

# The Phillips Curve

- Empirical relationship between inflation and unemployment.
- Derivation of Phillips Curve.
- The natural rate.
- Determining expectations: the accelerationist Phillips curve.

# Phillips Curve

- Aggregate supply:

$$P(t) = (1 + \mu) P(t)^e (1 - \alpha u(t) + z)$$

- Divide by  $P_{t-1}$  :

$$P(t) / P(t-1) = (1 + \mu) P(t)^e / P(t-1) (1 - \alpha u(t) + z)$$

- Approximate as:

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

# The Phillips Curve and The Natural Rate of Unemployment

$$\pi^e(t) = \pi(t)$$

$\Rightarrow$

$$u_n = \frac{(\mu+z)}{\alpha}$$

$$\pi(t) = \pi^e(t) - \alpha (u(t) - u_n)$$

# Expectations

- Reasonable way to compute expected inflation: some function of past inflation.

- Suppose  $\pi^e(\mathbf{t}) = a \pi(\mathbf{t}-1)$

- If  $a = 0$ , we have

$$\pi(\mathbf{t}) = -\alpha (\mathbf{u}(\mathbf{t}) - \mathbf{u}_n)$$

In this case, inflation and unemployment are inversely related.

- If  $a = 1$ , we have

$$\pi(\mathbf{t}) - \pi(\mathbf{t}-1) = -\alpha (\mathbf{u}(\mathbf{t}) - \mathbf{u}_n)$$

In this case, the change in inflation and unemployment are inversely related.

# Expectations over time

- Prior to 1970, inflation was on average zero and  $a=0$  was a reasonable approximation.
- 1970-2000: inflation rose steadily throughout 70's. Expected inflation is now better approximated using last period's inflation ( $a=1$ ).

# Expectations-augmented Phillips Curve

- We can write the expectations-augmented Phillips curve as:

$$\pi(t) - \pi(t-1) = -\alpha (u(t) - u_n)$$

- Implications:
  - If  $u(t) > u_n$ , inflation is decreasing.
  - If  $u(t) < u_n$ , inflation is increasing.

# NAIRU

- When  $u(t)=u_n$  we have  $\pi(t)=\pi(t-1)$
- The natural rate of unemployment is the rate of unemployment at which the inflation rate is not changing and the price level is not accelerating.
- We call this unemployment rate the NAIRU (Non-accelerating-inflation-rate of unemployment).

# Changes in the natural rate:

- Since  $u_n = (\mu+z)/\alpha$  , changes in labor market conditions over time may lead to changes in the natural rate.
- Cross-country differences in labor market policies also imply cross-country differences in the natural rate of unemployment.
- Europe and U.S. both have relatively stable inflation but Europe has higher unemployment – this implies Europe has a higher natural rate of unemployment.

# Wage indexation

- Suppose a fraction  $b$  of wage contracts are indexed to current inflation. In this case the Phillips curve is:

$$\pi(t) = b\pi(t) + (1-b)\pi(t) - \alpha(u(t) - u_n)$$

- Again suppose  $\pi(t) = \pi(t-1)$
- Solving we obtain:

$$\pi(t) - \pi(t-1) = -(\alpha/(1-b))(u(t) - u_n)$$

- Wage indexation increases the slope of the Phillips curve: a 1 percentage point increase in unemployment above the natural rate implies a  $(\alpha/(1-b))$  percentage point reduction in the rate of inflation.

# Summary:

- If unemployment is above (below) the natural rate the expectations-augmented Phillips curve implies that inflation is increasing (decreasing).
- When unemployment equals the natural rate of unemployment (NAIRU), inflation is stable.
- Cross-country variation in labor market policies and conditions implies cross-country variation in the natural rate of unemployment.