at Figure 4, suppose that the public is able to predict that the FED is planning to increase the inflation. Then the public's expectations will immediately become $\pi^e = \pi_2$ and the Phillips curve will shift upward at the same period when the inflation increases from π_1 to π_2 . Thus, with rational expectations, inflationary policy will not have an impact on unemployment even in the short run. The economy will jump from the initial point to the long run equilibrium with the same unemployment and higher inflation.

Lucas argument strengthened Phelps' argument and implied that even in the short-run, the central banks would not be able to boost the economy with inflationary monetary policies.

4.1 Numerical example

Suppose that $\beta = 1$, $u_n = 5$, and $\pi_t^e = \pi_{t-1}$ (backward-looking expectations).

1. Suppose that the FED creates inflation of 1% until period 3 and then increases the inflation permanently to 2%. Show the time path of inflation, expected inflation and unemployment from period 1 on.

Rewriting the expectations-augmented Phillips curve in equation (1) gives

$$\begin{aligned}\pi_t &= \pi_t^e - \beta(u_t - u_n) \\ \frac{\pi_t - \pi_t^e}{-\beta} &= u_t - u_n \\ u_t &= u_n + \frac{\pi_t - \pi_t^e}{-1} \\ u_t &= u_n + \pi_t^e - \pi_t\end{aligned}$$

The next table shows the time paths.

Time	$u_t = u_n + \pi_t^e - \pi_t$			
1	5	5	1	1
2	5	5	1	1
3	4	5	1	2
4	5	5	2	2
5	5	5	2	2
6	5	5	2	2
\vdots	\vdots	\vdots	\vdots	\vdots

2. Now suppose that the FED creates inflation of 1% until period 3 and then increases the inflation permanently to 2%, but this time people have rational expectations and they anticipate perfectly the increase in inflation. Show the time path of inflation, expected inflation and unemployment from period 1 on.

Time	$u_t = u_n + \pi_t^e - \pi_t$			
1	5	5	1	1
2	5	5	1	1
3	5	5	2	2
4	5	5	2	2
5	5	5	2	2
6	5	5	2	2
\vdots	\vdots	\vdots	\vdots	\vdots

3. Now suppose that the FED creates inflation of 1% until period 3 and then increases the inflation permanently to 2%, but this time people have almost rational expectations so they are expecting that in period 3 the FED will increase the inflation to 1.9%. After period 3 they learn that the inflation is 2%. Show the time path of inflation, expected inflation and unemployment from period 1 on.

Time	$u_t = u_n + \pi_t^e - \pi_t$			
1	5	5	1	1
2	5	5	1	1
3	4.9	5	1.9	2
4	5	5	2	2
5	5	5	2	2
6	5	5	2	2
\vdots	\vdots	\vdots	\vdots	\vdots

Notice that when we make the assumption of backward-looking expectations, then inflationary policy is effective in reducing unemployment only in the short run. If expectations are rational, then inflationary policy is not effective in reducing unemployment even in the short run. The last example showed that if expectations are almost rational, then the monetary policy has some effect in the short run, but this is getting smaller the better the public's prediction of inflation is.

5 Credibility of Monetary Policy (Finn E. Kydland, Edward C. Prescott)

Kydland and Prescott illustrated another problem with monetary policy - *time inconsistency*. To illustrate their argument, consider again the expectations-augmented Phillips curve. Notice that if the public has expectations for low inflation, then the central bank can reduce the unemployment rate by creating inflation. In other words, there is an incentive for the central bank (or government) to promise a low inflation rate in the next period, and when the public sets the wage contracts according to the low inflationary expectations, there is a temptation for the central bank to break the promise and create high inflation. If economic peacemakers lack the ability to commit in advance to a specific decision rule, they will often not implement the most desirable policy later on. Kydland and Prescott's results offered a common explanation for events that, until then, had been interpreted as separate policy failures, e.g., that economies become trapped in high inflation even though price stability is the *stated* objective of monetary policy. Their work established the foundations for an extensive research program on the credibility and political feasibility of economic policy. This research shifted the practical discussion of economic policy away from isolated policy measures towards the institutions of policymaking, a shift that has largely influenced the reforms of central banks and the design of monetary policy in many countries over the last decade.

Because of the time inconsistency problem, the recommended policy by Kydland and Prescott is "*Rules Rather Than Discretion*"². That is, they recommended that the central banks should commit to a simple rule (for example inflation targeting at certain level) and not attempt to exercise discretionary policy. When the central bank commits to a certain rule by law, this commitment is credible, while a promise without commitment is not. In other words, they recommended that the central banks should tie their hands and not conduct monetary policy which responds to economic events.

²Kydland, Finn E & Prescott, Edward C. 1977 "*Rules Rather Than Discretion: The Inconsistency of Optimal Plans*", The Journal of Political Economy .

6 Appendix: Estimating the Expectations-Augmented Phillips Curve

We want to test whether the assumption that $\beta > 0$ holds in the data. For simplicity we assume that expectations are *backward-looking*, $\pi_t^e = \pi_{t-1}$, i.e. we assume that people's expectation about inflation at time t is the time $t - 1$ inflation rate. Also, we can assume for simplicity that u_n is the average unemployment rate over the sample period, say 5%. Let $\Delta\pi_t \equiv \pi_t - \pi_{t-1}$ denote the difference in inflation rate between period $t - 1$ and t . The statistical relationship that we want to estimate is then

$$\Delta\pi_t = \beta_1 (u_t - u_n) + \varepsilon_t \quad (3)$$

Having obtained the estimate for the slope ($\hat{\beta}$), we test whether $\hat{\beta} < 0$. When we run this regression, we need to impose the restriction that the constant is zero.

Remark. The specification in equation (3) is not the same as

$$\Delta\pi_t = \beta_0 + \beta_1 u_t + \varepsilon_t \quad (4)$$

Rearranging equation (3) gives

$$\Delta\pi_t = -\beta_1 u_n + \beta_1 u_t + \varepsilon_t$$

Since $u_n = 5$ is given, then the first specification in eq. (3) is equivalent to the second, eq. (4), if we impose a restriction on the second specification that the intercept is equal to the slope times u_n . In other words, the specification that is implied by the theory requires estimating equation (3), which is the same as estimating the constrained relationship

$$\begin{aligned} \Delta\pi_t &= \beta_0 + \beta_1 u_t + \varepsilon_t \\ & \text{s.t.} \\ \beta_0 &= -\beta_1 \cdot u_n \end{aligned}$$