Topic 6: The Phillips Curve

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Reading and Lecture Plan

- Reading

1. SWJ Ch. 18.4-6

- Plan

1. Phillips Curve and Supply Shocks
2. The Aggregate Supply Curve

The Labour Market: A Recap

- Firms sell differentiated products (monopolistic competition) and price goods with a 'mark-up'.
- **Labour demand:**

$$L_i = \left[\frac{\alpha B}{bm^p}\right]^{\epsilon} \left(\frac{W_i}{P}\right)^{-\epsilon} \left(\frac{Y}{nB}\right)^{\epsilon/\sigma}$$

- with

$$m^p \equiv \frac{\sigma - 1}{\sigma} \text{ and } \epsilon \equiv \frac{\sigma}{\sigma - \alpha\left(\sigma - 1\right)}$$

- Recall that $\sigma > 1$ and $\alpha \leq 1$.

The Labour Market: A Recap

- Workers join trade unions and collectively bargain for their wage, resulting in a wage mark-up and a wage setting relationship.
- **Labour supply:**

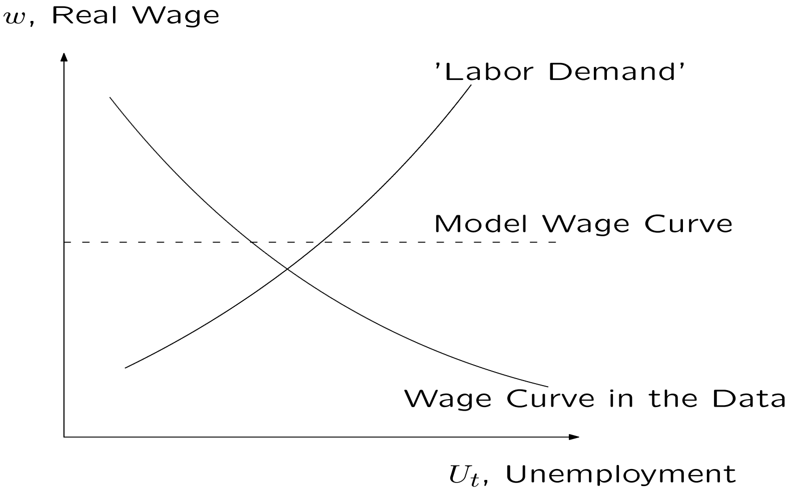
$$w_i = \frac{b}{m^w} \quad ; \quad w_i = \frac{W_i}{P}$$

- with

$$m^w \equiv \frac{\xi\epsilon - 1}{\xi\epsilon}$$

- Again, $\epsilon > 1$.

Recap Diagram



The Labour Market: Comments

1. These conditions only apply per sector. We want to say something about the whole economy.
2. We assumed that trade unions could predict the price level perfectly. In truth, they set wage given their expectations about the price level, which may be incorrect.
3. Aggregating and incorporating expectations allows us to discuss the Phillips Curve and relate this to the Aggregate Supply (AS) curve.
4. From here on, we focus only on nominal wage rigidity. We can continue to assume that there is a mark-up in the goods sector of the economy.

- One way to think about this is that *wages are more sluggish than prices.*

Expectations

- We recognize that the set wage should reflect expectations:

$$W_i = P^e \left(\frac{b}{m^w} \right)$$

- Here, P^e denotes the expected value of P.
- Say we are the trade union negotiators. If we want a higher real wage, and we make a bad guess about the price level, then we will be disadvantaged by the nominal wage we set.
- The actual real wage is:

$$w_i = \frac{W_i}{P} = \frac{P^e}{P} \left(\frac{b}{m^w} \right) \tag{1}$$

Expectations

- Because our predictions about the price level affect wage bargaining, they also have implications for labour supplied.
- Using (1) in labour demand, labor market equilibrium in sector i is:

$$L_i = \left(\frac{\alpha B}{b m^p m^w} \right)^{\epsilon} \left(\frac{P}{P^e} \right)^{-\epsilon} \left(\frac{Y}{nB} \right)^{\epsilon/\sigma} \tag{2}$$

- The higher (P/P^e), the more $P > P^e$, and the more the trade union underestimates the actual price level.
- This lowers wage claims and results in higher employment in each sector.
- Making a good or bad forecast determines how much labour we actually see supplied. Or rather, **labour is demand-determined.**

Aggregation

- If we know what happens in each sector, we can work out what happens in the economy as a whole.
- There are n sectors, so:

$$L = nL_i \text{ and } Y = nY_i$$

- Use this in (2) with the familiar production function $Y = BL^{\alpha}$:

$$L = \left[\left(\frac{\alpha B/b}{m^p m^w} \right) \left(\frac{P}{P^e} \right) \right]^{1/(1-\alpha)} \tag{3}$$

- Since $w_i = w$, use the wage setting equation in this expression to eliminate (P/P^e). This gives the **aggregate labour market equilibrium condition**.

Aggregate Labour Demand

- Returning to labour demand for a moment, there is an important difference between the sectoral and economy-wide conditions.
- Aggregate labor demand is:

$$L = n\left(\frac{\alpha B}{m^p}\right)^{1/(1-\alpha)}\left(\frac{W}{P}\right)^{1/(\alpha-1)}$$

- As with sectoral labor demand, we find $L = L(w)$ and $\partial l/\partial w < 0$.
- However, **the real wage elasticity of labor demand is different.**
- Previously it was $\epsilon = \epsilon(\sigma, \alpha)$. Now, it only depends on α.

The 'Natural Rate' Of Employment

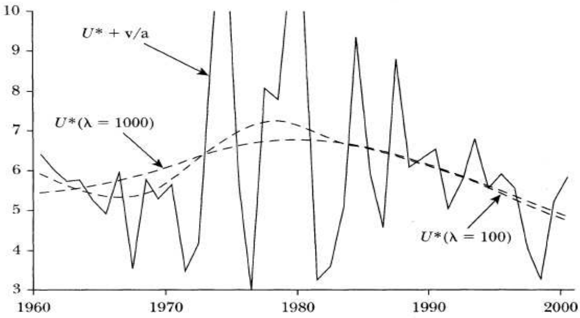
- The concept of a 'natural rate' has already been discussed in the context of the interest rate. There, it was the long-run or trend interest rate. It was pinned down by the AD curve.
- We can also compute a **natural rate of employment**, also called the **non-accelerating inflation rate of unemployment (NAIRU)**.
- Usually, the natural rate is defined as the level of employment that is independent of monetary policy.
- It only depends on real factors where $P^e = P$. Using this in (3), we have:

$$\overline{L} = n\left(\frac{\alpha B/b}{m^p m^w}\right)^{1/(1-\alpha)} \tag{4}$$

- The natural rate depends on technology and mark-ups, $\{m^p, m^w\}$.

Evolution Of The Natural Rate Over Time[1]

Time Varying NAIRUs, 1960–2000

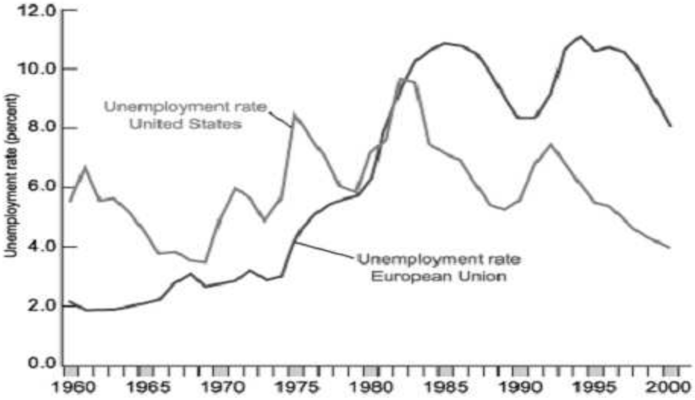


In our modelled economy, output *only* depends on markups and technology. It may actually depend on many other factors. In the USA, the NAIRU has changed substantially over time.

[1] Ball and Mankiw (2002, JEP)

The Natural Rate In Europe (Blanchard)

- The movement in the NAIRU is even more pronounced in Europe.[2]



[2] US vs. EU trade union presence is different. Hysteresis has also been used to explain the pattern of EU unemployment during the 1990s.

- **Consider the following:**
- When unemployment is low, inflation tends to be high. Whenever unemployment is high, inflation tends to be low.
- This inverse relationship between inflation and unemployment is called the Phillips Curve and was first tested by Phillips (1958, Economica).
- The Phillips Curve forms the basis for many Macro models.
- We derive a specific Phillips Curve, but there are a number of competing theories out there.

- Consider (3) and (4) again:

$$L = \left[\left(\frac{\alpha B/b}{m^p m^w} \right) \left(\frac{P}{P^e} \right) \right]^{1/(1-\alpha)}$$

$$\overline{L} = n \left(\frac{\alpha B/b}{m^p m^w} \right)^{1/(1-\alpha)}$$

- If B, m^p and m^w are the same across the business cycle, then

$$L = \left(\frac{P}{P^e} \right)^{1/(1-\alpha)} \overline{L}$$

- This is the Phillips Curve, in essence. However, we will convert this into an expression that maps unemployment to inflation, expected inflation and the natural rate of unemployment.

The Phillips Curve: Expectations

- **Define** the unemployment rate as u and $L = 1 - u$.
- Use that fact that $\ln(1-u) \approx -u$ for small u and take logs of the previous expression:

$$\overline{u} - u = \frac{1}{1-\alpha}\left(\ln P - \ln P^e\right)$$

- **Define** $\pi \equiv \ln P - \ln P_{-1}$ and $\pi^e \equiv \ln P^e - \ln P_{-1}$.
- Use this in the above expression:

$$\pi = \pi^e + (1-\alpha)(\overline{u} - u)$$

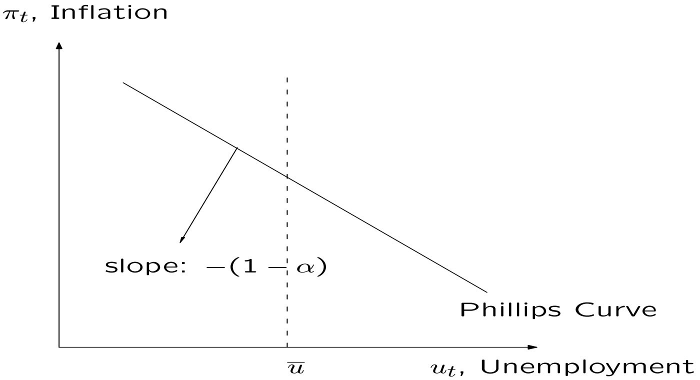
- This is sometimes called the **expectations-augmented Phillips curve**.

The Expectations-Augmented Phillips Curve[3]

- We can compute a value for $\overline{u}$ from $\overline{L}$. We also know what affects $\overline{L}$.
- For a given π^e, lower unemployment is associated with higher realized inflation, π (think of this as movement along the Phillips curve).
- However, if π^e rises, the real value of the preset money wage, W_i, falls (i.e. w_i). As this happens, firms expand employment above the natural rate and $u < \overline{u}$.
- **All important point:** a change in expected inflation causes the Phillips curve to shift.

[3]Phelps won the Nobel prize in 2006 for this insight. See his webpage at Columbia.

Diagram: The Phillips Curve



We see that $u < \overline{u}$ is associated with rising inflation (the economy may be 'overheating'). So a big rise in output levels may not be a good thing for the economy.[4]

[4] We have already discussed overheating via the demand side (see Lecture 4).

What the Data Say: The Relevance of Time Length

- Originally, economists thought that a simple negative relationship between inflation and unemployment held true in the data.
- However, that was because the sample data covered 1860-1950. Over this time, there was little inflation.[5] Thus, people set $\pi^e \simeq 0$. Inflation expectations were close to zero.
- After 1950, this began to change.

1. In the 1960s, inflation rose continuously.
2. In the 1970s, there were oil price shocks (and perhaps bad monetary policy).
3. Eventually, people set $\pi^e > 0$. They expected inflation.

[5] £100 in 1860 was worth £350 in 1950. The same inflation happened between 1970 and 1979 alone.

Phillips Curve: The Original Analysis

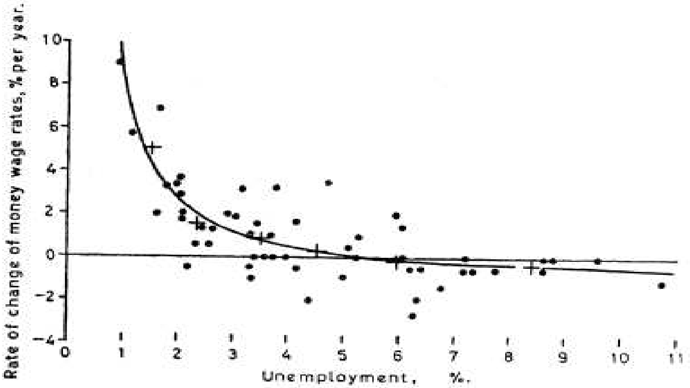
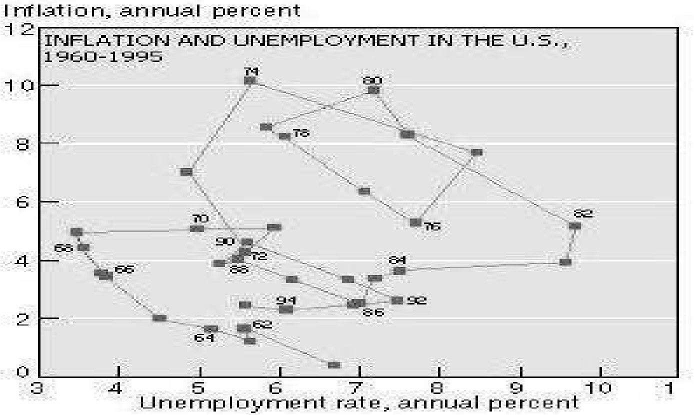


Fig.1. 1861 – 1913

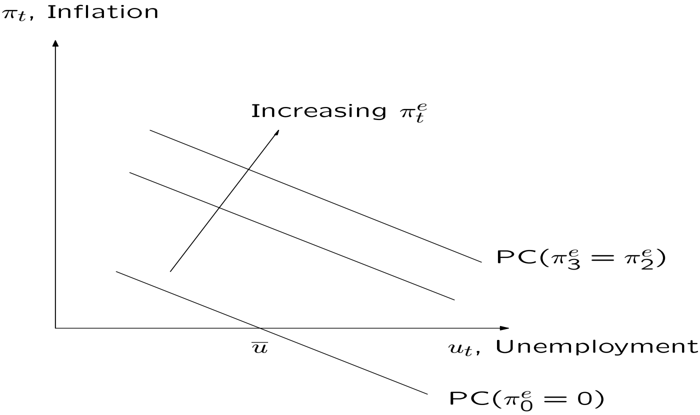
Phillips' (1958) analysis, which draws a downward sloped line in the same space for the UK. This only makes sense if π^e remains zero (which it was in Phillips' data).

Plotting the US Inflation-Unemployment Trade-off



Source: Cleveland Fed (1996, Economic Trends). The 1960s (bottom right) do display a Phillips Curve type relationship, suggesting a direct choice for the government. From the 1970s on, the simple Phillips curve breaks down.

Diagram: Phillips Curve Shift



- The idea that there is a simple, stable negative relationship is misleading for one reason: it takes π^e as given.
- A change in expected inflation shifts the Phillips curve.

Long-Run And Short-Run Phillips Curves

- The expectations-augmented Phillips curve is sometimes also called the surprise Phillips curve.
- It suggests the government can take advantage of the trade-off between unemployment and inflation to temporarily boost output if it 'surprises' market participants.
- However, this is necessarily a short-run situation. In the long run, $\pi = \pi^e$, $\overline{u} - u$, and there is no trade-off.
- The LR Phillips Curve is vertical and every possible inflation rate corresponds to the NAIRU.

Supply Shocks

- The simple Phillips Curve may additionally fail in the data if there are shocks to the supply side of the economy (i.e. failure is not just due to changing expectations).
- In the AD analysis, we modelled shocks to government spending.
- Here, we can model shocks in the same way. We consider two possibilities.

1. Mark-up shocks: an exogenous change in goods market competition or trade union power (via m^p and/or m^w) changes mark-ups charged by firms.
2. Technology shocks: exogenous changes in technical progress (via B) that change production possibilities for given inputs.

- Note that these shocks will shift both the short and long-run Phillips curves.

Supply Shocks In The Phillips Curve

- Recall (3) and (4). If we assume that welfare benefits are related to productivity levels such that $b = C\overline{B}$ for $C > 0$, then:

$$L = \left[\left(\frac{\alpha B / C\overline{B}}{m^p m^w} \right) \left(\frac{P}{P^e} \right) \right]^{1/(1-\alpha)}$$

$$\overline{L} = n \left(\frac{\alpha / C}{\overline{m}^p \overline{m}^w} \right)^{1/(1-\alpha)}$$

- Divide the two equations together:

$$\left(\frac{1-u}{1-\overline{u}} \right)^{1-\alpha} = \left(\frac{P}{P^e} \right) \underbrace{\frac{B\overline{m}^p \overline{m}^w}{\overline{B} m^p m^w}}_{\text{shocks}}$$

- The previous Phillips curve was a special case of this, without the possibility of shocks.

Supply Shocks In The Phillips Curve

- Take the logarithm of the previous equation:

$$\pi = \pi^e + (1 - \alpha)(\overline{u} - u) + \mathbb{Z} \tag{5}$$

- Now the parameter α gives the slope of the PC and $\mathbb{Z}$ measures the (supply-side) shocks.
- Supply shocks come from three sources:

$$\mathbb{Z} = \ln\left(\frac{m^p}{\overline{m}^p}\right) + \ln\left(\frac{m^w}{\overline{m}^w}\right) - \ln\left(\frac{B}{\overline{B}}\right)$$

- The earlier Phillips Curve has $\mathbb{Z} = 0$.

More on Shocks

- Now, we have a better model. Mark-up shocks and changes in productivity (i.e. production technology) affect inflation. This certainly reflects what we observe in reality.
- E.g.: Negative shock to technology $\Rightarrow B < \overline{B} \Rightarrow B/\overline{B} < 1 \Rightarrow \ln\left(B/\overline{B}\right) < 0 \Rightarrow \mathbb{Z} > 0$.
- We usually think of there being two main shocks in the macro economy: monetary shocks and real (technology) shocks.
- Monetary shocks are associated with AD and technology shocks with AS.

An improvement in the underlying level of technology shifts the natural rate (increased technology means a lower natural rate of unemployment). The same is true for a reduction in trade union power.

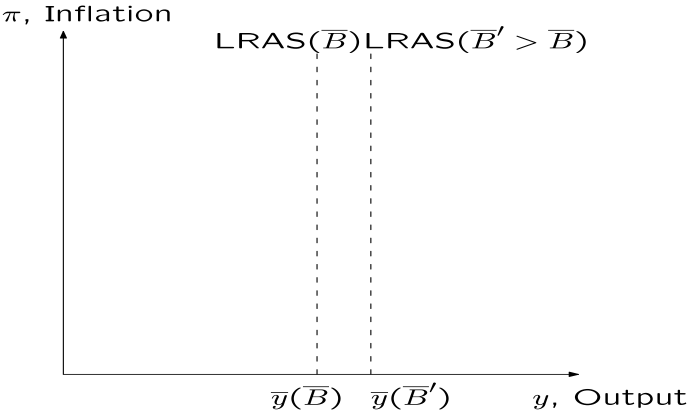
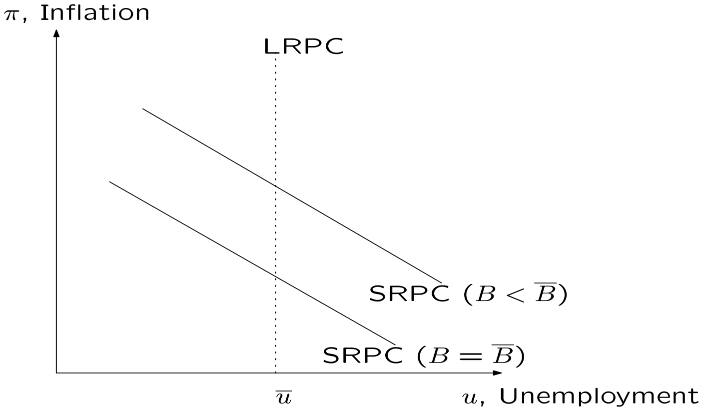


Diagram: Shifting The SRAS Curve

This is the typical characterization of a negative technology shock: higher prices and lower output, possibly leading to stagflation. (Compare to the 1970s oil price shocks.)



Aggregate Supply: Foundations

- Use the aggregate production function:

$$Y_i = BL_i^{\alpha} \Rightarrow Y = n^{1-\alpha} BL^{\alpha}$$
$$= n^{1-\alpha} BL^{\alpha}$$

- Take logs (short-run version):

$$y = (1-\alpha)\ln n + \ln B - \alpha u \qquad (6)$$

- Long-run version:

$$\overline{y} = (1-\alpha)\ln n + \ln \overline{B} - \alpha \overline{u} \qquad (7)$$

- Use long and short-run version in (5):

$$\pi = \pi^e + \left(\frac{1-\alpha}{\alpha}\right)(y - \overline{y})$$
$$+ \left(\frac{1-\alpha}{\alpha}\right)\left(\ln \overline{B} - \ln B\right) + \mathbb{Z}$$

- As $\mathbb{Z}$ also contains the technology term, we have:

$$\pi = \pi^e + \lambda\,(y - \overline{y}) + \mathbb{S}$$

where $\lambda \equiv (1-\alpha)\,/\alpha$, and

$$\mathbb{S} \equiv \ln\left(\frac{m^p}{\overline{m}^p}\right) + \ln\left(\frac{m^w}{\overline{m}^w}\right) - (1/\alpha)\ln\left(\frac{B}{\overline{B}}\right)$$

measures the extent of supply shocks.

The Short-Run Aggregate Supply Curve

- The short-run aggregate supply curve is:

$$\pi = \pi^e + \lambda \underbrace{(y - \overline{y})}_{\text{output gap}} + S$$

- The basic properties from the Phillips curve hold here. That is, changes in π^e also shift the SRAS.
- We have also re-introduced the output gap. This is consistent with the AD curve from previous lectures.

Review Of Aggregate Supply

- We have now covered (in separate classes) the building blocks of a powerful, complicated model.

1. AD: C, I, with government spending (fiscal shocks) and monetary policy (via an interest rate rule).
2. AS: Price- and wage-setting behavior, with supply-side shocks and expectations.

- From here on, we work with this model specifically. Questions:

1. Empirical Relevance.
2. Policy Issues.