



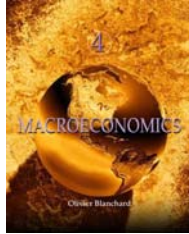
# Business Conditions Analysis

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
- Three models of Aggregate Supply in which output depends positively on the price level in the short run
- About the short-run tradeoff between inflation and unemployment known as the Phillips curve

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# Aggregate Supply in the “Long” Run

## Labor Demand

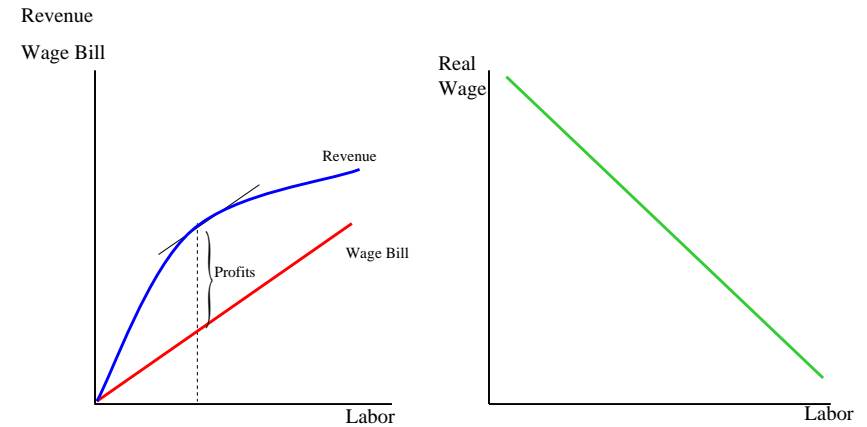
- Competitive Firms maximize profits

$$\begin{aligned}
 &= PF(L; \bar{K}) - WL \\
 \Rightarrow &PF_L(L^d; \bar{K}) = W \\
 \Rightarrow &L^d = L^d\left(\frac{W}{P}; \bar{K}\right) \\
 &\quad (-) \quad (+)
 \end{aligned}$$

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# Labor Demand



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## Labor Supply/ Wage setting

$$L^S = L^S(W/P)_{(+)}$$

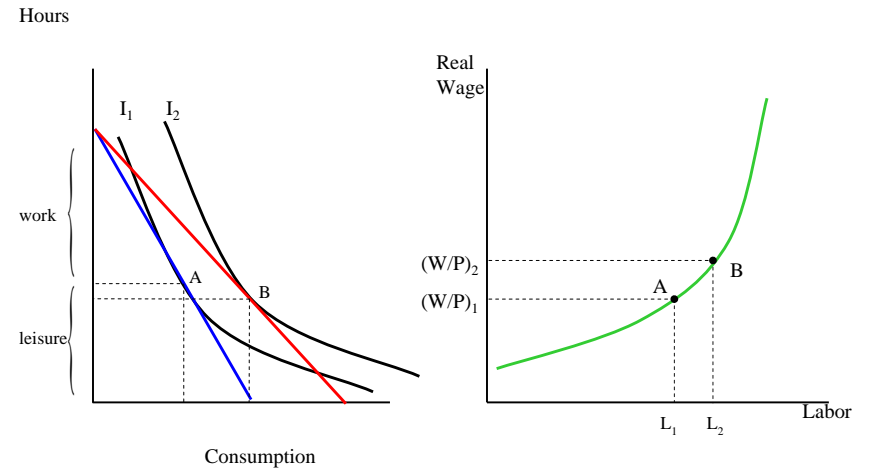
1. Competitive labor supply;
2. “Efficiency” wages; high wages raise productivity by preventing shirking, reducing quits etc.
3. Ability of Trade Unions to push wages above market clearing levels.

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## Competitive Labor Supply

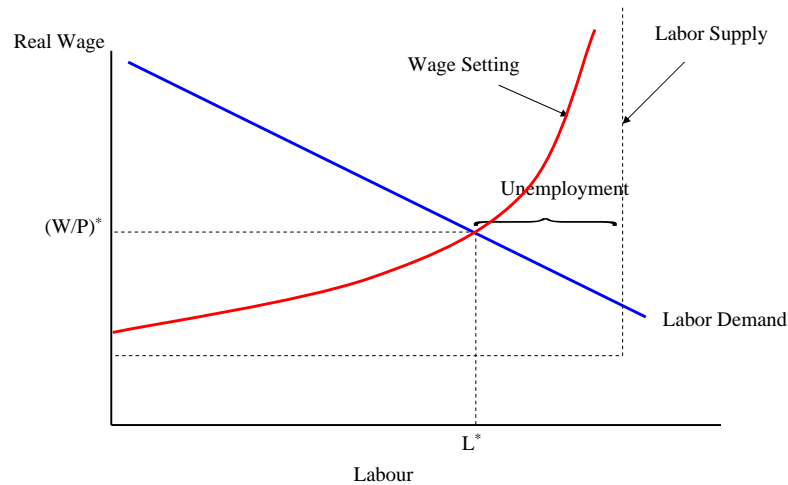


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## Wage Setting



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- Equilibrium  $\Rightarrow L^S = L^d = L^*$
- $L^*$  solves  $L^* = L^S[F_L(L^*; \bar{K})] \Rightarrow L^* = f(\bar{K})_{(+)}$
- Long Run (Classical) Supply:  

$$Y = F(L^*; \bar{K}) = F(f(\bar{K}); \bar{K}) = Y^S(\bar{K}) \equiv \bar{Y}_{(+)}$$

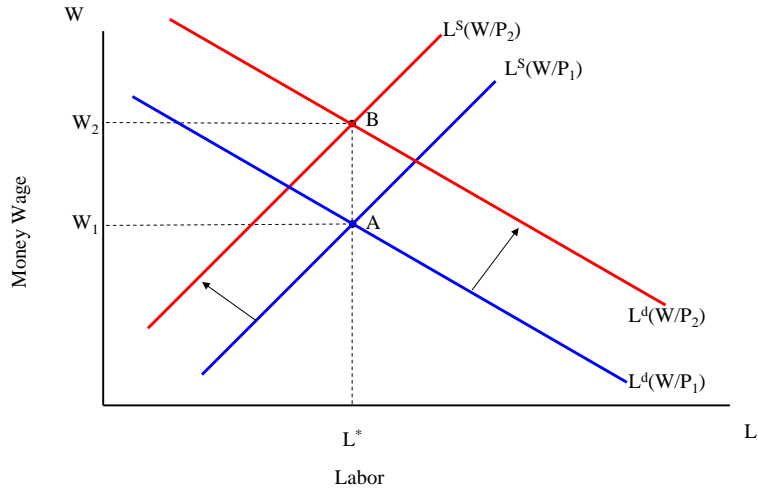
Note that  $\bar{Y}$  is independent of P.

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### Classical Supply



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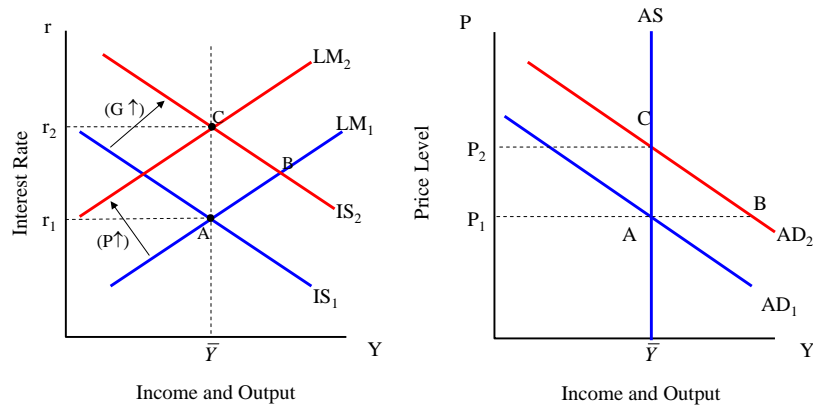
### Equilibrium with Flexible Prices

- 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**.

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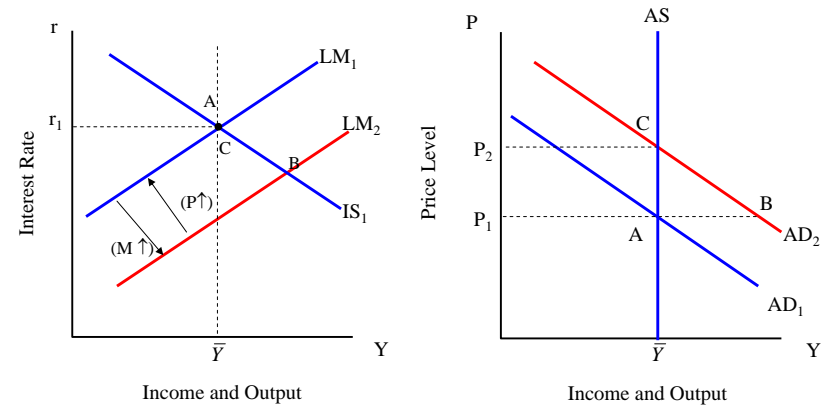
### Goods Market Disturbance



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### Money Market Disturbance



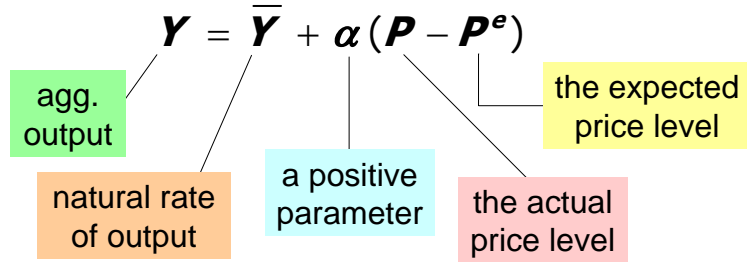
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## Models of Aggregate Supply

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”)

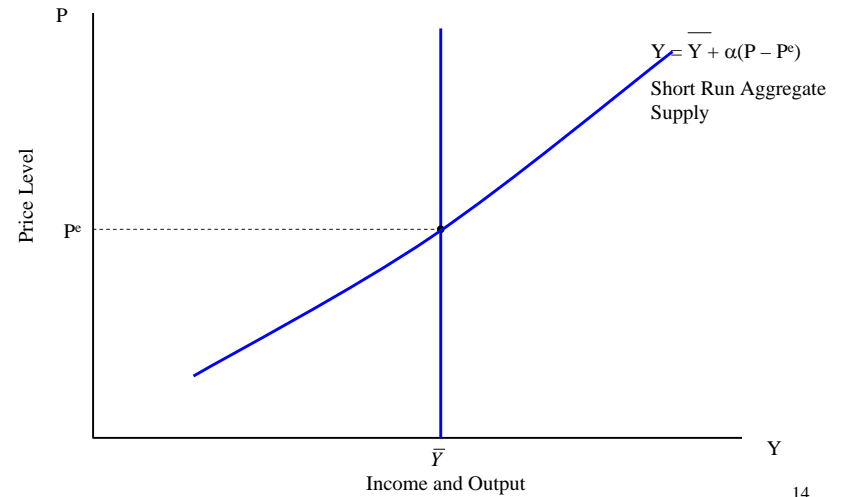
All these models imply:



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## The Short Run Aggregate Supply Curve



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## 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:

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

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

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## 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.

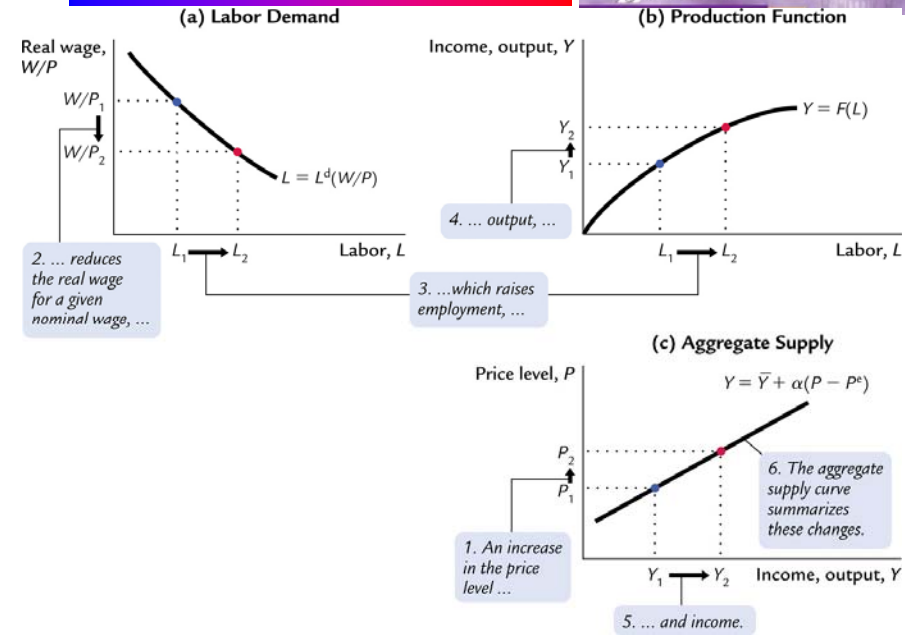
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## The Sticky-Wage model

- Labor Demand:  $L^d = L^d(W/P; K)$
- Labor Supply/ Wage Setting:  $L^S = L^S(W/P)$
- Negotiation costs  $\Rightarrow$  money wage set infrequently. Let  $\omega$  be expected equilibrium **real** wage. Then money wage set so that  $W = \omega P^e$ .

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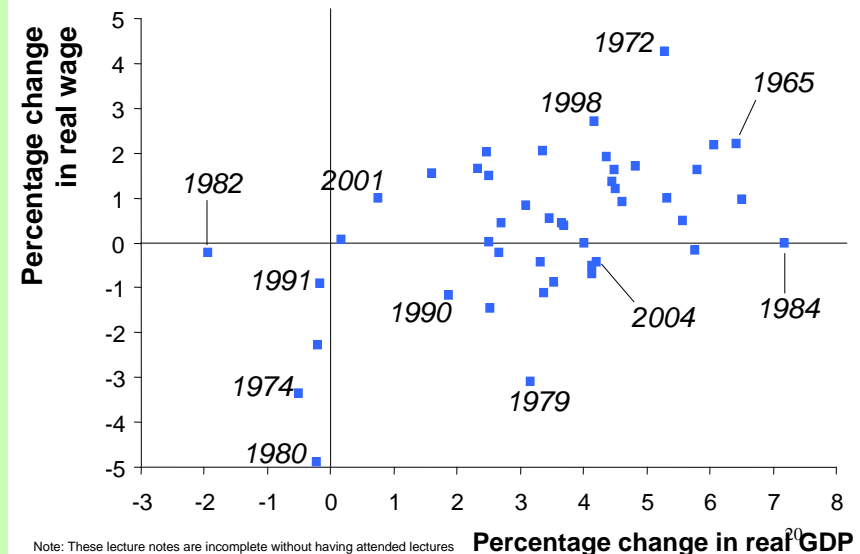
## The Sticky-Wage model

- 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:

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## The cyclical behavior of the real wage



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## Worker Misperceptions Model

- Similar to sticky wage model but:
  - (i) money 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:

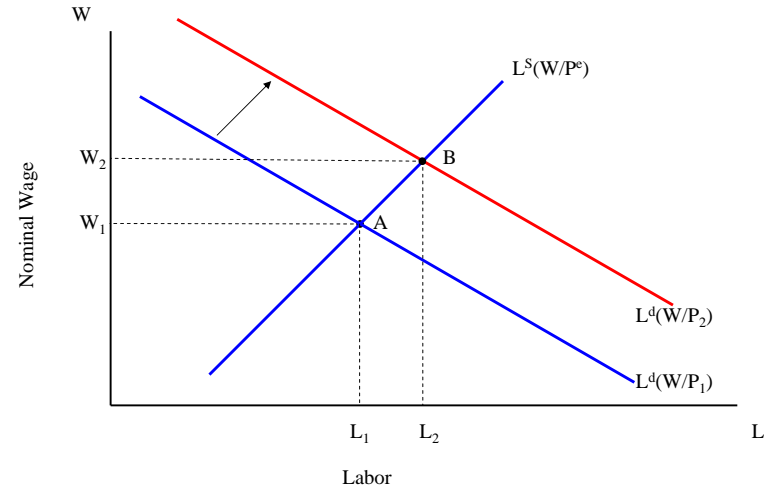
$$L = L^S[(W/P)(P/P^e)] = L^S[F_L(\bar{L}, \bar{K})(P/P^e)]$$

$$\Rightarrow L = f(P/P^e; \bar{K}) \Rightarrow Y^S = F(L; \bar{K}) = Y^S(P/P^e; \bar{K})$$

(+)
(+)
(+)
(+)



## 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 :  $Y^S_i = \bar{Y}^S_i + \alpha(P_i - P_+^e)$
- where  $P_+^e \equiv$  best guess of  $P$  given  $P^e$  and  $P_i$ .



## The Imperfect-Information model

- Using a result from statistics:  $P_i^e = \theta P^e + (1 - \theta)P_i$

where  $\theta \equiv \text{Var}(v_i) / (\text{Var}(v_i) + \text{Var}(u))$

Hence:  $Y_i^s = \bar{Y}_i^s + \alpha\theta(P_i - P^e)$

In aggregate:  $Y^s = \bar{Y}^s + \alpha\theta(P - P^e)$



## 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  $\theta$  is small.



## 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

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

price set by sticky price firms

price set by flexible price firms

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

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

- 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  $\Delta Y$  on  $P$ .



### The Sticky-Price model

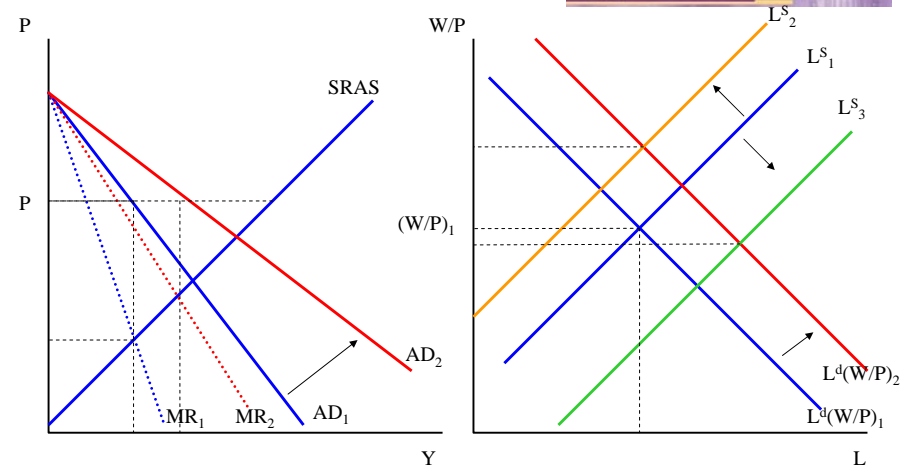
$$P = P^e + \left[ \frac{(1-s)a}{s} \right] (Y - \bar{Y})$$

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

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

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

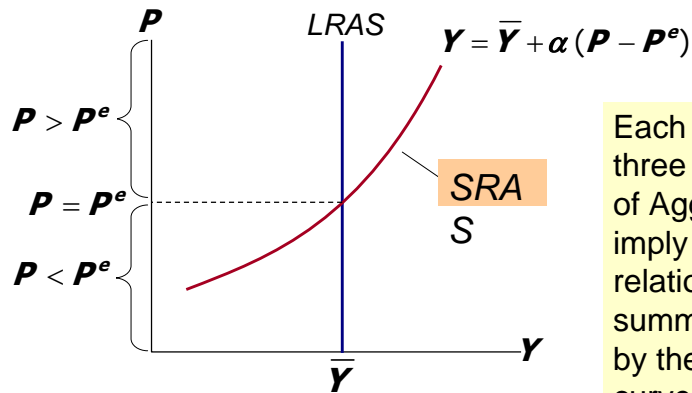
- Note: Slope of Aggregate Supply curve now depends on fraction of firms with pre-set prices.



- 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 three models of Agg. supply imply the relationship summarized by the SRAS curve & equation.

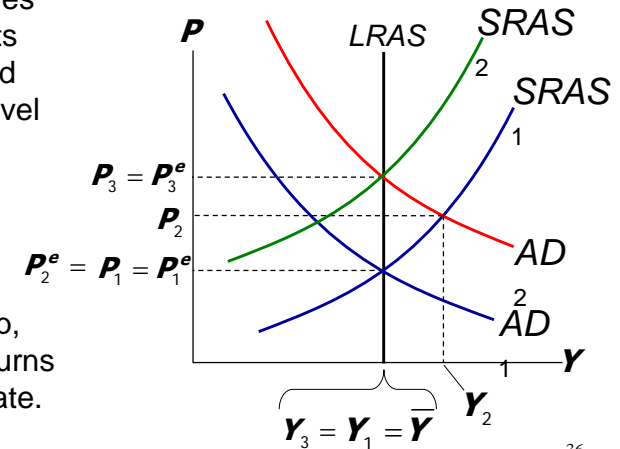


### Summary & Implications

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

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

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





### Summary of Model Implications For Real Wage

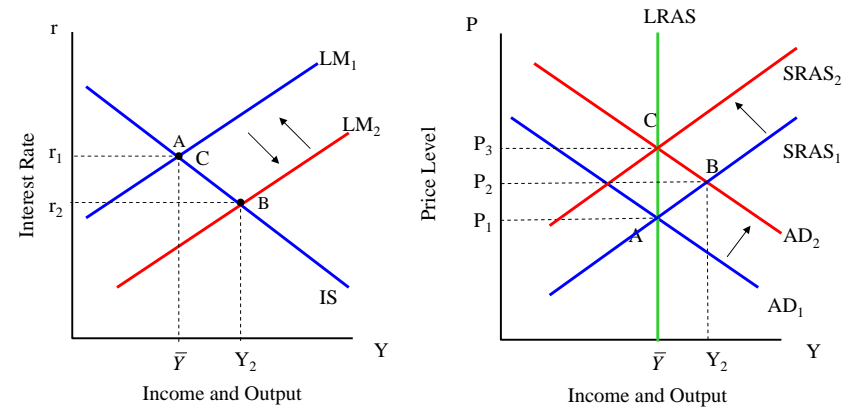
| Model                 | Market Clearing? | Effect of AD on Real Wage? |
|-----------------------|------------------|----------------------------|
| Sticky Wage           | No               | Countercyclical            |
| Worker Misperception  | Yes              | Countercyclical            |
| Imperfect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

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### Putting it all together...

#### Monetary Expansion

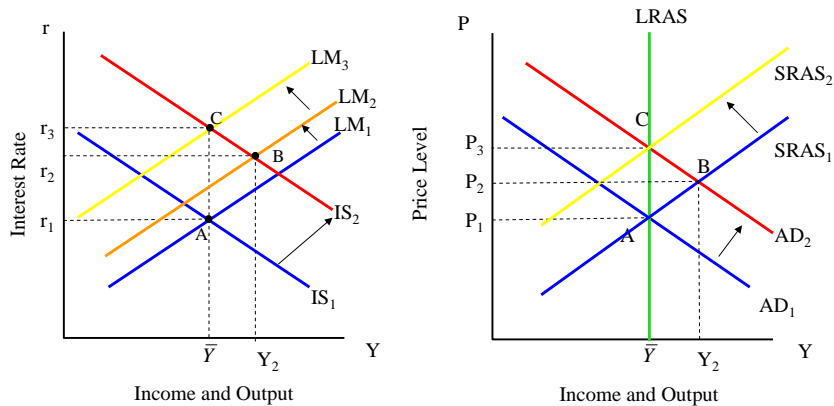


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### Putting it all together...

#### Fiscal Expansion



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### And now...

## Inflation, Unemployment, and the Phillips Curve

## Inflation, Unemployment, and the Phillips Curve

- Governments care about  $\pi$  and  $u$ , not  $P$  and  $Y$ .
- Aggregate Supply: 
$$Y = \bar{Y} + \alpha(P - P^e)$$
$$= \bar{Y} + \alpha[P_{-1}(1 + \pi) - P_{-1}(1 + \pi^e)]$$
$$= \bar{Y} + \alpha'(\pi - \pi^e)$$
- Okun's Law :  $-\beta(u - u^n) = (1/\alpha')\beta(Y - \bar{Y})$   
 $\Rightarrow$  Phillips Curve:  $\pi = \pi^e - \beta(u - u^n)$   
 $\Rightarrow$  with shock:  $\pi = \pi^e - \beta(u - u^n) + \nu$
- So the Phillips Curve is just an alternative way of describing the Aggregate Supply Curve.

## Inflation, Unemployment, and the Phillips Curve

The **Phillips curve** states that  $\pi$  depends on

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

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

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

## The Phillips Curve and SRAS

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

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

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

## Key Question: How are Expectations Formed?

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

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.



## Two causes of rising & falling inflation

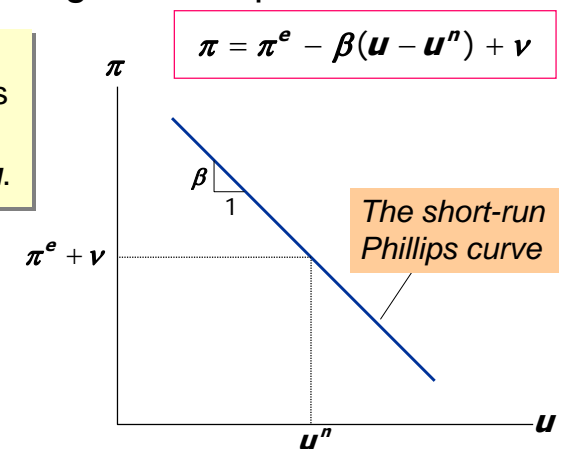
$$\pi = \pi_{-1} - \beta(u - u^n) + v$$

- **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.



## Graphing the Phillips curve

In the short run, policymakers face a tradeoff between  $\pi$  and  $u$ .

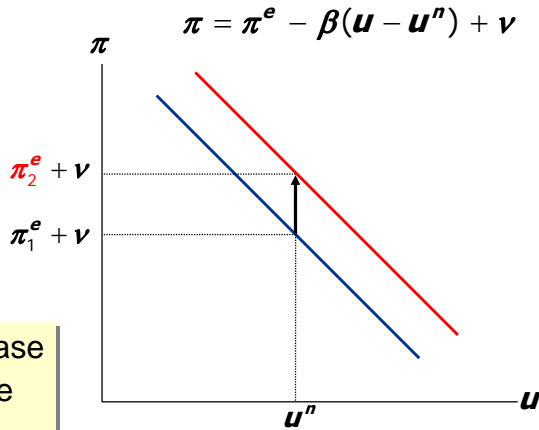




## Shifting the Phillips curve

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

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



## 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:  

$$\text{GDP loss} = \frac{(\text{inflation reduction})}{4} \times \frac{(\text{sacrifice ratio})}{5}$$
- 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 (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  $\pi \downarrow \Rightarrow \pi^e \downarrow$

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### 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  $\pi^e$  will fall, perhaps by the full 4 points.
- Then,  $\pi$  can fall without an increase in  $u$ .

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### 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%

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### 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.

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## The natural rate hypothesis

Our analysis of the costs of disinflation, and of economic fluctuations in the preceding lectures, is based on the **natural rate hypothesis**:

Changes in aggregate demand affect output and employment only in the short run.

In the long run, the economy returns to the levels of output, employment, and unemployment described by the classical model.

## An alternative hypothesis: Hysteresis

- **Hysteresis**: the long-lasting influence of history on variables such as the natural rate of unemployment.
- Negative shocks may increase  $u^n$ , so economy may not fully recover.

## Hysteresis: Why negative shocks may increase the natural rate

- The skills of cyclically unemployed workers may deteriorate while unemployed, and they may not find a job when the recession ends.
- Cyclically unemployed workers may lose their influence on wage-setting; then, insiders (employed workers) may bargain for higher wages for themselves.

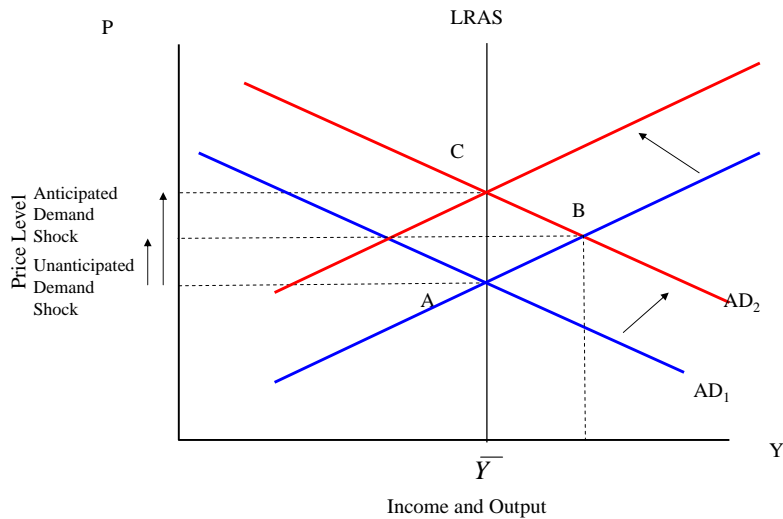
Result: The cyclically unemployed “outsiders” may become structurally unemployed when the recession ends.

## Policy Ineffectiveness Proposition

- Rational Expectations + “Surprise” supply function + Market Clearing + Symmetric Information  $\Rightarrow$

**Policy Ineffectiveness Proposition** (Lucas, Sargent-Wallace): Only unanticipated policy matters  $\Rightarrow$  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.



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## 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.

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## “Menu” Costs

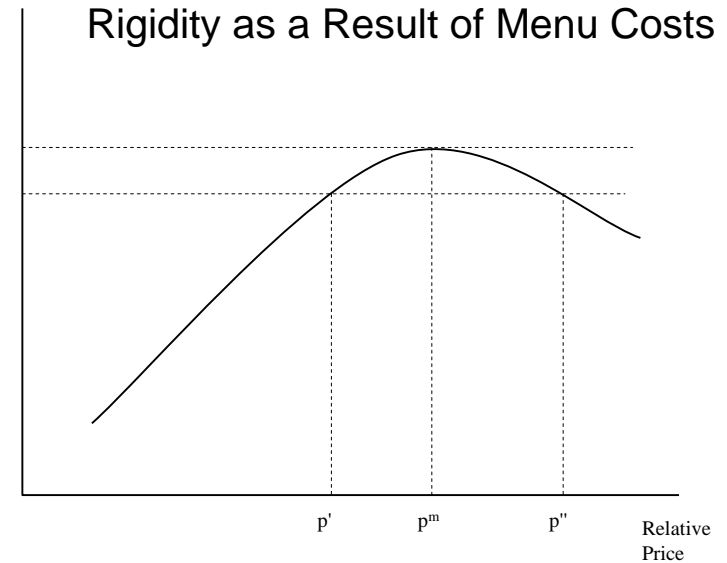
- At an optimum a small change in price will have little effect on profits ( $d\Pi/dP_i=0$ )
- So small “menu” cost is enough to produce rigidity
- But small change in price can nevertheless have large welfare effects

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Profits

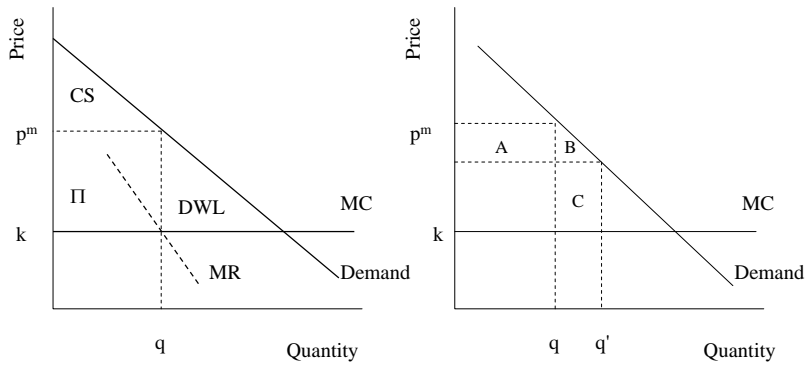
## Rigidity as a Result of Menu Costs



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## Welfare Effects of a Price Change



Change in Consumer Surplus = A + B

Change in Profits = C - A

Change in Social Welfare = B + C

- Change in social welfare, **B+C** can be large!

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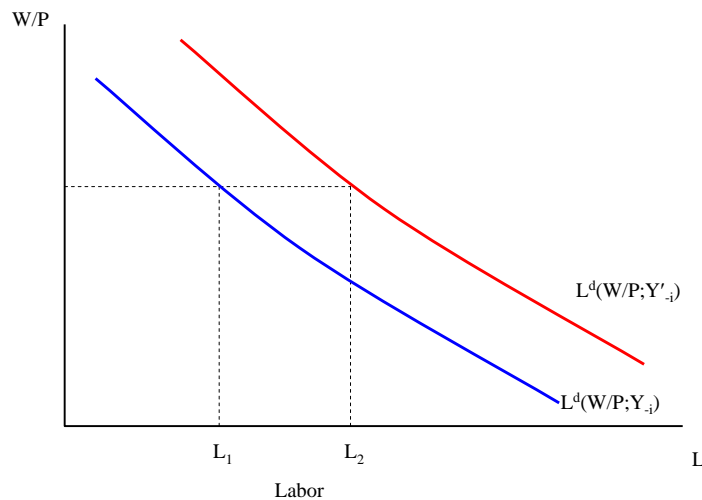
## Coordination Failure

- “Thick-Market” externality: trade is costly, and cheaper in “thick” markets.
- High activity **elsewhere** in the economy lowers costs and raises output and employment.  
(Costs<sub>i</sub> = f(Y<sub>i</sub>, Y<sub>-i</sub>))  
(+) (-)
- If the positive externality is sufficiently strong, you can get multiple equilibria.
- Economy can be stuck at a low level of activity.

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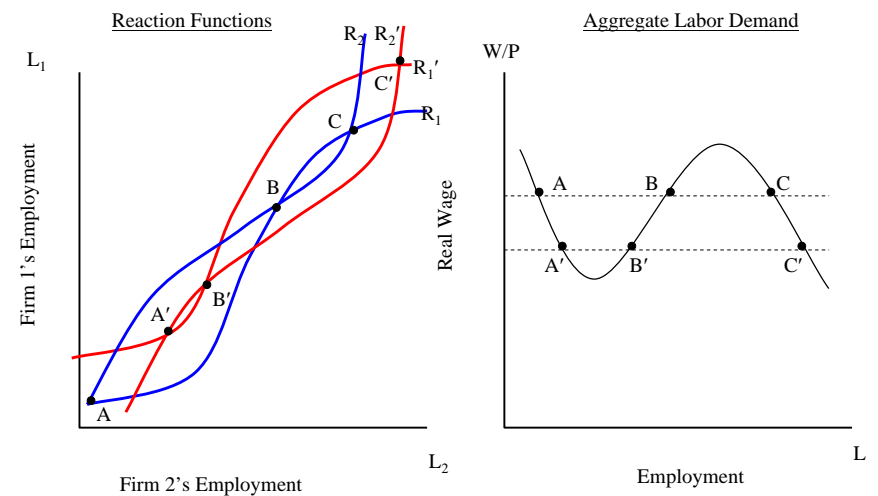
## Labor Demand in Individual Firm



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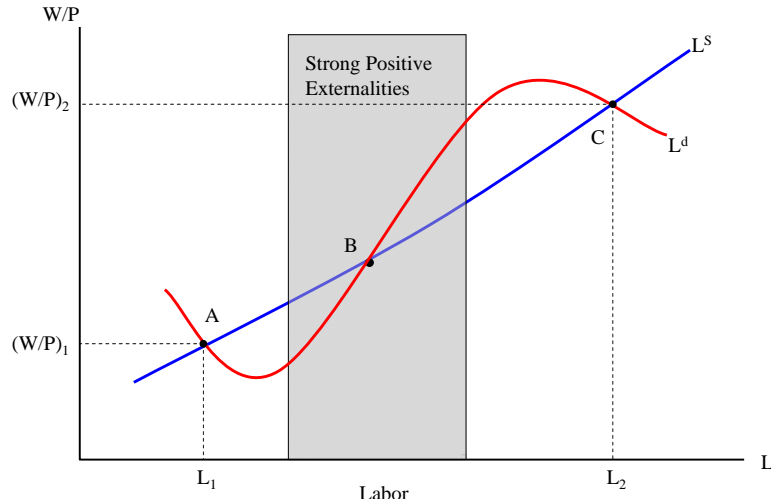
## A Two-Firm Example



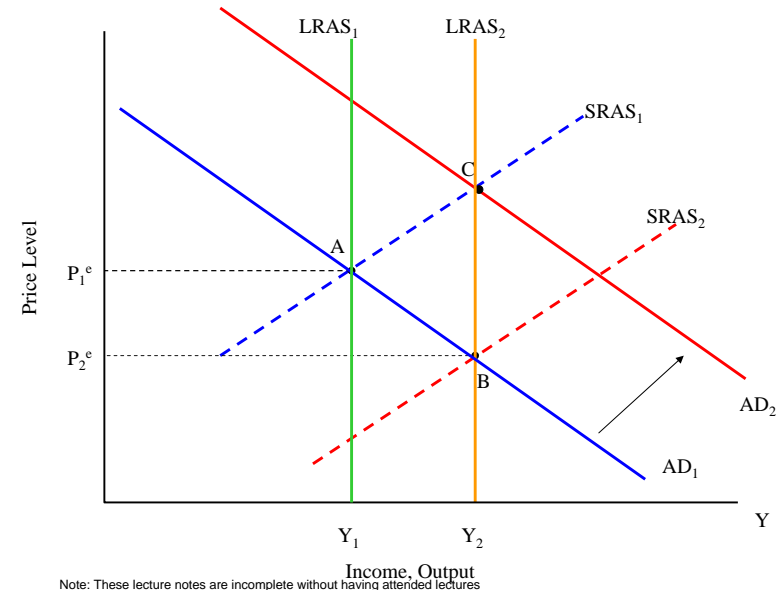
Note: These lecture notes are incomplete without having attended lectures



## Labor Market: Multiple Equilibria



Note: These lecture notes are incomplete without having attended lectures



Note: These lecture notes are incomplete without having attended lectures



## Summary

### 1. Three models of aggregate supply in the short run:

- sticky-wage 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.

Note: These lecture notes are incomplete without having attended lectures



## 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

Note: These lecture notes are incomplete without having attended lectures



## 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

Note: These lecture notes are incomplete without having attended lectures

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## Summary

### 4. The natural rate hypothesis and hysteresis

- **The Natural Rate Hypotheses**
  - states that changes in aggregate demand can only affect output and employment in the short run
  
- **Hysteresis**
  - states that aggregate demand can have permanent effects on output and employment

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## Summary

### 5. 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

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## Summary

### 6. Reasons for wages/prices not to adjust:

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

Note: These lecture notes are incomplete without having attended lectures

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