Lecture 20: Aggregate Supply --
Price level $P$, Inflation $\pi$, & Wages $W$

Aggregate Demand (AD)

& Aggregate Supply (AS)
1. Ultra-Keynesian A.S. case
2. Neoclassical A.S. case
3. Intermediate A.S. curve
4. Expectations-augmented A.S. curve
5. Rational-expectations A.S.
6. Real Business Cycle models (RBC)

Appendices -- 7. Labor market rigidities.
Aggregate Demand curve slopes down.

Why? Say $P \uparrow$ (e.g., because $W \uparrow$)

$$\Rightarrow \frac{M1}{P} \downarrow \quad \text{("real balance effect")}$$

$$\Rightarrow \mathbf{LM} \text{ shifts left}$$

$$\Rightarrow Y \downarrow$$
A monetary expansion shifts AD to the right.

Or it shifts AD \textit{up}.

In proportion to $\Delta M1$.

By how much?

By the answer to IS-LM.

Equilibrium outcome ($Y$ vs. $P$) depends on AS.

By how much?
The notion of Aggregate Supply

• If demand rises too rapidly, it shows up in the price level, not output.

• In practice, the path of potential output $\bar{Y}$ is often measured by the point beyond which inflation begins to accelerate;

• and the natural rate of unemployment $\bar{u}$ is measured as the rate below which inflation begins to accelerate.
US output fell sharply below potential in 2008-09.
Inflation fell in the 2008-09 global recession.
ALTERNATIVE SUPPLY RELATIONSHIPS

All-purpose supply function: \( Y/\bar{Y} = (\omega P/W)\sigma \)

where:
- \( \bar{Y} \equiv \text{potential output} \)
- \( W \equiv \text{nominal wage} \)
- \( W/P \equiv \text{real wage} \)
- \( \omega \equiv \text{“warranted real wage”} \)
- \( \sigma \equiv \text{elasticity of aggregate supply}. \)

Can readily be derived from aggregation of supply decisions by individual firms that maximize profits and operate in competitive goods & labor markets.

Then \( \omega \equiv \text{MP of Labor at full employment} \).

(See graphs in Appendix I.)
Two polar extreme cases

1) Ultra-Keynesian case:
AS flat, at $\bar{P}$
=> AD expansion goes entirely into $Y$.
Realistic in Very Short Run.

2) Classical case
AS vertical at $\bar{Y}$
=> AD expansion goes entirely into $P$.
Realistic in Long Run.
Only AS shocks move $Y$, e.g., productivity shocks.
3) Intermediate case:

\[ W = \bar{W} \Rightarrow AS \text{ has some slope, even in the SR.} \]

SR supply relationship:

\[ \frac{Y}{\bar{Y}} = \left( \omega \frac{P}{\bar{W}} \right)^\sigma \]

Implication:
Demand expansion goes partly into \( P \), partly into \( Y \).
Monetary expansion raises AD in the SR.

- A rise in the current level of \( M \) shifts \( LM \) curve out, because \( M/P \uparrow \), in the SR.

- Alternatively, a rise in expected future growth rate of \( M \) shifts \( IS \) out, because \( \pi^e \uparrow \)
  
  \[ \Rightarrow r \downarrow \]
  
  \[ \Rightarrow A \uparrow . \]

Either way, \( IS-LM \) shifts right

\[ \Rightarrow AD \text{ shifts right:} \]

Result is higher \( Y \) and higher \( P \).
SR supply relationship: \[ \frac{Y}{\bar{Y}} = \left( \omega \frac{P}{\bar{W}} \right)^\sigma \]

4) Friedman-Phelps supply curve:

\( W \) is set in line with \( P^e \), which adjusts over time.

Yearly wage contract \( \bar{W} = \omega P^e \).

\[ \frac{Y}{\bar{Y}} = \left( \frac{P}{P^e} \right)^\sigma \]

or in logs, \[ y - \bar{y} = \sigma (\pi - \pi^e) \]

where \( \pi \equiv p - p_{-1} \)

and \( \pi^e \equiv p^e - p_{-1} \).

But over time \( \pi^e \) adjusts to actual \( \pi \), so \( Y = \bar{Y} \). In LR, AS is vertical.

SR: Point \( B \) in Figure 26.4. MR: Point \( C \). LR: Point \( D \).
Initially –
Point A.
Then monetary expansion.

SR -- Point B:
before \( W \) has had time to adjust.

MR -- Point C: \( P^e \) adjusts partway => \( W \) does too.

LR -- Point D:
\( P^e \), and so \( W \), have fully adjusted.
5) Lucas supply relationship

\[ \frac{Y}{\bar{Y}} = \left( \frac{P}{P_e} \right)^\sigma \]

or in logs,

\[ y - \bar{y} = \sigma (\pi - \pi^e) \]

\[ = \sigma \epsilon, \quad \text{where } \epsilon \text{ is the forecast error.} \]

Rational expectations => \( \epsilon \) is unforecastable.

Implications: An unpredictable demand expansion goes partly into \( P \), partly into \( Y \) in the short run; but predictable demand expansions have no effect on \( Y \).

\[ \Rightarrow \] Committing monetary policy to a nominal anchor would reduce inflation at little cost in terms of output.
If monetary policy cannot have a systematic effect on output anyway, the central bank might as well give up, and attain the only goal it can: price stability. But only if it “ties its hands” will its commitment not to inflate be credible.
Alternative Nominal Anchors

Money supply targets (e.g., monetarism in 1980s.)

Pegged price of gold (e.g., classical gold standard)

Price level target (e.g., Inflation Targeting)

Fixed exchange rate (e.g., currency board)
6. Real business cycle (RBC) theory

- \( Y = \bar{Y} \)
- \( N = \bar{N} \).

- According to this theory, all fluctuations are due to real (supply) factors:
  - technology shocks &
  - shifts in preferences for work vs. leisure.
  - Not monetary policy.
Appendix I: Derivation of general AS relationship

Appendix II: Another AS relationship

• 7. Indexed wages
  – Application: real wage rigidity in Europe, vs. US.

Appendix III: Measures of output gap

Appendix IV: An example of rational expectations
Appendix I

Employment determines output, via the production function.

And the real wage determines employment, via the demand for labor.

If a firm’s Marginal Product of Labor

\[ \frac{MPL}{W/P} \]

> \( W/P \) => hire more \( N \).

If \( MPL \) of Labor

< \( W/P \) => cut \( N \).

Sum labor demand across all firms. Then set equal to supply of labor. Determines \( w \).
An alternative approach:

The New Keynesian Phillips curve

allows firms to be imperfectly competitive, with a profit mark-up over cost, but still has $Y \uparrow \Rightarrow P \uparrow$

via firms’ demand for labor & marginal cost.
Appendix II: Labor market rigidities

Explicit wage indexation:

Examples in 1970s-80s --
- US: Cost of Living Adjustment clauses
- Italy: scala mobile
- Argentina: complete indexation of everything

Implicit real wage rigidity:

Example -- thought to characterize Europe.

\[
\frac{Y}{\bar{Y}} = (w \frac{P}{W})^\sigma, \quad \text{where } \bar{Y} \text{ is potential output,}
\]
\[
W \text{ is the nominal wage,}
\]
\[
\frac{W}{P} \text{ is the real wage,}
\]
and \( w \) is the "warranted" real wage.

7. **INDEXED-WAGES MODEL**

When \( W \) indexed to price of domestic product:

\[
W = \bar{w}P, \text{ by contract;}
\]

where \( \bar{w} \) is the "targeted" real wage

\[
=> \quad \frac{Y}{\bar{Y}} = (w \frac{P}{\bar{w} P})^\sigma = (w / \bar{w})^\sigma.
\]

**Implications:**
Demand expansion goes entirely into \( P \), no effect on \( Y \).
But if an adverse supply shock reduces warranted \( W/P \), and \( w \) is frozen at wrong level, then \( Y \) falls below potential, and demand policy can’t help.
If actual real wage $\bar{W} >$ warranted real wage $\omega$,

- $Y < \bar{Y}$ permanently.

- Growth in demand will not show up in increased employment.  
  - because it is “classical unemployment,” not Keynesian unemployment.

- E.g., comparison of US vs. Europe:
  - In the 1970s the upward trend of warranted $w$ slowed sharply
    - $\leq$ productivity slowdown $\leq$ oil shocks.
  - In the US, employment continued to rise, but real $w$ did not;
    - in Europe, real $\bar{w}$ continued to rise, but employment did not.
In the 1970s & 80s, the upward trend of warranted $w$ slowed employment rose in US, while real wage contracts rose in Europe.

1. Total compensation per employee deflated by the GDP deflator.
Source: CEPII Economic Outlook database.
One view: Europeans prefer job security; Americans prefer job growth.

The Netherlands may have found a “middle way.”
“Labor market rigidities” in Europe go beyond sticky real wages; They include also, e.g., laws against laying off workers, which discourage hiring.

One view of the divergence between Germany & Greece: Labor market reforms enacted by Gerhard Schröder 2003-05 improved labor market efficiency.

Employment Protection Legislation often does not raise overall employment. If anything, the reverse.

Source: Giuseppe Bertola (2001)
Appendix III: Measures of output gap

Three measures of excess supply tend to move together.

Sources: OECD, Economic Outlook; and IMF staff estimates.

1Estimates of the nonaccelerating inflation rate of unemployment (NAIRU) come from the OECD. Estimates of the output gap, expressed as a percent of potential GDP, are based on IMF staff calculations. Capacity utilization measured as deviations from 1980–2006 averages for the United States (percent of total capacity) and Japan (operation rate index for manufacturing
Inflation turned negative in 1930-33, along with the output gap, and again in 1938-39.
Jobs vary with GDP though usually less-than-proportionately, in practice.

Real GDP and total employment growth since the onset of the crisis, 2008-2013

Appendix IV
An example of rational expectations:

Mexican sexenio

From 1976 through 1994, inflation would shoot up and/or the peso would devalue, every 6th year (presidential election years).