Aggregate Supply

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Building a basic model of aggregate supply.
The Phillips curve.
Markup pricing.
Okun’s Law.
Production function.
Aggregate supply.
Building a basic model of aggregate supply

- The AD relationship derived from IS and MP curves gives a relationship between inflation and the output gap.
- We therefore need a model of the supply side that also gives rise to a relationship between the rate of change of prices and the output gap.
The Phillips curve is a relationship between the rate of change of a nominal value (wages, or prices) and real quantities (deviation of unemployment rate from natural level, or output gap).

The Phillips curve has a long history.
Phillips curve: where is the stickiness?

- Keynesian models from the 1930s - 1970s assumed sticky wages - Keynes (1936), Phelps (1968), Taylor (1980)
The original (wage) Phillips curve

Phillips’ original paper estimated a relationship between nominal wage growth and the unemployment rate.

The original Phillips curve describes a relationship between nominal wage growth and unemployment:

\[ W_t - W_{t-1} = \varphi(u_t - u_t^N) \]

where
- \( W = \) log of nominal wage level
- \( \varphi = \) sensitivity of wage growth to the unemployment gap \( (u_t - u_t^N) \), \( \varphi > 0 \)
- \( u = \) log of natural rate of unemployment
- \( u^N = \) log of unemployment rate

To 'explain' a downward-sloping relationship between nominal wage growth and the unemployment rate, we need: Sticky nominal wages. (Keynesian)
The original (wage) Phillips curve

- To ensure that in the long run unemployment is at its natural rate, the wage Phillips curve is augmented with expected wage growth.

- Unemployment will only deviate from the natural rate if actual wage growth differs from expected:

\[
\Delta W_t = W_t^e - \varphi(u_t - u_t^N)
\]

where
\[
\Delta W_t = \text{nominal wage growth}
\]

\[
W_t^e = \text{expected nominal wage growth}
\]

- A particularly simple model (accelerationist wage Phillips curve) arises when expectations are backward-looking, so that \( W_t^e = W_{t-1} \) and \( W_t = W_{t-1} - \varphi(u_t - u_t^N) \).
The wage Phillips curve - expectations-augmented or otherwise - requires nominal wage rigidity.

Any model of aggregate supply that assumes nominal wage rigidity is described as Keynesian.

Are nominal wages rigid?
- Could measure cyclicality of nominal wages.
- Or could simply investigate the prevalence of nominal wage rigidity, which could be symmetric or stronger downward.
The original (wage) Phillips curve

If we assume the underlying relationship is between nominal wage growth and the unemployment rate, then to get to the AS relationship (with inflation on the vertical axis) we need to specify how nominal wages and prices are related.

We typically assume markup pricing. Firms with some market power set prices above nominal marginal cost \( MC \):

\[
P = MC \times M, \quad \text{where} \quad M \geq 1.
\]

\( M = \frac{\epsilon}{\epsilon - 1} \) where \( \epsilon \) is the price elasticity of demand. 

- \( M = 1 \) corresponds to perfect competition (\( \epsilon \to \infty \)).
- \( M > 1 \) implies imperfect competition (\( \epsilon < \infty \)), normally assumed to take the form of monopolistic competition (many firms, each producing a differentiated good, hence each having some market power in relation to their good).
The original (wage) Phillips curve

- Taking logs:

\[ p = mc + \mu \]

- Measuring marginal cost: assuming labour is the only factor of production, marginal cost will be related to the nominal wage \( W \). Marginal cost is the nominal wage divided by the marginal product of labour. In logs:

\[ mc = w - mpl \]

- For simplicity, it is sometimes assumed that the level of \( mpl \) is constant, and normalise this level to unity (thus \( mpl = \log(MPL) = \log(1) = 0 \)), so \( mc = w \). Then, in logs:

\[ p = w + m \]
The original (wage) Phillips curve

If the markup is constant over time, markup pricing plus nominal wage stickiness, generating the expectations-augmented wage Phillips curve, leads to a straightforward relationship between price inflation and unemployment:

\[ p = w + m \rightarrow \Delta p = \pi = \Delta w, \]

so:

\[ \Delta W_t = W_t^e - \varphi(u_t - u_t^N) \Rightarrow \pi = \pi^e - \omega(u_t - u_t^N) \]

where

\[ \pi = \text{inflation} \]
\[ \pi^e = \text{expected inflation} \]
\[ \omega = \text{sensitivity of } \pi \text{ to unemployment gap } (u - u^N), \omega > 0s \]
\[ u = \log \text{ of unemployment rate} \]
\[ u^N = \log \text{ of natural rate of unemployment} \]
If we do assume the underlying relationship involves the unemployment rate, we also need to specify how unemployment and output are related.

A short-run aggregate supply curve can be derived from the modern Phillips curve by replacing the unemployment gap \((u - u^N)\) with the output gap between actual output and potential output \((y - \bar{y})\).

Okun’s law, named after Arthur Okun, empirically describes a negative relationship between the unemployment gap and the output gap.

In general, Okun’s Law has the form:

\[
{u_t - u^N_t} = -\alpha (y - \bar{y})
\]

where \(a > 0\).
We can now derive an aggregate supply curve.

The aggregate supply curve represents the relationship between the total quantity of output that firms are willing to produce and the inflation rate.

Long-run aggregate supply curve (LRAS) - Vertical at potential output, $\bar{y}$ (the level of production that an economy can sustain in the long run).

A short-run aggregate supply curve (SRAS) - can be derived from the short run Phillips curve (SRPC) by replacing the unemployment gap $(u - u^N)$ with the output gap between actual output and potential output $(y - \bar{y})$, using Okun’s Law:

\[
\text{SRPC: } \pi = \pi^e - \omega (u_t - u_t^N) \\
\text{Okun’s Law: } u_t - u_t^N = -\alpha (y - \bar{y}) \\
\text{SRAS: } \pi = \pi^e + \gamma (y_t - \bar{y})
\]
From the equation above, it is clear that the aggregate supply schedule is upward sloping in \((\pi, y)\) space, and can therefore be represented as: