

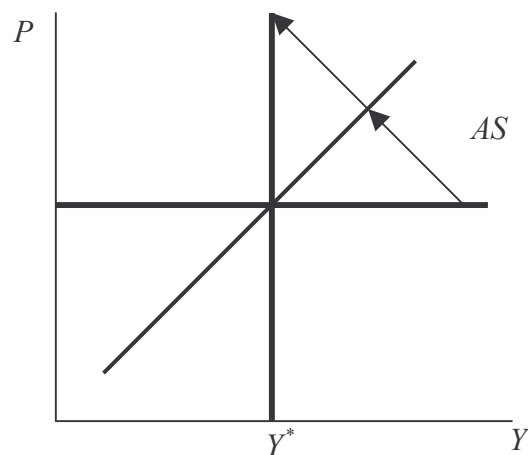
## Ch.6 Aggregate Supply, Wages, Prices, and Unemployment

### I. Introduction

- A. The dynamic changes of AS and the price adjustment
- B. Link between the price change (inflation) and unemployment: Phillips curve
- C. The role of price expectation and the 'rational expectations revolution'

### II. Changes of AS over time and price level

- A. In the short run, AS curve is horizontal and price is unchanged, but, in the long run, AS is vertical and output level is unchanged and in equilibrium. Therefore, AS curve rotates, counterclockwise, from horizontal to vertical with the passage of time.

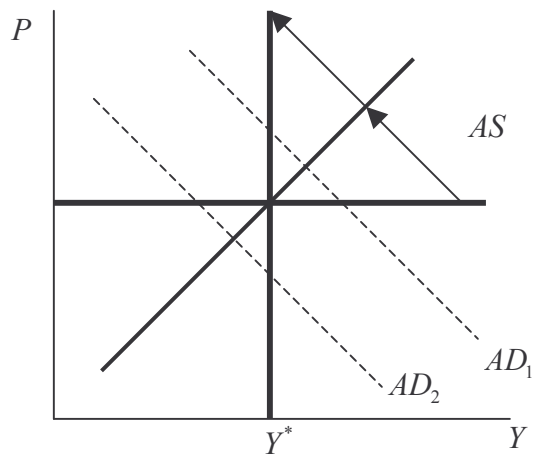


Note: The output level in the long run is called the potential output because all factor markets are cleared and factors are fully employed in long run

- B. When current output (GDP) is above the potential output (GDP), price rises until the output is reduced to the potential output. Conversely, when current output is

less than the potential output, price rises until the output equals the potential output.

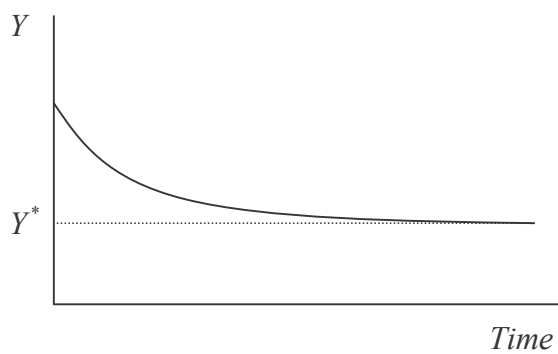
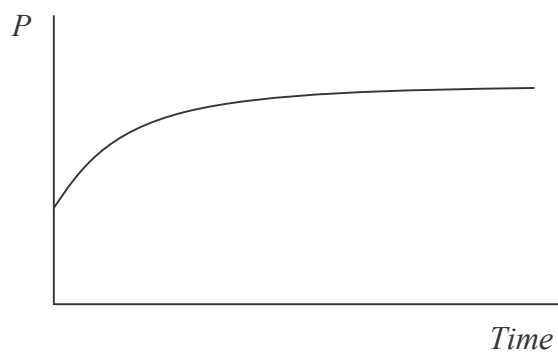
$$P_{t+1} = P_t [1 + \lambda(Y - Y^*)]$$



Note: the different between GDP and potential GDP,  $Y - Y^*$ , is called the GDP gap

### C. Adjustment paths of prices level and output

- Suppose  $Y > Y^*$ . Price eventually rises, and GDP decreases. Notice that the speed of price adjustment is controlled by the parameter  $\lambda$ .



### III. The Phillips curve

- A. A. W. Phillips found an inverse relationship between the rate of unemployment and the rate of increase in money wages from the study in the UK for 1861-1957. This relation is called the Phillips curve. That is, there is a tradeoff between wage inflation and unemployment.

- Formally,

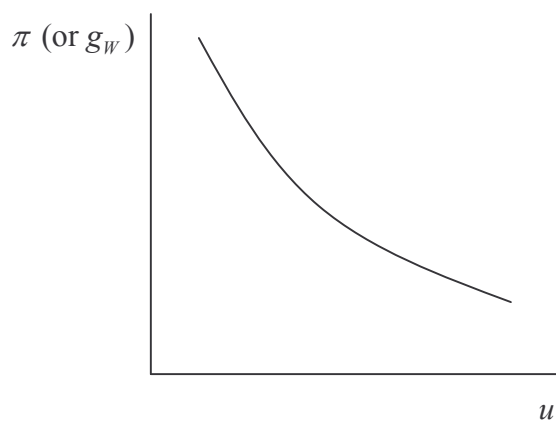
$$g_w = \frac{W_{t+1} - W_t}{W_t} = -\varepsilon(u - u^*)$$

where  $W_t$  is the wage this period, and  $W_{t+1}$  is the wage next period.  $u$  is the unemployment rate and  $u^*$  is the natural rate of unemployment.

Or equivalently,

$$W_{t+1} = W_t [1 - \varepsilon(u - u^*)]$$

- The higher the rate of unemployment, the lower the rate of (wage) employment
- The wages depend on past wages and the negative of the rate of unemployment



#### B. Rationale

Wages are sticky due to contracts and long-term relations between workers and firms. Thus wages do not instantly adjust to create full employment

#### C. Empirical evidence

The data for the 1960s in US fits this simple Phillips curve, but the data from the 1970s and 1980s do not fit the simple Phillips curve

- D. Although the original Phillips curve is the relation between the wage inflation and the rate of unemployment, usually the Phillips curve means the trade off between the inflation (not only wage inflation) and the rate of unemployment. For detail discussion, read the appendix in this note.

#### IV. An Expectations-augmented Phillips Curve: Role of expectations and Stagflation

##### A. Inflation expectation and Phillips curve

Workers are concerned with real wages. They will take into account inflation when they negotiate wage rate. Firms also take inflation into account in that they are willing to allow wage inflation if they feel that prices will also rise. Thus the Phillips curve needs to reflect expected inflation

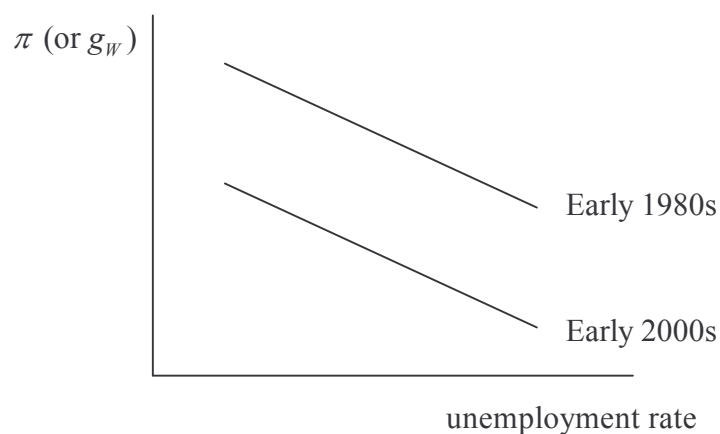
$$g_w - \pi^e = -\varepsilon(u - u^*)$$

Therefore, the (inflation) expectations-augmented Phillips curve is

$$\pi = \pi^e - \varepsilon(u - u^*)$$

##### B. Shifts of the short-run Phillips curve and the inflation expectation

- If the expected inflation is high, the Phillips curve shifts up (e.g. early 80s)
- If the expected inflation is low, the Phillips curve shifts down



### C. Stagflation

- Stagflation is a term coined to mean high unemployment and high inflation
- Example: In 1982, unemployment was over 9% and inflation was around 6%
- The simple Phillips curve could not explain the stagflation. However, it can be explained with the expectations-augmented Phillips curve and high expected inflation in 80s

## V. The Rational Expectations Revolution

- A. Robert Lucas introduces the notation of the 'rational expectation' in macroeconomics
- B. If agents in an economy have rational expectation, the expected inflation should be the same as the actual inflation, and unemployment must be at the natural rate (and the output should be the potential output). In addition, any predictable policy doesn't have effect on the economy, and only unpredicted policy has effects.
- C. Why doesn't rational expectations explain how the world operate?

Some possible answers

- Sticky price: although agents are rational, some prices can't be adjusted quickly (e.g. wage contract)
- Even fully rational agents learn slowly

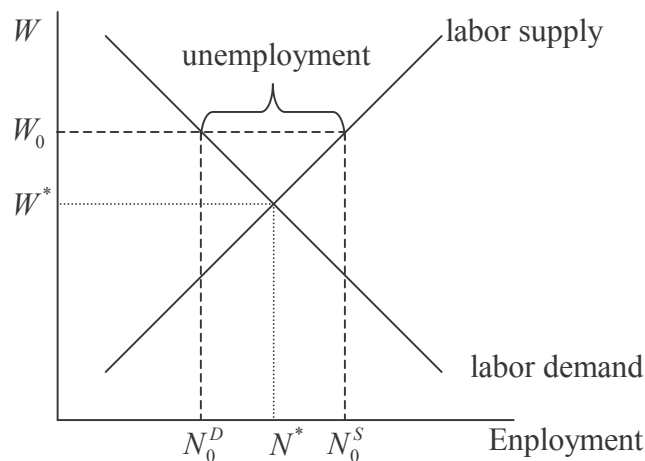
## VI. Sticky Wages

- A. Rationale of the Phillips curve
- Wages are sticky due to contracts and long-term relations between workers and firms. Thus wages do not instantly adjust to create full employment
- If wages are not sticky, wages instantly adjust to the equilibrium wages, and the

labor market is always cleared.

B. Several explanations of the sticky wage (or price)

- Imperfect information: Wages are fully flexible but adjust slowly because expectations are temporarily wrong
- Coordination problem: A firm cannot adjust its price or wage offer easily. Unless all firms adjust simultaneously, it is possible that the firm that adjusts its price or wage alone loses business to the others.
- Efficiency wages: Firms may pay wages above the market-clearing wage to ensure that employees work hard to avoid their good jobs
- Cost of price change (menu cost): There are costs of changing prices.
- Insider-outsider models: Insiders (the employed) have an advantage over outsiders (the unemployed). That is, it is costly for firms to turn over their labor force – firing costs, hiring costs, and training costs.



labor market and unemployment

VII. The expectations-augmented Phillips curve and the expectations-augmented aggregate supply curve

- We can derive the aggregate supply curve from the expectations-augmented Phillips curve

A. Okun's law

- GDP increases when the unemployment rate declines. Empirical study shows 1 extra point of unemployment costs 2% of GDP.

$$\frac{Y - Y^*}{Y^*} = -\omega(u - u^*) \quad (1)$$

where  $\omega \approx 2$ .

#### B. The expectations-augmented Phillips curve and AS

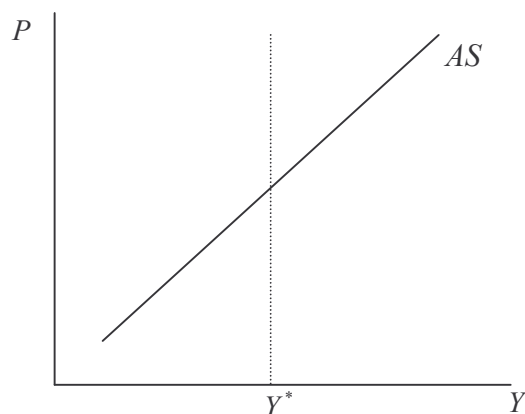
- Combining the Okun's law and the expectations-augmented Phillips curve, we can obtain the expectations-augmented AS curve

$$\begin{aligned} \pi &= \pi^e - \varepsilon(u - u^*) \\ \Leftrightarrow \frac{P_{t+1} - P_t}{P_t} &= \frac{P_{t+1}^e - P_t}{P_t} + \frac{\varepsilon}{\omega} \left( \frac{Y - Y^*}{Y^*} \right) \\ \Leftrightarrow P_{t+1} &= P_{t+1}^e + P_t \frac{\varepsilon}{\omega} \left( \frac{Y - Y^*}{Y^*} \right) \quad (2) \end{aligned}$$

Often, we replace the above equation with the following approximate version

$$P_{t+1} = P_{t+1}^e \left[ 1 + \lambda(Y - Y^*) \right] \quad (3)$$

These equations are the expectations-augmented AS curve. Notice that the AS curve is upward-sloping in  $Y$ .

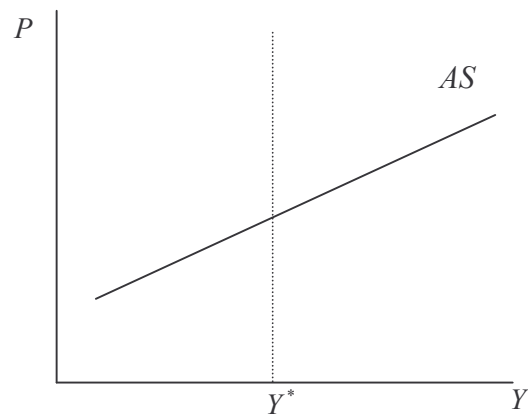


#### C. (Relatively) short-run AS curve

- In the (relatively) short run, the expected rate of inflation and the expected price in future is held constant.

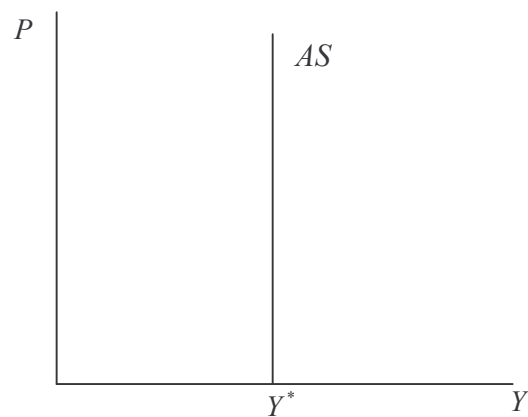
Note: in the very short run, price is unchanged and the AS curve is a horizontal line (Keynesian case). However, in the (relatively) short run, price can be adjusted.

- Upward-sloping AS curve
- High expected inflation (or high expected price in future) shifts the AS inward



#### D. Long run AS curve

- In long run, the actual and expected inflation (or price level) are equal
- From (2), we can see  $Y = Y^*$ , and the AS curve is vertical (Classical case).



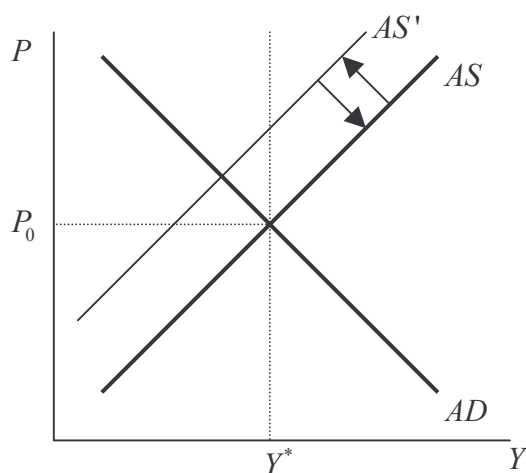
### VIII. Supply Shocks

- Supply shock is a disturbance to the economy whose first impact is a shift in the aggregate supply curve

#### A. An adverse supply shock

Ex: an increase in the price of oil

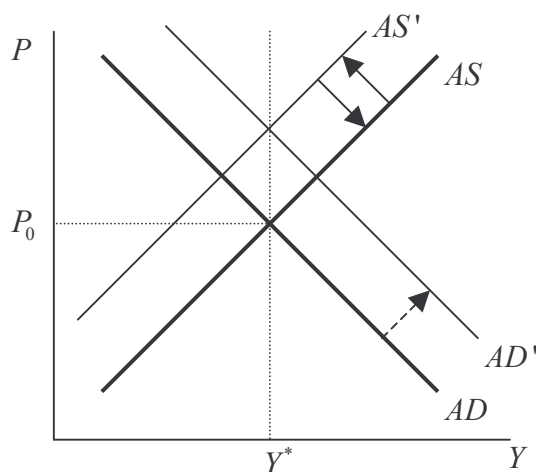
- (1) AS curve shifts inward
- (2) Actual GDP is less than the potential GDP in short run
- (3) Nominal wage decreases due to unemployment
- (4) AS curve shifts back to original AS curve in long run
- (5) Equilibrium moves back to the original one
- (6) However, the real wage decreases since the nominal wage is reduced and price level is the same



### B. Accommodation of supply shocks

- When a supply shock hit the economy, the monetary and fiscal policy can shift AD curve for the economy to be in the full-employment equilibrium. This policy is called accommodating policy.

Ex: an increase in the price of oil



Nominal wage is unchanged

However, the real wage fall due to increase in the price level

## IX. Appendix. Wage inflation and price inflation

### A. Production function (output and employment)

Suppose firms have a proportionate production function

$$Y = aN$$

where  $a$  is labor productivity and  $N$  is employment. Notice that  $1/a$  units of labor input are required to produce 1 unit of output.

### B. Mark-up pricing

Since  $1/a$  is the required labor inputs to produce 1 unit of output, the ratio  $W/a$  is the unit labor cost; that is, the labor cost to produce 1 unit of output. With markup pricing, firms set a price that is some multiple of the unit labor cost. Thus output price is proportional to unit labor cost or to the nominal wage. Formally,

$$P = (1+z) \frac{W}{a} \quad (4)$$

where  $P$  is output price,  $z$  is the markup, and  $W/a$  is unit labor cost. Or equivalently, equation (4) can be rewritten as:

$$W = \frac{aP}{(1+z)} \quad (5)$$

### C. Wage inflation and price inflation

Notice that originally the Phillips curve is a relationship between wage inflation and unemployment rate. Since the wage inflation can be expressed using wages, the wage inflation also can be expressed in terms of price using (5). Further, wage inflation is same to price inflation here. (Note: in practice, wage and price inflation aren't always equal)

$$g_w = \frac{W_{t+1} - W_t}{W_t} = \frac{aP_{t+1}/(1+z) - aP_t/(1+z)}{aP_t/(1+z)} = \frac{P_{t+1} - P_t}{P_t} = \pi_t$$