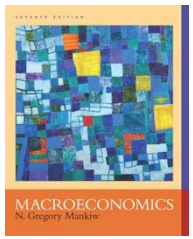
Business Conditions Analysis

ECON 736

Professor Yamin Ahmad

Lecture 6:

- Theories of Aggregate Supply
- Phillips Curve
- Expectations
- Policy Ineffectiveness Proposition



Key Concepts…

- Aggregate Supply in the long run
- Four models of Aggregate Supply in which output depends positively on the price level in the short run
- The short run tradeoff between inflation and unemployment known as the Phillips Curve
- Policy Effectiveness Proposition

Note: These lecture notes are incomplete without having attended lectures

Production Decisions

- Regardless of the long run or the short run, firms want to maximize profits
  - Profits: Revenue – Costs
  - Chooses labor and capital
- Short Run:
  - Certain factors of production are fixed, e.g. $\overline{K}, \overline{Z}$
  - Wages and/or prices may be fixed
- Long Run:
  - All factors of production are flexible
  - Wages and prices are flexible

Note: These lecture notes are incomplete without having attended lectures

Focus: The Labor Market

Labor Demand

- Competitive Firms maximize profits

$$= PF\left(L;\overline{K}\right) - WL$$

$$\Rightarrow PF_L\left(L^d;\overline{K}\right) = W$$

$$\Rightarrow L^d = L^d\left(\frac{W}{P};\overline{K}\right)$$

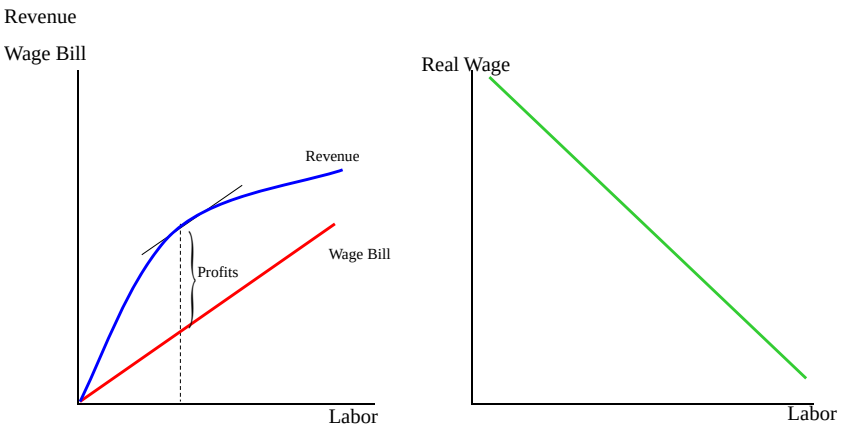
$$(-) \quad (+)$$

Note: These lecture notes are incomplete without having attended lectures

Example: Deriving labor demand

- Suppose that $Y = F\left(\bar{K}, L, \bar{Z}\right) = ZK^{\frac{1}{3}}L^{\frac{2}{3}}$ where Z=1
- Profit maximization involves: $\max_{L} PF\left(\bar{K}, L\right) - WL$
- How do we find the "correct" amount of labor to hire that will maximize profits?
  - Intuition is as follows (next slide)

Labor Demand

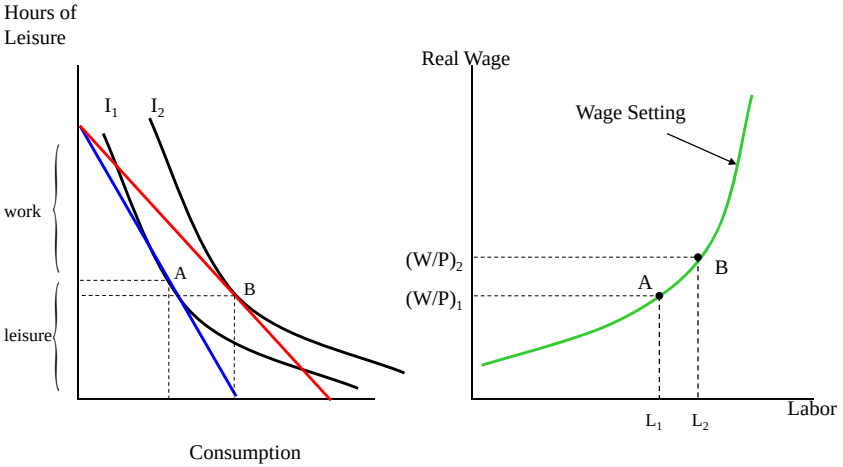


Labor Supply

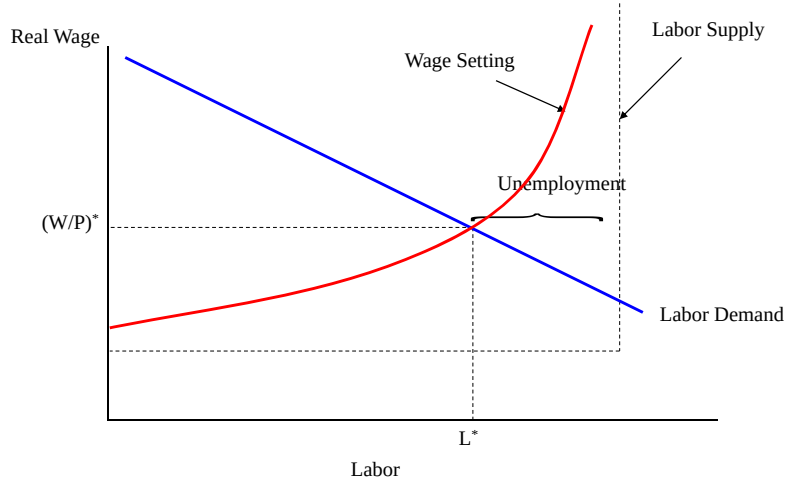
Household Problem

- Choice for households is to allocate time between labor and leisure: $\max_{C,L} U(C, L)$
- Worker derives utility from leisure
- However, disutility of labor yields a wage that the worker can use to purchase goods and services
  - Thus labor supply is positively related to the real wage: $L^S = L\left(\frac{W}{P}\right)$ $(+)$

Wage Setting



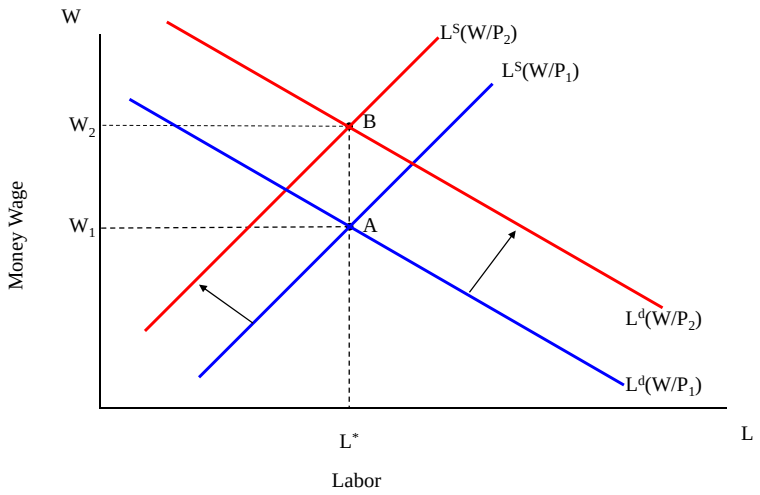
Labor Market Equilibrium



Labor Market Clearing

- In equilibrium, $L^s = L^d = L^*$
- Continuing our example, we can see that $L^* = f\left(\bar{K}\right)$, i.e. L* =
- Long run (classical) output, is thus determined as:
  $Y = F\left(\bar{K}, L^*\right) = K^{\frac{1}{3}} L^{*\frac{2}{3}}$
- Note that output is independent of prices in the long run.

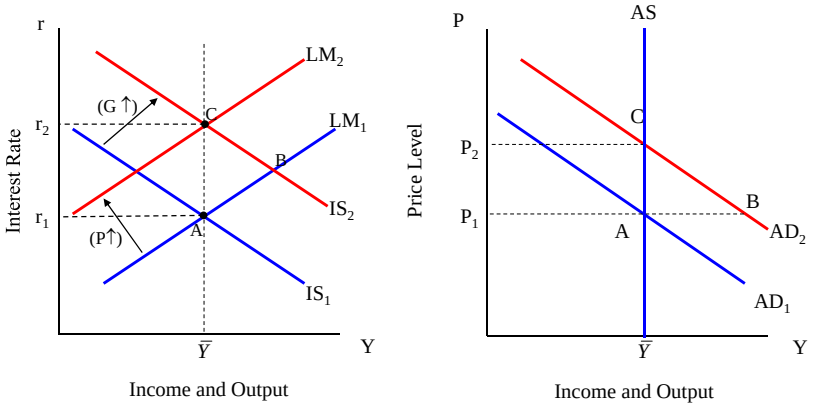
Classical Supply



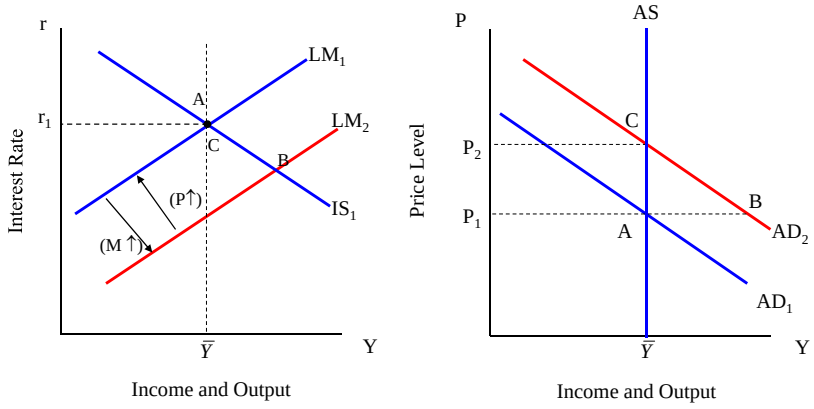
Equilibrium with Flexible Prices

- Disturbances to the demand for goods (e.g. a change in G or T) are fully offset by a change in the interest rate ("real crowding out").
- Disturbances to the demand for, or supply of, money are completely offset by a change in the price level. Money is said to be neutral.
- Real variables are independent of nominal ones. This is known as the Classical Dichotomy.

Goods Market Disturbance



Money Market Disturbance



Models of Aggregate Supply

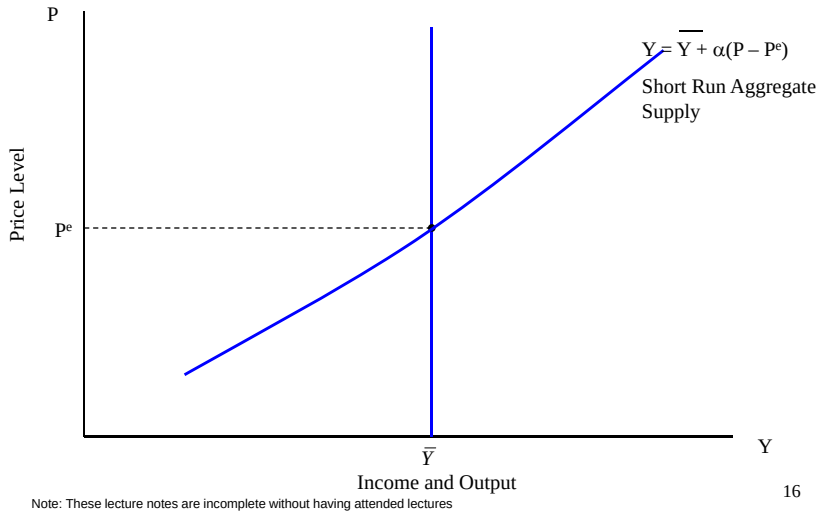
1. The Sticky-Wage model (Traditional Keynesian)
2. Worker Misperceptions model (Friedman, Phelps)
3. The Imperfect-Information model (Lucas)
4. The Sticky-Price model ("New Keynesian", "New Neoclassical")

All these models imply:

$$Y = \overline{Y} + \alpha(P - P^e)$$

- Y: agg. output
- $\overline{Y}$: natural rate of output
- α: a positive parameter
- P: the actual price level
- P^e: the expected price level

The Short Run Aggregate Supply Curve



The Sticky-Wage model

- Assumes that firms and workers negotiate contracts and fix the nominal wage before they know what the price level will turn out to be.
- The nominal wage they set is the product of a target real wage and the expected price level:

$$W = \omega \times P^e$$

Target real wage

$$\Rightarrow \frac{W}{P} = \omega \times \frac{P^e}{P}$$

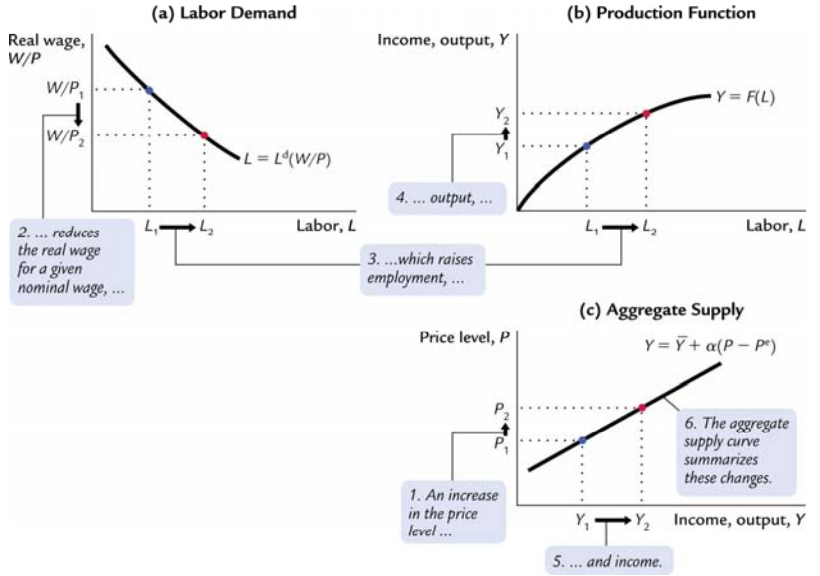
The Sticky-Wage model

$$\frac{W}{P} = \omega \times \frac{P^e}{P}$$

If it turns out that	then
$P = P^e$	Unemployment and output are at their natural rates.
$P > P^e$	Real wage is less than its target, so firms hire more workers and output rises above its natural rate.
$P < P^e$	Real wage exceeds its target, so firms hire fewer workers and output falls below its natural rate.

The Sticky-Wage model

- Labor Demand: $L^d = L^d\left(\frac{W}{P}; \bar{K}\right)$ (−) (+)
- Labor Supply/ Wage Setting: $L^S = L^S\left(\frac{W}{P}\right)$ (+)
- Negotiation costs ⇒ money wage set infrequently. Let ω be expected equilibrium real wage. Then money wage set so that $W = \omega P^e$
- $L = L\left(\frac{\bar{W}}{P}; \bar{K}\right) = L^d\left(\omega\frac{P^e}{P}; \bar{K}\right) \Rightarrow Y^S = F\left(L^d; \bar{K}\right) = Y^S\left(\frac{P}{P^e}; \bar{K}\right)$ (+) (+)

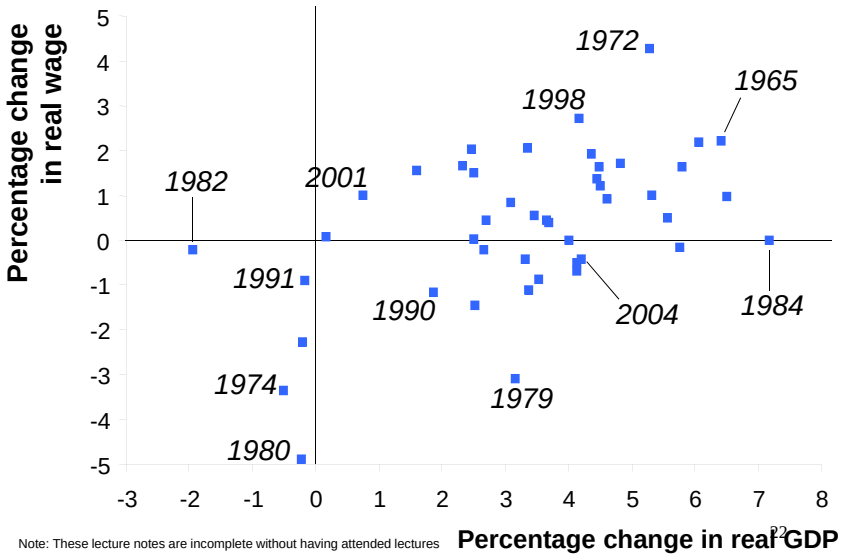


The Sticky-Wage model

- Implies that the real wage should be ***counter-cyclical***, should move in the opposite direction as output during business cycles:
  - In booms, when ***P*** typically rises, real wage should fall.
  - In recessions, when ***P*** typically falls, real wage should rise.

- This prediction does not come true in the real world:

The cyclical behavior of the real wage



Worker Misperceptions Model

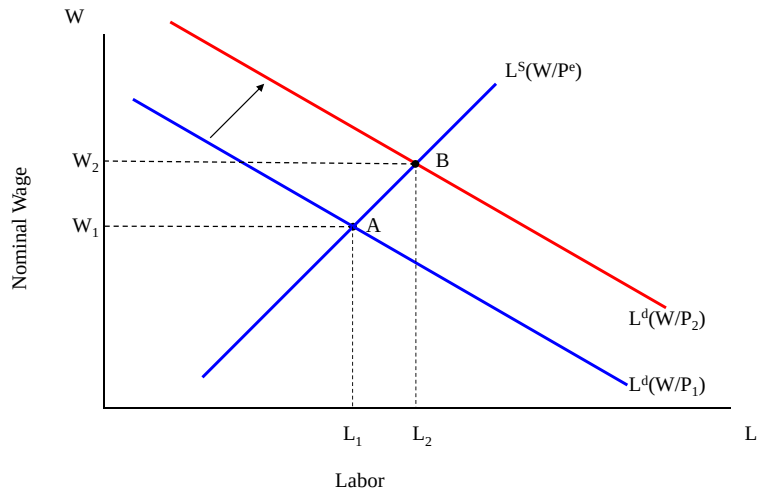
- Similar to sticky wage model but:
  - i. money (nominal) wage flexible (market clearing);
  - ii. workers have incomplete information about general price level $\Rightarrow L = L^S(W/P^e)$

- Labor Market Equilibrium $\Rightarrow$ $L^S = L^d = L$, so:

- $$L = L^S\left[\left(\frac{W}{P}\right)\left(\frac{P}{P^e}\right)\right] = L^s\left[\frac{\partial F\left(\bar{K}, L\right)}{\partial L}\cdot\left(\frac{P}{P^e}\right)\right]$$

$$\Rightarrow L = f\underset{(+)}{\left(\frac{P}{P^e}\underset{(+)}{;}\bar{K}\right)} \Rightarrow Y^S = F\left(L, \bar{K}\right) = Y^s\left(\frac{P}{P^e}\underset{(+)}{;}\bar{K}\right)$$

Worker Misperceptions Model



The Imperfect-Information model

Assumptions

- All wages and prices are perfectly flexible, all markets are clear.
- Each supplier produces one good, consumes many goods.
- Each supplier knows the nominal price of the good she produces, but does not know the overall price level.
- Supplier does not know price level at the time she makes her production decision, so uses the expected price level, P^e.

The Imperfect-Information model

- Similar to worker misperception model, but people use local market conditions to make inferences about aggregate prices.
- General Price Level: $P = P^e + u$ (u random)
- Local Price Level : $P_i = P + v_i$ (v_i random)
- Worker-firm pair : $Y_i^S = \bar{Y}_i^S + \alpha\left(P_i - P_+^e\right)$

  where $P_+^e \equiv$ best guess of P given P^e and P_i.

The Imperfect-Information model

- Suppose P rises but P^e does not.
  - Supplier thinks her relative price has risen, so she produces more.
  - With many producers thinking this way, Y will rise whenever P rises above P^e.
- So slope of Aggregate Supply curve also depends on the informativeness of the price mechanism. If aggregate demand is very variable, e.g. because of erratic policy, the AS will be very steep because θ is small.

The Imperfect-Information model

How Do Agents Form Price Expectations?

- Suppose that the best guess of the aggregate price level is a weighted average of what suppliers believe aggregate prices to be and what they observe about prices in their own market, i.e.
  - Using a result from statistics: $P_+^e = \theta P^e + (1-\theta) P_i$

    where $\theta = \dfrac{Var(v_i)}{Var(v_i) + Var(u)} = \dfrac{\sigma_{v_i}^2}{\sigma_{v_i}^2 + \sigma_u^2}$
- Hence: $Y_i^S = \bar{Y}_i^S + \alpha\theta\left(P_i - P^e\right)$
- In aggregate: $Y^S = \bar{Y}^S + \beta\left(P - P^e\right)$ where $\beta = \alpha\theta$

The Sticky-Price model

- Like the Sticky Wage Model, but now prices are pre-set.

- Firm side:-
  - Monopolistic Competition: produce differentiated products
  - Fraction of firms can reset their prices (Calvo, Taylor)
  - Firms set price as a markup over marginal cost
  - All goods 'bundled' into one product through an 'Aggregator'

- Consumer side:-
  - Consumers purchase units of 'bundled' goods
  - Maximize utility

The Sticky-Price model

- Reasons for sticky prices:
  - long-term contracts between firms and customers
  - menu costs
  - firms not wishing to annoy customers with frequent price changes

- Key Assumptions:
  - Firms set their own prices as a markup over marginal costs (*e.g.*, as with monopolies).
  - Only a fraction of firms can reoptimize their price

The Sticky-Price model

- An individual firm's desired price is

$$p = P + a(Y - \bar{Y})$$

where $a > 0$.

Suppose two types of firms:

- firms with flexible prices, set prices as above
- firms with sticky prices, must set their price before they know how P and Y will turn out:

$$p = P^e + a(Y^e - \bar{Y}^e)$$

The Sticky-Price model

$$p = P^e + a(Y^e - \bar{Y}^e)$$

- Assume sticky price firms expect that output will equal its natural rate. Then,

$$p = P^e$$

- To derive the aggregate supply curve, we first find an expression for the overall price level.
- Let s denote the fraction of firms with sticky prices. Then, we can write the overall price level as…

The Sticky-Price model

$$P = s P^e + (1-s)[P + a(Y - \bar{Y})]$$

price set by sticky price firms

price set by flexible price firms

- Subtract $(1-s)P$ from both sides:

$$sP = s P^e + (1-s)[a(Y - \bar{Y})]$$

- Divide both sides by s :

$$P = P^e + \left[\frac{(1-s)a}{s}\right](Y - \bar{Y})$$

The Sticky-Price model

$$P = P^e + \left[\frac{(1-s)a}{s}\right](Y - \bar{Y})$$

- High $P^e \Rightarrow$ High P
  If firms expect high prices, then firms that must set prices in advance will set them high.
  Other firms respond by setting high prices.

- High $Y \Rightarrow$ High P
  When income is high, the demand for goods is high.
  Firms with flexible prices set high prices.
  The greater the fraction of flexible price firms, the smaller is s and the bigger is the effect of ΔY on P.

The Sticky-Price model

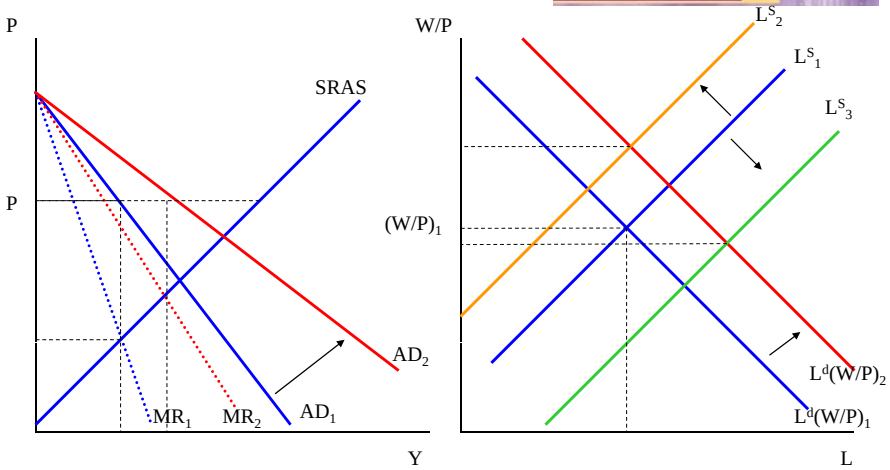
$$P = P^e + \left[\frac{(1-s)a}{s}\right](Y - \bar{Y})$$

- Finally, derive *AS* equation by solving for Y:

$$Y = \bar{Y} + \alpha(P - P^e),$$

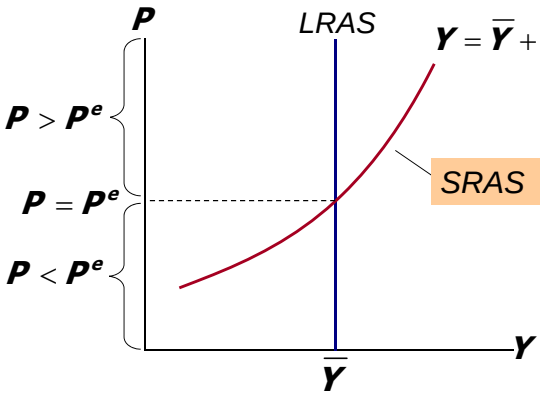
$$\text{where } \alpha = \frac{s}{(1-s)a}$$

- Note: Slope of Aggregate Supply curve now depends on fraction of firms with pre-set prices.



- If substitution effect dominates, labor supply shifts L^S_1 to L^S_2
- If income effect dominates, labor supply shifts L^S_1 to L^S_3

Summary & Implications



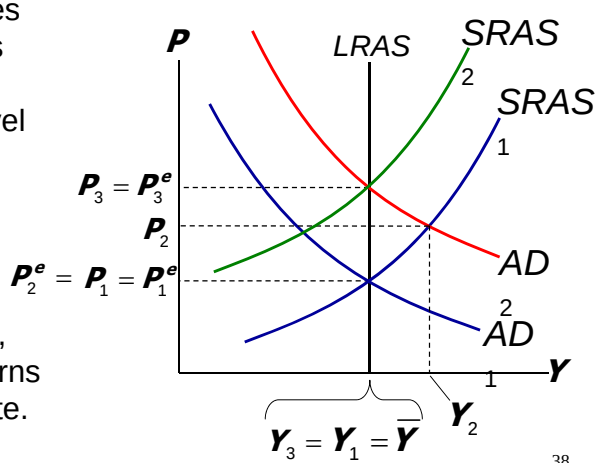
Each of the models of Agg. supply imply the relationship summarized by the *SRAS* curve & equation.

Summary & Implications

SRAS equation: $Y = \bar{Y} + \alpha(P - P^e)$

Suppose a positive *AD* shock moves output above its natural rate and P above the level people had expected.

Over time, P^e rises, *SRAS* shifts up, and output returns to its natural rate.

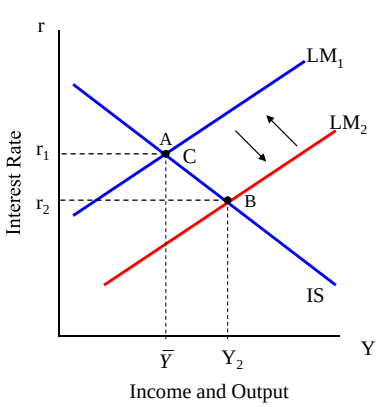


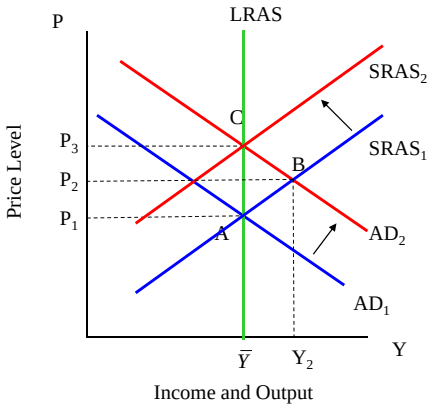
Summary of Model Implications For Real Wage

Model	Market Clearing?	Effect of AD on Real Wage?
Sticky Wage	No	Countercyclical
Worker Misperception	Yes	Countercyclical
Imperfect Information	Yes	Countercyclical
Sticky Price	No	Pro- or Countercyclical

Putting it all together…

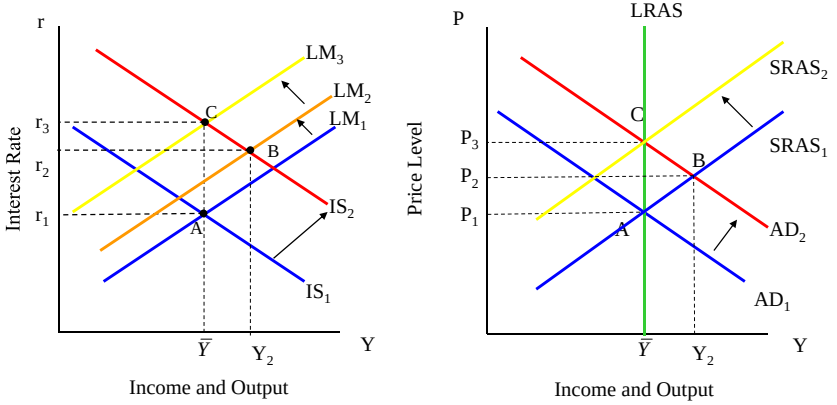
Monetary Expansion





Putting it all together…

Fiscal Expansion



And now …

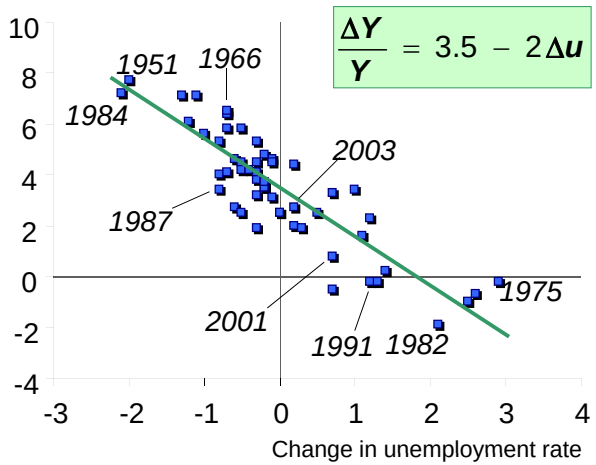
INFLATION, UNEMPLOYMENT AND THE PHILLIPS CURVE

Inflation, Unemployment, and the Phillips Curve

- Governments (and society in general) care about inflation, π, and unemployment, u, not prices, P, and output, Y.
- To go from prices to inflation is fairly straightforward!
  - Just calculate the percentage change in prices.
- To go from output to inflation, we need Okun's Law, which highlights this tradeoff.

Okun's Law

- **Okun's Law**: the negative relationship between GDP and unemployment.



Inflation, Unemployment, and the Phillips Curve

- Aggregate Supply: $Y_t = \bar{Y}_t + \alpha\left(P_t - P_t^e\right)$

$$= \bar{Y}_t + \alpha\left[P_{t-1}\left(1+\pi_t\right) - P_{t-1}\left(1+\pi_t^e\right)\right]$$

$$= \bar{Y}_t + \tilde{\alpha}\left(\pi_t - \pi_t^e\right)$$

- Okun's Law :

$$-\beta\left(u - u^n\right) = \left(\frac{1}{\tilde{\alpha}}\right)\left(Y - \bar{Y}\right)$$

- So the Phillips Curve is just an alternative way of describing the Aggregate Supply Curve.

$\Rightarrow$ Phillips Curve: $\pi_t = \pi_t^e - \beta\left(u_t - u_t^n\right)$

$\Rightarrow$ with shock: $\pi_t = \pi_t^e - \beta\left(u_t - u_t^n\right) + \nu_t$

Inflation, Unemployment, and the Phillips Curve

The **Phillips curve** states that π depends on

- expected inflation, π^e.
- **cyclical unemployment**: the deviation of the actual rate of unemployment from the natural rate
- supply shocks, ν (Greek letter "nu").

$$\pi = \pi^e - \beta(u - u^n) + \nu$$

where $\beta > 0$ is an exogenous constant.

The Phillips Curve and *SRAS*

SRAS: $Y = \bar{Y} + \alpha(P - P^e)$

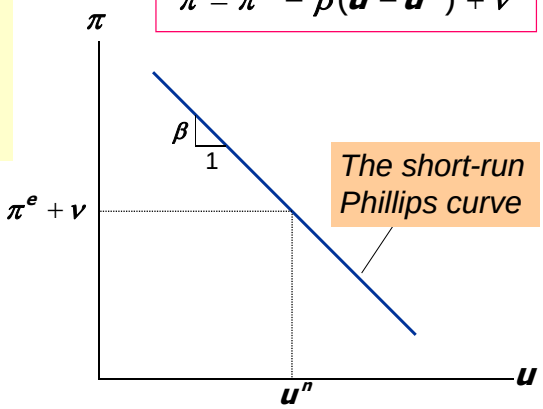
Phillips curve: $\pi = \pi^e - \beta(u - u^n) + \nu$

- *SRAS* curve:
  Output is related to unexpected movements in the price level.
- Phillips curve:
  Unemployment is related to unexpected movements in the inflation rate.

Graphing the Phillips curve

In the short run, policymakers face a tradeoff between π and u.

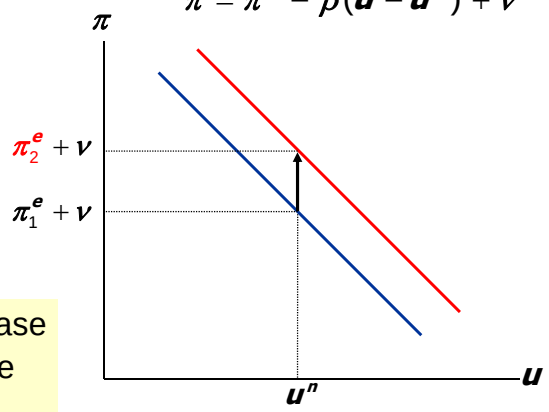
$\pi = \pi^e - \beta(u - u^n) + \nu$



Shifting the Phillips curve

People adjust their expectations over time, so the tradeoff only holds in the short run.

$$\pi = \pi^e - \beta(u - u^n) + v$$



E.g., an increase in π^e shifts the short-run P.C. upward.

Two causes of rising & falling inflation

$$\pi_t = \pi_t^e - \beta(u_t - u_t^n) + v_t$$

- **cost-push inflation**: inflation resulting from supply shocks

  Adverse supply shocks typically raise production costs and induce firms to raise prices, "pushing" inflation up.

- **demand-pull inflation**: inflation resulting from demand shocks

  Positive shocks to aggregate demand cause unemployment to fall below its natural rate, which "pulls" the inflation rate up.

Key Question: How are Expectations Formed?

Phillips curve: $\pi = \pi^e - \beta(u - u^n) + v$

We will look at two types:

- Adaptive Expectations
- Rational Expectations

Adaptive expectations

- **Adaptive expectations**: an approach that assumes people form their expectations of future inflation based on recently observed inflation.
- A simple example:
  Expected inflation = last year's actual inflation

  $$\pi^e = \pi_{-1}$$
- Then, the P.C. becomes

  $$\pi = \pi_{-1} - \beta(u - u^n) + v$$

Inflation Inertia

$$\pi = \pi_{-1} - \beta(u - u^n) + v$$

In this form, the Phillips curve implies that inflation has inertia:

- In the absence of supply shocks or cyclical unemployment, inflation will continue indefinitely at its current rate.
- Past inflation influences expectations of current inflation, which in turn influences the wages & prices that people set.

The Sacrifice Ratio

- To reduce inflation, policymakers can contract Aggregate Demand, causing unemployment to rise above the natural rate.
- The **sacrifice ratio** measures the percentage of a year's real GDP that must be foregone to reduce inflation by 1 percentage point.
- A typical estimate of the ratio is 5 in the US.
- [For UK, a 1% reduction in output for one year lowers inflation by about ¼% point.]

The Sacrifice Ratio

- Example: To reduce inflation from 6 to 2 percent, must sacrifice 20 percent of one year's GDP:

  GDP loss = (inflation reduction) x (sacrifice ratio)
  = 4 x 5

- This loss could be incurred in one year or spread over several years, *e.g.*, 5% loss for each of four years.
- The cost of disinflation is lost GDP.
  One could use Okun's law to translate this cost into unemployment.

Rational Expectations

Ways of modeling the formation of expectations:

- **Adaptive expectations**:
  People base their expectations of future inflation on recently observed inflation.
- **Rational expectations**:
  People base their expectations on all available information, including information about current and prospective future policies.

Rational Expectations

- Rational Expectations (Muth): People use available information efficiently, including how the economy works.
- In practice this boils down to assuming agents use the same model of the economy as the researcher ("model-consistent" expectations).
- People can make mistakes, but they do not make systematic forecasting errors.
- With rational expectations disinflation is painless: (credible) announcement $\pi\downarrow \Rightarrow \pi^e\downarrow$

Painless disinflation?

- Proponents of rational expectations believe that the sacrifice ratio may be very small:
- Suppose $u = u^n$ and $\pi = \pi^e = 6\%$, and suppose the Fed announces that it will do whatever is necessary to reduce inflation from 6 to 2 percent as soon as possible.
- If the announcement is credible, then π^e will fall, perhaps by the full 4 points.
- Then, π can fall without an increase in u.

Calculating the sacrifice ratio for the Volcker disinflation

- 1981: $\pi = 9.7\%$
  1985: $\pi = 3.0\%$
  } Total disinflation = 6.7%

year	u	u^n	$u-u^n$
1982	9.5%	6.0%	3.5%
1983	9.5	6.0	3.5
1984	7.4	6.0	1.4
1985	7.1	6.0	1.1
		Total	9.5%

Calculating the sacrifice ratio for the Volcker disinflation

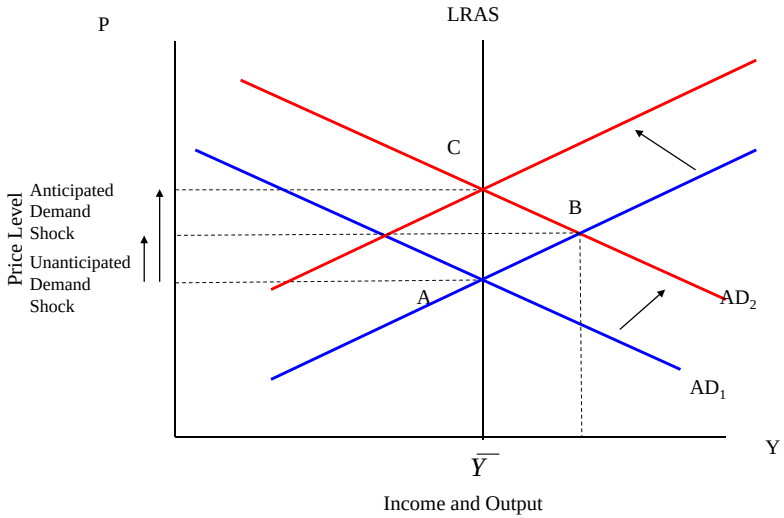
- From previous slide: Inflation fell by 6.7%, total cyclical unemployment was 9.5%.
- Okun's law: 1% of unemployment = 2% of lost output.
- So, 9.5% cyclical unemployment = 19.0% of a year's real GDP.
- **Sacrifice ratio** = (lost GDP)/(total disinflation) = 19/6.7 = 2.8 percentage points of GDP were lost for each 1 percentage point reduction in inflation.

Policy Ineffectiveness Proposition

- Rational Expectations + "Surprise" supply function + Market Clearing + Symmetric Information ⇒

  Policy Ineffectiveness Proposition (Lucas, Sargent-Wallace): Only unanticipated policy matters ⇒ no role for stabilization policy.

- To get a role for policy *either*:
  (i) the government must have superior information; or
  (ii) agents must be locked into old contracts as in non-market clearing models.



No Price/Wage Adjustment?

Why might wages/prices not adjust?

1. "Menu" costs of changing prices;
2. Staggering of wage and price changes;
3. Co-ordination failure and multiple equilibria.

All of these explanations require some form of market imperfection.

Summary

1. Four models of aggregate supply in the short run:
   - sticky-wage model
   - worker misperceptions model
   - imperfect-information model
   - sticky-price model

All three models imply that output rises above its natural rate when the price level rises above the expected price level.

Summary

2. Phillips curve

- derived from the SRAS curve
- states that inflation depends on
  - expected inflation
  - cyclical unemployment
  - supply shocks
- presents policymakers with a short-run tradeoff between inflation and unemployment

Summary

3. How people form expectations of inflation

- Adaptive Expectations
  - based on recently observed inflation
  - implies "inertia"
- Rational Expectations
  - based on all available information
  - implies that disinflation may be painless

Summary

4. Policy Ineffectiveness Proposition

- With Rational Expectations, the expectations augmented supply curve, market clearing and symmetric information
  - There is no role for stabilization policy; only unanticipated policy matters
- Must have either:
  - Some agent has superior information
  - Workers/Agents locked into contracts

Summary

5. Reasons for wages/prices not to adjust:

- Menu Costs
- Staggering of wages and prices
- Coordination Failure and Multiple Equilibria