



# The Lucas Imperfect - Information Model

oleh

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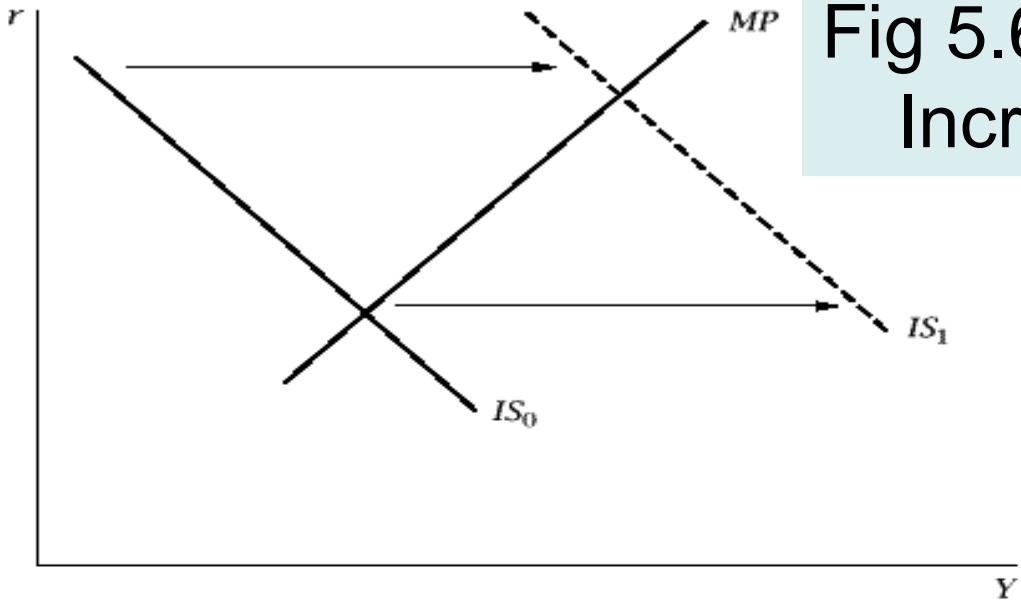
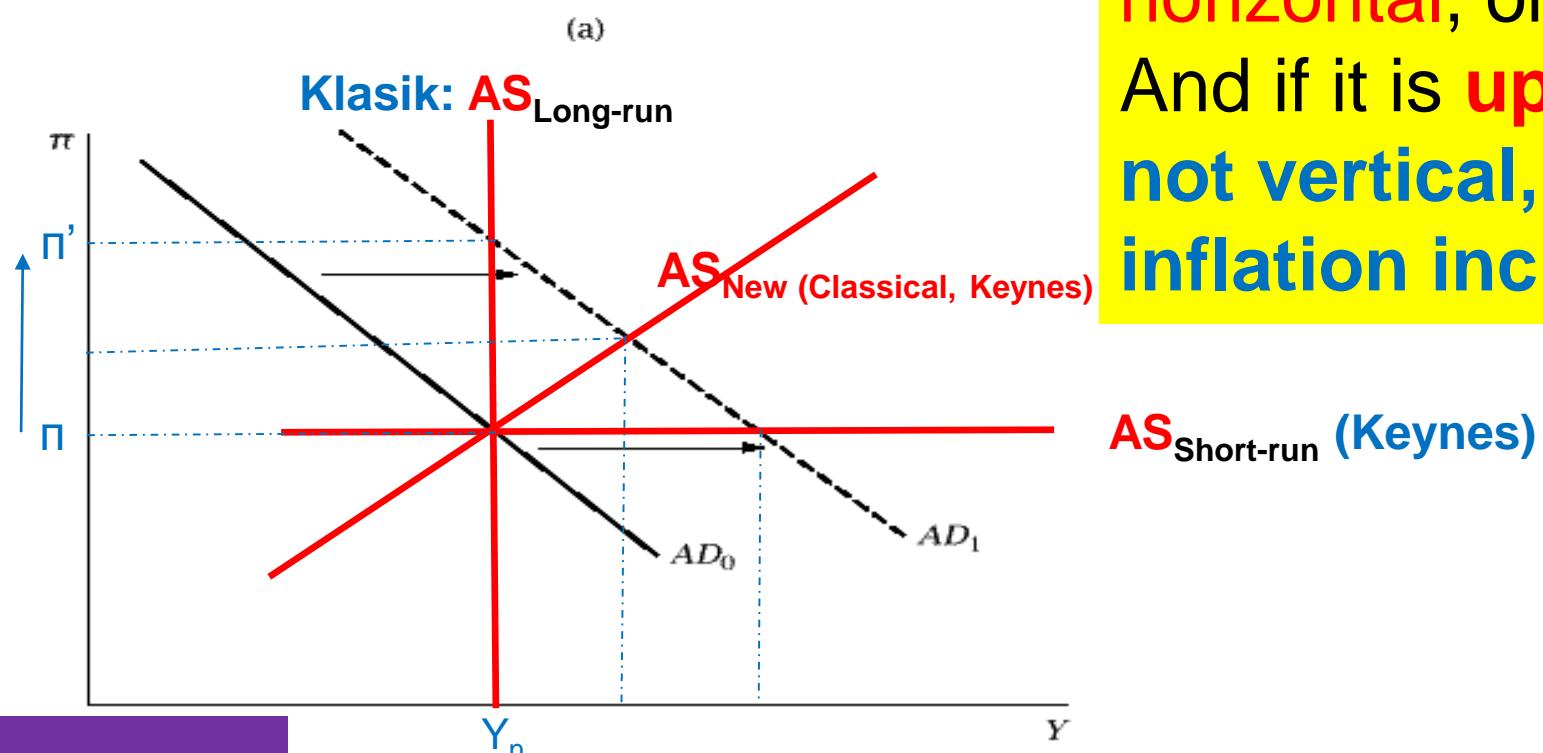


Fig 5.6 The Effects of an Increase in Gov't Purchases



The Impact of this change in AD on output and inflation depends on the AS curve. If it is **vertical**, only inflation increase. If it is **horizontal**, only output increase. And if it is **upward-sloping but not vertical**, both **output and inflation increase**

# PENDAHULUAN

**Gagasan utama model Lucas (1972) & Phelps (1970) :**

- ✿ Ketika produsen mengamati perubahan harga produknya → tidak mengetahui apakah terjadi perubahan dari harga relatif atau perubahan harga agregat.
- ✿ Perubahan harga agregat → tidak merubah produksi optimal.
- ✿ Ketika harga barang produsen meningkat → ada dua kemungkinan :
  - kenaikan tingkat harga atau kenaikan harga relatif dari barang tersebut**
- ✿ Produsen meningkatkan outputnya → kenaikan harga secara keseluruhan atau kenaikan output secara keseluruhan

# *A Model of Imperfect Competition & Price Setting*

- ❖ Tiap barang diproduksi oleh perusahaan tunggal. Fungsi produksi perusahaan ke-i:

$$Y_i = L_i \quad (6.1 \rightarrow 6.37)$$

$L_i$  = jumlah TK

$Y_i$  = jml barang yg dihasilkan

- **Firms hire labor in a perfectly competitive labor market and sell output in imperfectly competitive goods markets.** They are owned by the **households**, and so any profits they earn accrue to the households. As in the model of Section 6.1, we normalize the number of households to 1.
- The utility of the representative household depends positively on its **consumption (C)** and negatively on the amount of labor it supplies (**Household  $i$ 's objective function is therefore**):

$$U_i = C_i - \frac{1}{\gamma} L_i^\gamma, \quad \gamma > 1. \quad (6.2) \rightarrow (6.72)$$

# Kasus Informasi Sempurna

## Perilaku Produsen

- Jika harga agregat ( $P$ ) diketahui, maksimisasi dgn mensubstitusi  $C_i = P_i Y_i / P$  dan  $Y_i = L_i$  dalam (6.2) sehingga diperoleh:

$$U_i = \frac{P_i L_i}{P} - \frac{1}{\gamma} L_i^\gamma. \quad (6.3)$$

$Y_i = L_i$ . The producers takes prices as given. Thus if producer  $i$  knew  $P_i$  and  $P$ , the first-order condition for its utility-maximizing choice of  $Y_i$  would be:

$$\frac{P_i}{P} - L_i^{\gamma-1} = 0, \quad (6.4)$$

$$L_i = (P_i / P)^{1/(\gamma-1)} \quad (6.5)$$

Persamaan dlm bentuk logaritma (huruf kecil),  $l_i = y_i$ :

$$\ell_i = \frac{1}{\gamma-1} (P_i - p) \quad (6.6)$$

Jadi penawaran tenaga kerja & produksi meningkat tergantung harga relatif produk

## Kasus Informasi Sempurna : Permintaan

- **Permintaan barang diasumsikan tergantung 3 faktor: pendapatan riil, harga barang relatif, & gangguan acak thd preferensi**
- **Permintaan barang i adalah:**

$$q_i = y + z_i - \eta(p_i - p), \quad \eta > 0, \quad (6.7)$$

$y$  = log pendapatan riil agregat,

$z_i$  = goncangan permintaan barang i, dan

$\eta$  = elastisitas permintaan tiap barang.

$q_i$  = permintaan produsen untuk barang i,  $z_i$  mempunyai nilai rataan

nol terhadap barang.  $y$  diasumsikan sama dgn rata-rata antar barang  $q_i$  dan  $p$  adalah rata-rata  $p_i$

$$y = \bar{q}_i \quad (6.8) \quad p = \bar{p}_i \quad (6.9)$$

Pers: (6.7)–(6.9) menyatakan permintaan barang akan lebih tinggi ketika produksi total (dan penerimaan/pendapatan total) lebih tinggi, ketika harganya relatif rendah thd harga lainnya, & ketika individu memiliki preferensi lebih kuat

# Kasus Informasi Sempurna : Permintaan

- Permintaan agregat dari model menjadi:

$$y = m - p \quad (6.10)$$

- Persamaan menunjukkan hubungan berlawanan antara harga & output
  - $m$  = variabel generik yg mempengaruhi permintaan agregat → bisa saja uang riil (namun sisi kanan harus diganti dgn:  $m+v-p$ )
  - $v$  = gangguan permintaan agregat selain pergeseran supply uang)

# Kasus Informasi Sempurna : Ekuilibrium

- Keseimbangan dalam pasar barang i **mensyaratkan bhw permintaan masing-masing produsen sama dgn penawarannya**
- Dari persamaan (6.6) dan (6.7) diperoleh:

$$\frac{1}{\gamma - 1} (p_i - p) = y + z_i - \eta(p_i - p) \quad (6.11)$$

- Penyelesaian persamaan  $p_i$  menghasilkan:

$$p_i = \frac{\gamma - 1}{1 + \eta\gamma - \gamma} (y + z_i) + p \quad (6.12)$$

- Rata-rata  $p_i$  dan rata-rata  $z_i$  adalah nol, shg diperoleh:

$$p = \frac{\gamma - 1}{1 + \eta\gamma - \eta} y + p \quad (6.13)$$

## Kasus Informasi Sempurna : Ekuilibrium

- Dari pers tsb, nilai keseimbangan  $\gamma$  adalah:

$$y = 0 \quad (6.14)$$

- Dari persamaan (6.14) dan (6.10) diperoleh:

$$m = p \quad (6.15)$$

- Uang adalah netral pada model,
- peningkatan m mendorong peningkatan yg sama pada  $p_i$ , dan indeks harga keseluruhan, p.  
Tidak ada variabel riil yg dipengaruhi

## Kasus Informasi yang Tidak Sempurna

### Perilaku Produsen

- harga relatif dari barang  $i$  sebagai  $r_i = p_i - p$

$$\begin{aligned} p_i &= p + (p_i - p) \\ &= p + r_i \end{aligned} \tag{6.16}$$

- Produksi berdasarkan  $r_i$  saja (lihat [6.6]). Tidak mengamati  $r_i$ , namun harus memperkirakannya dengan pengamatan  $p_i$ .
- Lucas membuat dua asumsi
  - Pertama, bahwa mendapatkan ekspektasi  $r_i$  berdasarkan informasi  $p_i$ , dan kemudian menghasilkan sebanyak yang dia inginkan, sehingga persamaan (6.6) menjadi

$$\ell_i = \frac{1}{\gamma-1} E[r_i | p_i]. \tag{6.17}$$

- kedua, bahwa produsen mendapatkan ekspektasi dari  $r_i$  berdasarkan informasi  $p_i$  secara rasional yaitu,  $E[r_i | p_i]$

Permasalahan produsen adalah mendapatkan ekspektasi dari  $r_i$  berdasarkan  $p_i$ . Suatu hasil yang penting dalam statistik adalah bahwa ketika dua variabel secara gabungan terdistribusi secara normal. Ekspektasi dari salah satunya adalah suatu fungsi linier dari pengamatan yang lainnya. Jadi  $E[r_i|p_i]$

$$E[r_i | p_i] = \alpha + \beta p_i \quad (6.18)$$

dimana  $p_i$  setara  $r_i$  plus suatu variabel independen, (6.18) akan mengambil bentuk spesifik

$$\begin{aligned} E[r_i | p_i] &= -\frac{V_r}{V_r + V_p} E[p] + \frac{V_r}{V_r + V_p} p_i \\ &= \frac{V_r}{V_r + V_p} (p_i - E[p]). \end{aligned} \quad (6.19 \rightarrow 6.82)$$

where  $V_r$  and  $V_p$  are the variances of  $p$  and  $r_i$ , and where the second line uses the fact that the symmetry of the model implies that the mean of each relative price is zero

Substitusi (6.19) kedalam (6.17) akan menghasilkan penawaran pekerja produsen:

$$\begin{aligned}\ell_i &= \frac{1}{\gamma-1} \frac{V_r}{V_r+V_p} (p_i - E[p]) \\ &\equiv b(p_i - E[p])\end{aligned}\tag{6.20}$$

Dengan merata-ratakan (6.20) diantara produsen (dan menggunakan definisi  $y$  dan  $p$ ) akan menghasilkan suatu persamaan untuk keseluruhan output:

$$y = b(p_i - E[p])\tag{6.21}$$

Persamaan (6.21) adalah *kurva penawaran (agregat) Lucas*. Persamaan tersebut menyatakan bahwa perbedaan output dari tingkat normalnya (yaitu nol pada model) merupakan suatu fungsi naik dari kejutan dalam tingkat harga.

Kurva penawaran Lucas pada intinya sama dengan ekspektasi *Augmented Philips curve*

Dengan menggunakan (6.25) dan fakta bahwa  $m = E[m] + (m-E[m])$ , kita dapat menulis kembali (6.22) dan (6.23) sebagai

$$p = E[m] + \frac{1}{1+b} (m - E[m]), \quad (6.26)$$

$$y = \frac{b}{1+b} (m - E[m]). \quad (6.27)$$

Untuk melengkapi model tersebut, kita harus mengekspresikan  $b$  dalam bentuk parameter yang mendasari, dari pada dalam bentuk ragam  $p$  dan  $r_i$ . Mengingat bahwa  $b = [1/(\gamma-1)][V_r/(V_r+V_p)]$  (lihat [6.20]). Persamaan (6.26) menunjukkan  $V_p = V_m/(1+b)^2$ . Kurva permintaan, (6.7), dan kurva penawaran, (6.21), dapat digunakan untuk mendapatkan  $V_r$ , ragam  $p_i-p$ . Khususnya, kita dapat mensubtitusi  $y = b(p-E[p])$  kedalam (6.7), untuk mendapatkan  $q_i = b(p - E[p]) + z_i - \eta(p_i - p)$ , dan kita dapat menulis kembali (6.20) sebagai  $l_i = b(p_i - p) + b(p - E[p])$ . Menyelesaikan kedua persamaan ini untuk  $p_i-p$  akan menghasilkan  $p_i - p = z_i/(\eta + b)$ . Jadi  $V_r = V_z/(\eta + b)^2$ .

Dengan mensubtitusi persamaan tersebut untuk  $V_p$  dan  $V_r$  kedalam definisi  $b$  (lihat [6.20]) akan menghasilkan

$$b = \frac{1}{\gamma - 1} \left[ \frac{V_z}{V_z + \frac{(\eta + b)^2}{(1+b)^2} V_m} \right] \quad (6.28)$$

Persamaan (6.28) secara implisit menjelaskan  $b$  dalam bentuk  $V_z$ ,  $V_m$  dan  $\gamma$ , sehingga melengkapi model tersebut. *Hal ini untuk menunjukkan bahwa  $b$  meningkat dalam  $V_z$  dan menurun dalam  $V_m$ . Dalam kasus khusus  $\eta = 1$ , kita dapat memperoleh suatu ekspresi dengan bentuk tertutup untuk  $b$ :*

$$b = \frac{1}{\gamma - 1} \frac{V_z}{V_z + V_m} E[p], \quad (6.29)$$

Akhirnya, perhatikan bahwa  $p = E[m] + [1/(1 + b)] (m - E[m])$  dan  $ri = zi/(\eta + b)$  yang menunjukkan bahwa  $p$  dan  $ri$  adalah fungsi linier dari  $m$  dan  $zi$ . Karena  $m$  dan  $zi$  adalah independen,  $p$  dan  $ri$  adalah independen; dan karena fungsi linier dari variabel normal adalah normal,  $p$  dan  $ri$  adalah normal. *Hal ini membenarkan asumsi yang dibuat diatas mengenai variabel-variabel ini.*

# Imperfect-Information Model

The explanation for the upward slope of the short-run aggregate supply curve is called the *imperfect-information model*. Unlike the sticky-wage model, this model assumes that markets clear-- that is, all wages and prices are free to adjust to balance supply and demand. In this model, the short-run and long-run aggregate supply curves differ because of **temporary misperceptions about prices**.

The imperfect-information model assumes that each supplier in the economy **produces a single good and consumes many goods**. Because the number of goods is so large, suppliers cannot observe all prices at all times. They monitor the prices of their own goods but not the prices of all goods they consume. Due to imperfect information, they sometimes **confuse changes in the overall price level with changes in relative prices**. This confusion influences decisions about how much to supply, and it leads to a positive relationship between the price level and output in the short run.

Let's consider the decision of a single wheat producer, who earns income from selling wheat and uses this income to buy goods and services. The amount of wheat she chooses to produce depends on the price of wheat relative to the prices of other goods and services in the economy. If the relative price of wheat is high, she works hard and produces more wheat. If the relative price of wheat is low, she prefers to work less and produce less wheat. The problem is that when the farmer makes her production decision, she does not know the relative price of wheat. She knows the nominal price of wheat, but not the price of every other good in the economy. She **estimates the relative price of wheat using her expectations of the overall price level**.

If there is a sudden increase in the price level, the farmer doesn't know if it is a change in overall prices or just the price of wheat. Typically, she will assume that it is a relative price increase and will therefore increase the production of wheat. Most suppliers will tend to make this mistake. To sum up, the notion that **output deviates from the natural rate when the price level deviates from the expected price level** is captured by:

$$Y = \bar{Y} + \alpha(P - P^e) \quad \text{atau} \quad y = b(p_i - E[p]) \quad (6.21)$$

# Three Models of Aggregate Supply

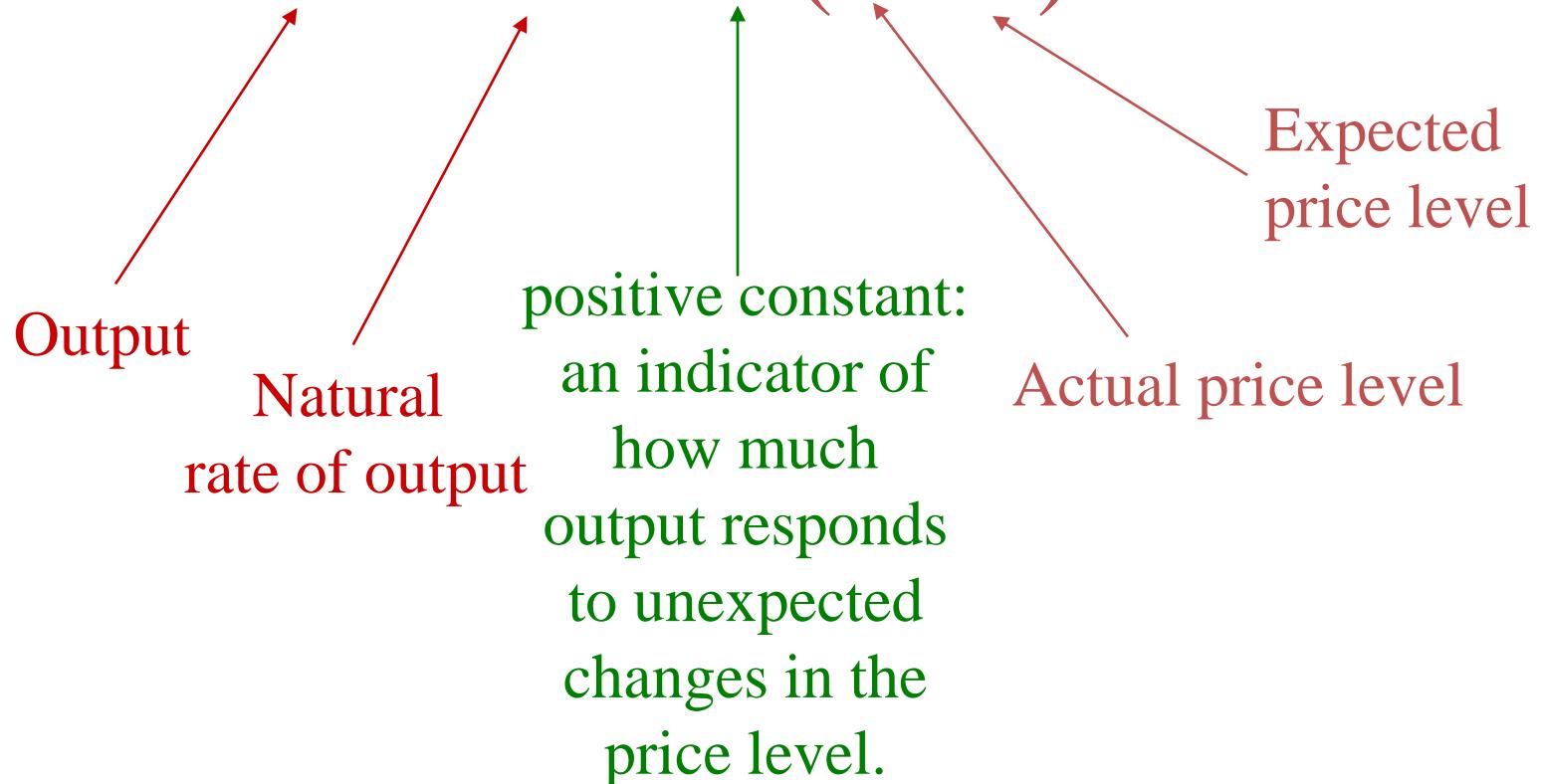
Let's now examine three prominent models of aggregate supply, roughly in the order of their development. In all the models, some market imperfection causes the output of the economy to deviate from its classical benchmark. As a result, the short-run aggregate supply curve is upward sloping, rather than vertical, and shifts in the aggregate demand curve cause the level of output to deviate temporarily from the natural rate. These temporary deviations represent the booms and busts of the business cycle.

Although each of the three models takes us down a different theoretical route, each route ends up in the same place. That final destination is a short-run aggregate supply equation of the form...

Other models: Sticky-Wage Model, Sticky-Price Model, Collective Bargaining

# Short-run Aggregate Supply Equation

$$Y = \bar{Y} + \alpha (P - P^e) \text{ where } \alpha > 0$$



This equation states that output deviates from its natural rate when the price level deviates from the expected price level. The parameter  $\alpha$  indicates how much output responds to unexpected changes in the price level,  $1/\alpha$  is the slope of the aggregate supply curve.

# The Sticky-Wage Model

The *sticky-wage model* shows what a sticky nominal wage implies for aggregate supply. To preview the model, consider what happens to the amount of output produced when the price level rises:

- 1) When the nominal wage is stuck, a rise in the price level lowers the real wage, making labor cheaper.
- 2) The lower real wage induces firms to hire more labor.
- 3) The additional labor hired produces more output.

This positive relationship between the price level and the amount of output means the aggregate supply curve slopes upward during the time when the nominal wage cannot adjust.

The workers and firms set the nominal wage  $W$  based on the target real wage  $\omega$  and on their expectation of the price level  $P^e$ . The nominal wage they set is:

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

Nominal Wage = Target Real Wage  $\times$  Expected Price Level

$$\frac{W}{P} = \omega \times \left(\frac{P^e}{P}\right)$$

Real Wage=Target Real Wage  $\times$ (Expected Price Level/Actual Price Level)

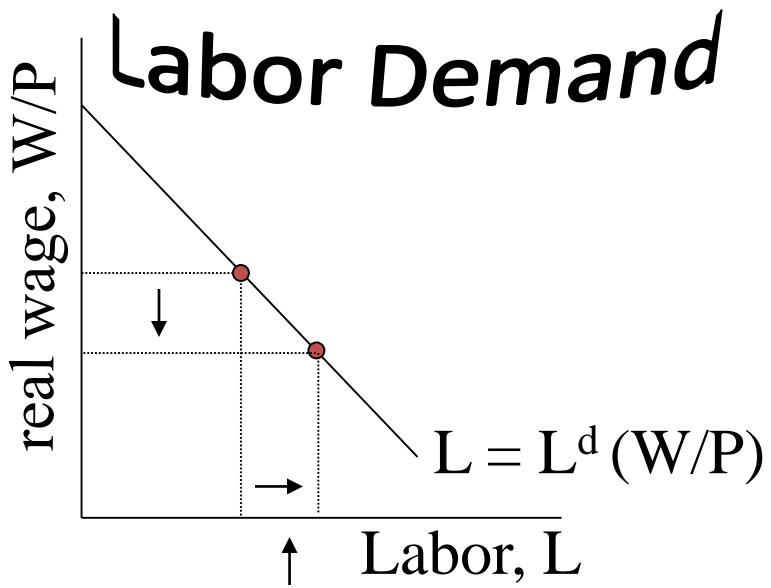
This equation shows that the real wage deviates from its target if the actual price level differs from the expected price level. When the actual price level is greater than expected, the real wage is less than its target; when the actual price level is less than expected, the real wage is greater than its target.

The final assumption of the sticky-wage model is that employment is determined by the quantity of labor that firms demand. In other words, the bargain between the workers and the firms does not determine the level of employment in advance; instead, the workers agree to provide as much labor as the firms wish to buy at the predetermined wage. We describe the firms' hiring decisions by the labor demand function:

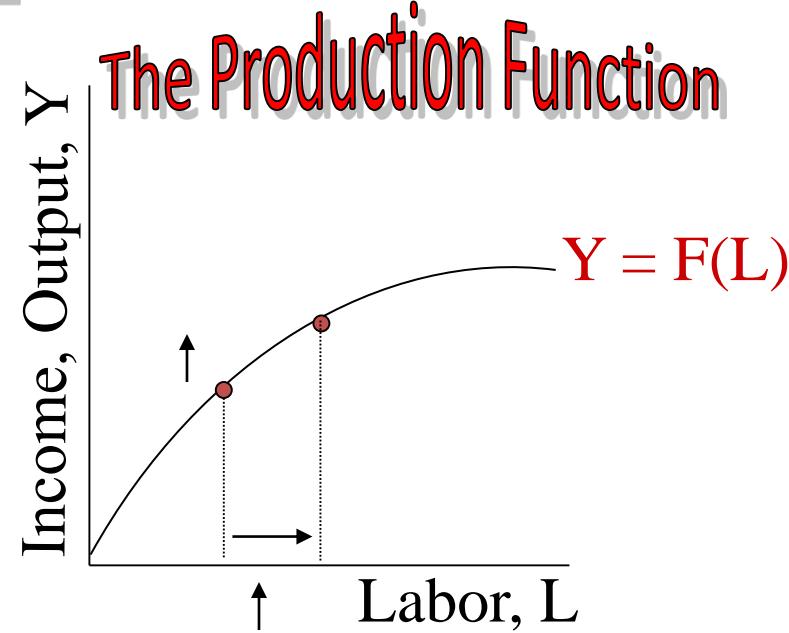
$$L = L^d (W/P),$$

which states that the lower the real wage, the more labor firms hire and output is determined by the production function  $Y = F(L)$ .

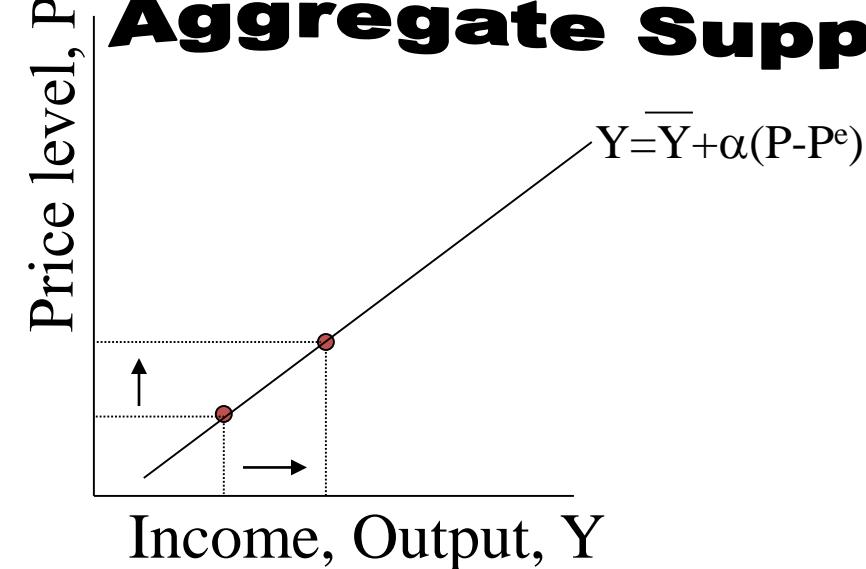
# The Sticky-Wage Model



An increase in the price level, reduces the real wage for a given nominal wage, which raises employment and output and income.



### Aggregate Supply



# The Sticky-Price Model

A third explanation for the upward-sloping short-run aggregate supply curve is called the *sticky-price model*. This model emphasizes that firms do not instantly adjust the prices they charge in response to changes in demand. Sometimes prices are set by long-term contracts between firms and consumers.

To see how sticky prices can help explain an upward-sloping aggregate supply curve, first consider the pricing decisions of individual firms and then aggregate the decisions of many firms to explain the economy as a whole. We will have to relax the assumption of perfect competition whereby firms are price takers. Now they will be price setters.

Consider the pricing decision faced by a typical firm. The firm's desired price  $p$  depends on two macroeconomic variables:

- 1) The overall level of prices  $P$ . A **higher price level implies that the firm's costs are higher**. Hence, the higher the overall price level, the more the firm will like to charge for its product.
- 2) The level of aggregate income  $Y$ . A **higher level of income raises the demand for the firm's product**. Because **marginal cost increases at higher levels of production, the greater the demand, the higher the firm's desired price**.

The firm's desired price is:

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

This equation states that the desired price  $p$  depends on the overall level of prices  $P$  and on the level of aggregate demand relative to its natural rate  $\bar{Y}$ . The parameter  $a$  (which is greater than 0) measures how much the firm's desired price responds to the level of aggregate

Now assume that there are **two types of firms**. Some have **flexible prices**: they always set their prices according to this equation. Others have **sticky prices**: they announce their prices in advance based on what they expect economic conditions to be. Firms with sticky prices set prices according to

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

where the superscript ‘e’ represents the expected value of a variable. For simplicity, assume these firms expect output to be at its natural rate so that the last term  $a(Y^e - \bar{Y}^e)$ , drops out. Then these firms set price so that  $p = P^e$ . That is, **firms with sticky prices set their prices based on what they expect other firms to charge**.

We can use the pricing rules of the two groups of firms to derive the aggregate supply equation. To do this, we find the **overall price level in the economy as the weighted average of the prices set by the two groups**. After some manipulation, the overall price level is:

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

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

The two terms in this equation are explained as follows:

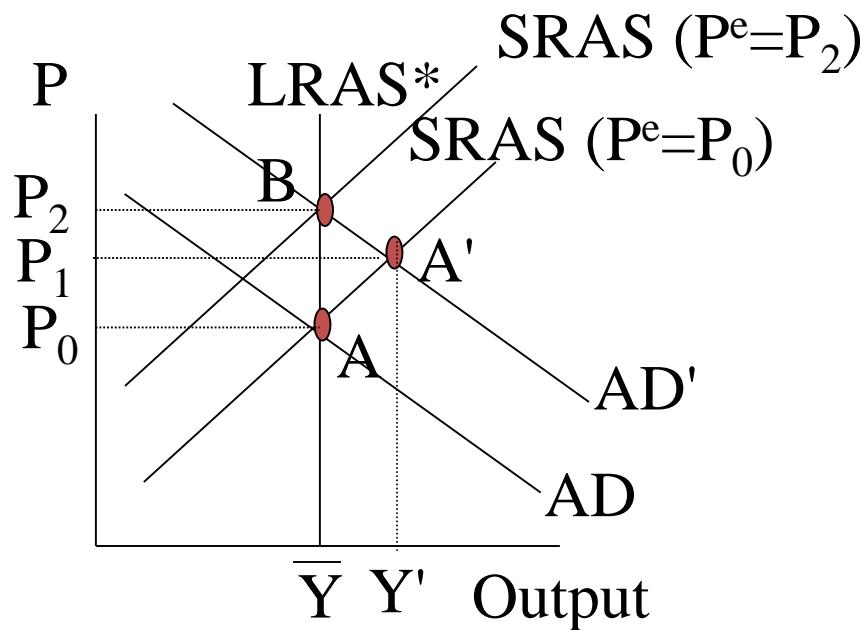
- 1) When firms expect a high price level, they expect high costs. Those firms that fix prices in advance set their prices high. These high prices cause the other firms to set high prices also. Hence, a high expected price level  $P^e$  leads to a high actual price level  $P$ .
- 2) When output is high, the demand for goods is high. Those firms with flexible prices set their prices high, which leads to a high price level. The effect of output on the price level depends on the proportion of firms with flexible prices. Hence, the overall price level depends on the expected price level and on the level of output. Algebraic rearrangement puts this aggregate pricing equation into a more familiar form:

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

where  $\alpha = s/[(1-s)a]$ . Like the other models, the sticky-price model says that the deviation of output from the natural rate is positively associated with the deviation of the price level from the expected price level.

# Short-run Aggregate Supply Curve in ACTION

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



Start at point A; the economy is at full employment  $\bar{Y}$  and the actual price level is  $P_0$ . Here the actual price level equals the expected price level. Now let's suppose we increase the price level to  $P_1$ .

Since  $P$  (the actual price level) is now greater than  $P^e$  (the expected price level)  $Y$  will rise above the natural rate, and we slide along the  $SRAS (P^e = P_0)$  curve to  $A'$ .

Remember that our new  $SRAS (P^e = P_0)$  curve is defined by the presence of fixed expectations (in this case at  $P_0$ ). So in terms of the SRAS equation, when  $P$  rises to  $P_1$ , holding  $P^e$  constant at  $P_0$ ,  $Y$  must rise.

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

The “long-run” will be defined when the expected price level equals the actual price level. So, as price level expectations adjust,  $P^e \Rightarrow P_2$ , we’ll end up on a new short-run aggregate supply curve,  $SRAS (P^e = P_2)$  at point B.

Hooray! We made it back to LRAS, a situation characterized by perfect information where the actual price level (now  $P_2$ ) equals the expected price level (also,  $P_2$ ).

In terms of the SRAS equation, we can see that as  $P^e$  catches up with  $P$ , that entire “expectations gap” disappears and we end up on the long run aggregate supply curve at full employment where  $Y = \bar{Y}$ .

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

# Deriving the Phillips Curve From the Aggregate Supply Curve

The *Phillips curve* in its modern form states that the inflation rate depends on three forces:

- 1) Expected inflation
- 2) The deviation of unemployment from the natural rate, called *cyclical unemployment*
- 3) Supply shocks

These three forces are expressed in the following equation:

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

Inflation  
Expected Inflation  
 $\beta \times$  Cyclical Unemployment  
Supply Shock

The Phillips-curve equation and the short-run aggregate supply equation represent essentially the same macroeconomic ideas. Both equations show a link between real and nominal variables that causes the classical dichotomy (the theoretical separation of real and nominal variables) to break down in the short run.

The Phillips curve and the aggregate supply curve are two sides of the same coin. The aggregate supply curve is more convenient when studying output and the price level, whereas the Phillips curve is more convenient when studying unemployment and inflation.

Semoga bermanfaat  
Sampai ketemu di **topik yang lain**  
Terima kasih  
(Salam, BJ)



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## Perhitungan

$$U_i = C_i - \frac{1}{\gamma} L'_i, \quad \gamma > 1. \quad (6.2)$$

Substitusi dengan :  $C_i = P_i Q_i / P$  dan  $Q_i = L_i$  (6.1)

$$U_i = \frac{P_i Q_i}{P} - \frac{1}{\gamma} L'_i$$

$$U_i = \frac{P_i L_i}{P} - \frac{1}{\gamma} L'_i \quad (6.3)$$

$$U_i = \frac{P_i L_i}{P} - \frac{1}{\gamma} L_i^\gamma \quad (6.3)$$

FOC       $U_{L_i} = \frac{P_i}{P} - \frac{1}{\gamma} y L_i^{\gamma-1}$

Maksimalkan, FOC = 0

$$U_{L_i} = 0$$

$$\frac{P_i}{P} - L_i^{\gamma-1} = 0, \quad (6.4)$$

$$\frac{P_i}{P} = L_i^{\gamma-1}$$

$$L_i = \left( \frac{P_i}{P} \right)^{1/(\gamma-1)} \quad (6.5)$$

$$L_i = \left( \frac{P_i}{P} \right)^{1/(\gamma-1)} \quad (6.5)$$

$$\log L_i = \log \left( \frac{P_i}{P} \right)^{1/(\gamma-1)}$$

$$\log L_i = 1/(\gamma-1) \log \left( \frac{P_i}{P} \right)$$

$$\log L_i = 1/(\gamma-1) (\log P_i - \log P)$$

$$\ell_i = \frac{1}{\gamma-1} (p_1 - p) \quad (6.6)$$

(6.6)

$$\ell_i = \frac{1}{\gamma-1}(p_1 - p)$$

$$\frac{1}{\gamma-1}(p_i - p) = y + z_1 - \eta(p_i - p).$$

$$\frac{1}{\gamma-1}(p_i - p) + \eta(p_i - p) = y + z_1$$

$$\left\{ \frac{1}{\gamma-1} + \eta \right\} (p_i - p) = y + z_1$$

$$\left\{ \frac{1}{\gamma-1} + \eta \right\} p_i - \left\{ \frac{1}{\gamma-1} + \eta \right\} p = y + z_1$$

$$\left\{ \frac{1}{\gamma-1} + \eta \right\} p_i = y + z_1 + - \left\{ \frac{1}{\gamma-1} + \eta \right\} p$$

$$p_i = \frac{y + z_1}{\frac{1}{\gamma-1} + \eta} + p$$

$$p_i = \frac{(\gamma-1)(y + z_1)}{1 + \eta\gamma - \eta} + p$$

(6.7)

$$q_i = y + z_i - \eta(p_i - p), \quad \eta > 0,$$

(6.11)

$$p_i = \frac{(\gamma-1)(y + z_1)}{1 + (\gamma-1)\eta} + p$$

(6.12)

$$p_i = \frac{(\gamma-1)(y + z_1)}{1 + \eta\gamma - \eta} + p \quad (6.12)$$

$$\bar{p} = \bar{p}_i$$

$$\bar{z}_i = 0$$

$$p = \frac{(\gamma-1)}{1 + \eta\gamma - \eta} y + p \quad (6.13)$$

$$\frac{(\gamma-1)}{1 + \eta\gamma - \eta} y = 0$$

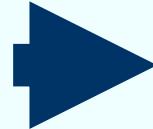
$$y = 0 \quad (6.14)$$

$$y = m - p \quad \rightarrow \quad p = m \quad (6.15)$$

$$y = 0$$

$$y = b(p_i - E[p]) \quad (6.21)$$

$$y = m - p \quad (6.10)$$



$$m - p = b(p - E[p]),$$

$$m - p = bp - bE[p],$$

$$p + bp = m + bE[p]$$

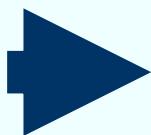
$$p(1+b) = m + bE[p]$$

$$p = \frac{1}{1+b}m + \frac{b}{1+b}E[p], \quad (6.22)$$

$$p = \frac{1}{1+b}m + \frac{b}{1+b}E[p], \quad (6.22)$$

$$y = m - p$$

(6.10)



$$y = m - \left( \frac{1}{1+b}m + \frac{b}{1+b}E[p] \right)$$

$$y = m - \frac{1}{1+b}m - \frac{b}{1+b}E[p]$$

$$y = \left( 1 - \frac{1}{1+b} \right)m - \frac{b}{1+b}E[p]$$

$$y = \frac{(1+b)-1}{1+b}m - \frac{b}{1+b}E[p]$$

$$y = \frac{b}{1+b}m - \frac{b}{1+b}E[p] \quad (6.23)$$

$$E[p] = \frac{1}{1+b}E[m] + \frac{b}{1+b}E[p] \quad (6.24)$$

$$E[p] - \frac{b}{1+b}E[p] = \frac{1}{1+b}E[m]$$

$$(1 - \frac{b}{1+b})E[p] = \frac{1}{1+b}E[m]$$

$$(\frac{1+b-b}{1+b})E[p] = \frac{1}{1+b}E[m]$$

$$(\frac{1}{1+b})E[p] = \frac{1}{1+b}E[m]$$

$$E[p] = E[m] \quad (6.25)$$

$$p = \frac{1}{1+b}m + \frac{b}{1+b}E[p] \quad (6.22)$$

$$E[p] = E[m] \quad (6.25)$$

$$m = E[m] + (m - E[m])$$

$$p = \frac{1}{1+b}\{Em + (m - E[m])\} + \frac{b}{1+b}E[m],$$

$$p = \frac{1}{1+b}E[m] + \frac{b}{1+b}E[m] + \frac{1}{1+b}(m - E[m])$$

$$p = \left(\frac{1}{1+b} + \frac{b}{1+b}\right)E[m] + \frac{1}{1+b}(m - E[m])$$

$$p = E[m] + \frac{1}{1+b}(m - E[m]) \quad (6.26)$$

$$y = \frac{b}{1+b}m - \frac{b}{1+b}E[p], \quad (6.23)$$

$$E[p] = E[m] \quad (6.25)$$

$$m = E[m] + (m - E[m])$$

$$y = \frac{b}{1+b}\{Em + (m - E[m])\} - \frac{b}{1+b}E[m],$$

$$y = \frac{b}{1+b}Em + \frac{b}{1+b}(m - E[m]) - \frac{b}{1+b}E[m],$$

$$y = \frac{b}{1+b}(m - E[m]) \quad (6.27)$$