macro

Topic 10:

Aggregate Demand II

(chapter 11)

macroeconomics

fifth edition

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PowerPoint® Slides
by Ron Cronovich

Context

- Chapter 9 introduced the model of aggregate demand and supply.
- Chapter 10 developed the IS-LM model, the basis of the aggregate demand curve.
- In Chapter 11, we will use the IS-LM model to
  - see how policies and shocks affect income and the interest rate in the short run when prices are fixed
  - derive the aggregate demand curve
  - explore various explanations for the Great Depression

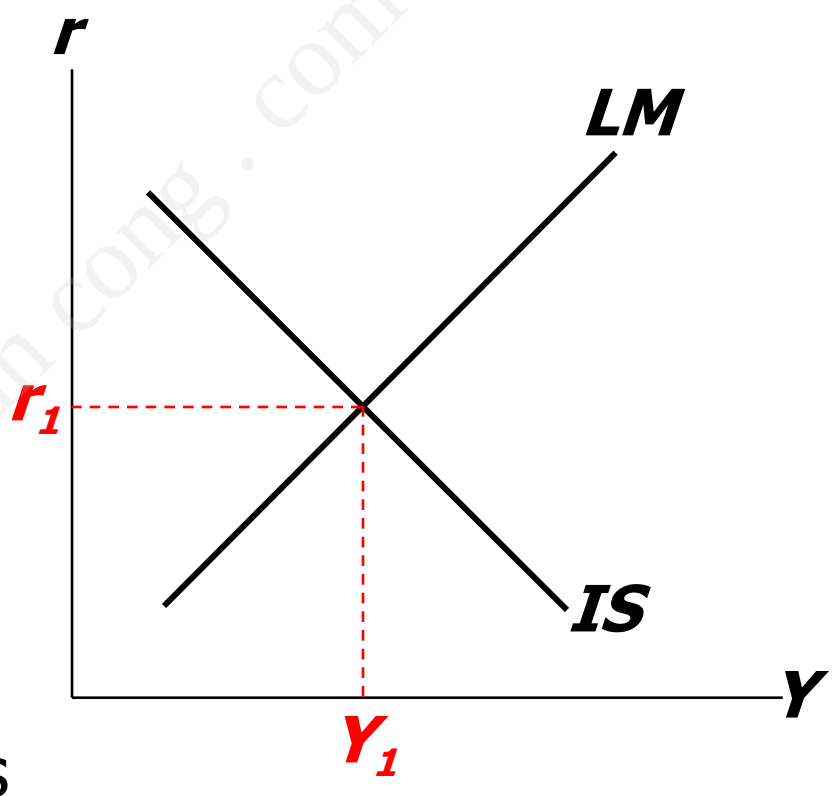
Equilibrium in the *IS-LM* Model

The *IS* curve represents equilibrium in the goods market.

$$Y = C(Y - \bar{T}) + I(r) + \bar{G}$$

The *LM* curve represents money market equilibrium.

$$\bar{M}/\bar{P} = L(r, Y)$$



The intersection determines the unique combination of ***Y*** and ***r*** that satisfies equilibrium in both markets.

Policy analysis with the *IS-LM* Model

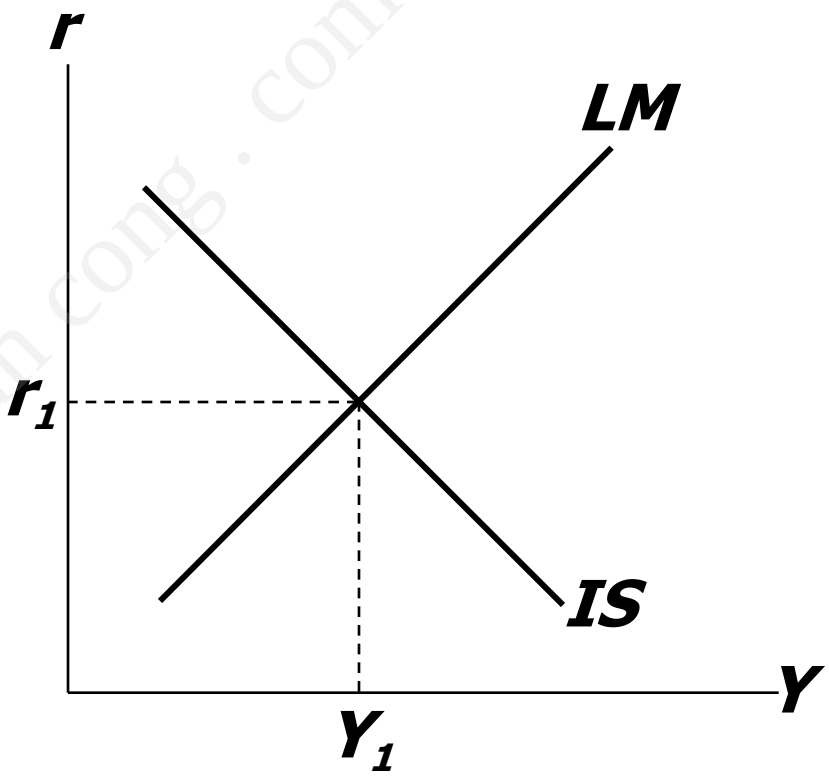
$$Y = C(Y - \bar{T}) + I(r) + \bar{G}$$

$$\bar{M}/\bar{P} = L(r, Y)$$

Policymakers can affect macroeconomic variables with

- fiscal policy: G and/or T
- monetary policy: M

We can use the *IS-LM* model to analyze the effects of these policies.



An increase in government purchases

1. *IS* curve shifts right

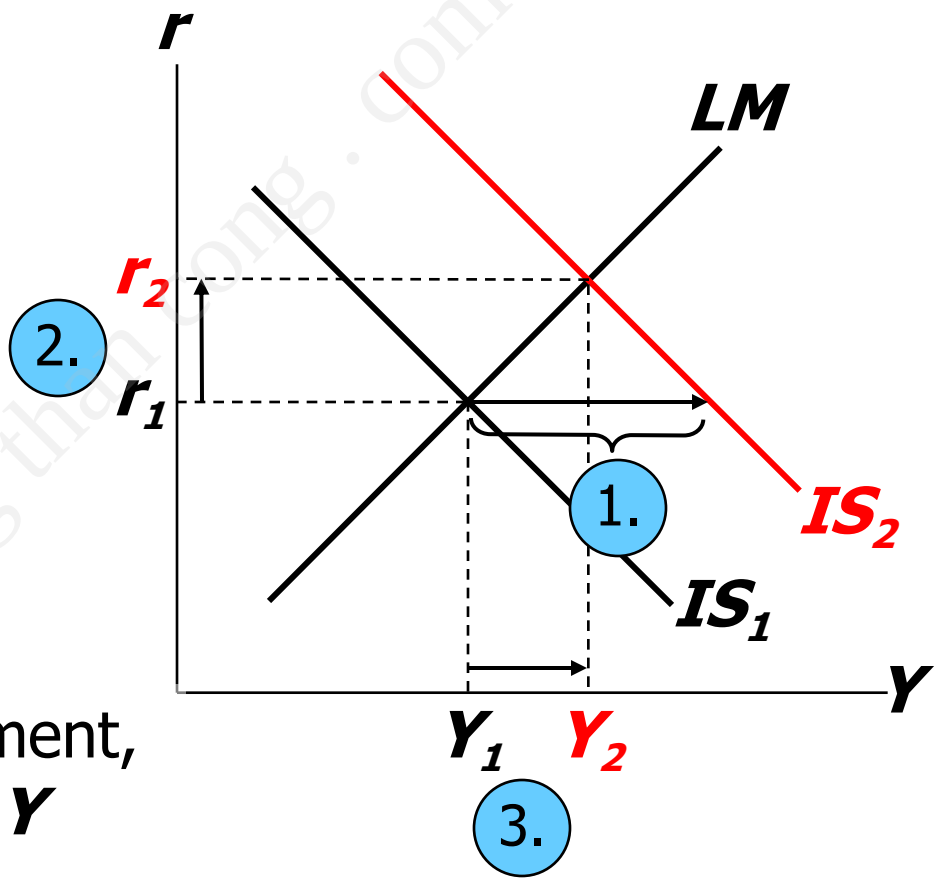
   by $\frac{1}{1 - MPC} \Delta G$

   causing output & income to rise.

2. This raises money demand, causing the interest rate to rise…

3. …which reduces investment, so the final increase in Y

   is smaller than $\frac{1}{1 - MPC} \Delta G$



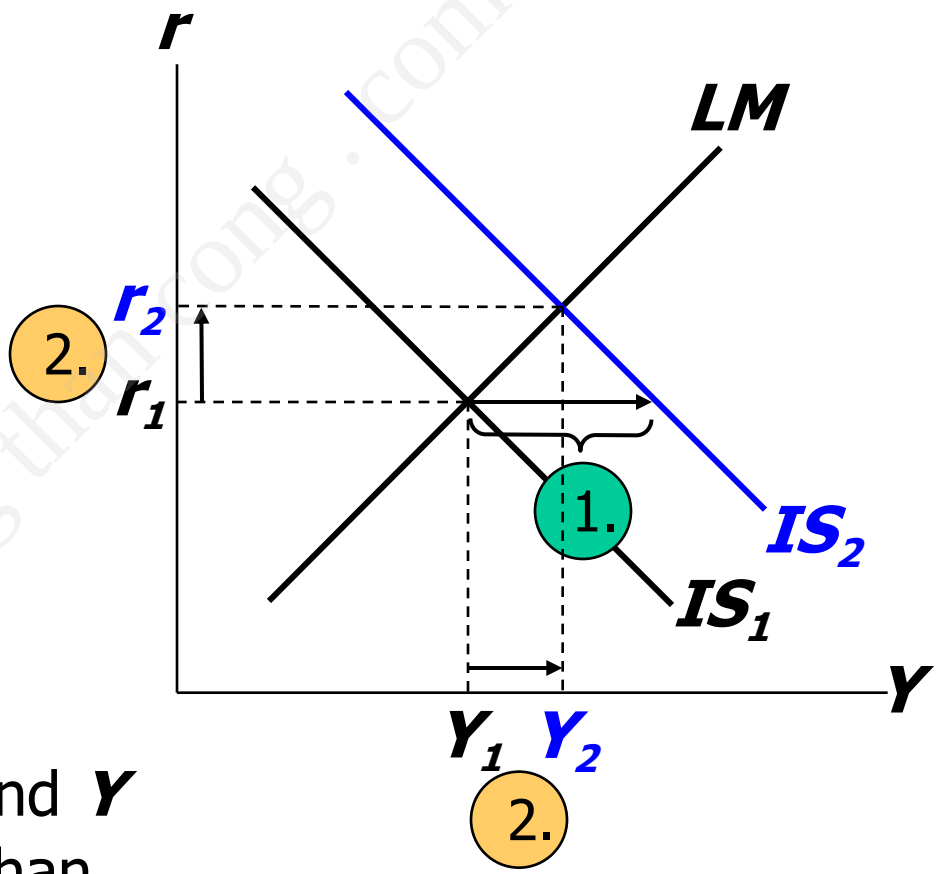
A tax cut

Because consumers save (1–MPC) of the tax cut, the initial boost in spending is smaller for ΔT than for an equal ΔG…

and the *IS* curve shifts by

1. $\frac{-MPC}{1-MPC}\Delta T$

2. …so the effects on r and Y are smaller for a ΔT than for an equal ΔG.

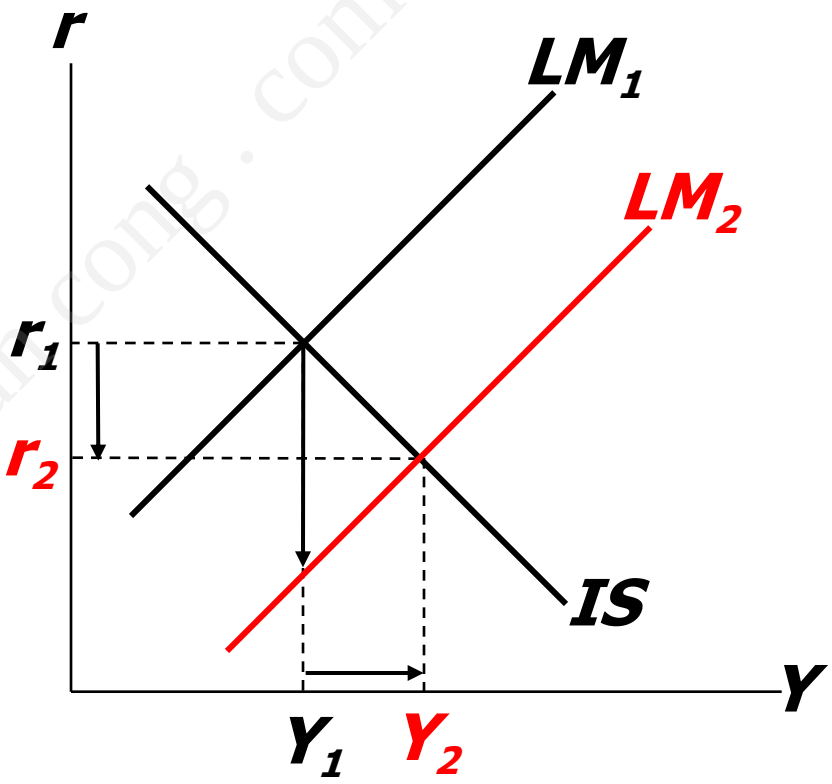


Monetary Policy: an increase in *M*

1. $\Delta M > 0$ shifts the *LM* curve down (or to the right)

2. …causing the interest rate to fall

3. …which increases investment, causing output & income to rise.



Interaction between monetary & fiscal policy

- Model:
  monetary & fiscal policy variables
  (***M***, ***G*** and ***T***) are exogenous
- Real world:
  Monetary policymakers may adjust ***M***
  in response to changes in fiscal policy,
  or vice versa.
- Such interaction may alter the impact of the original policy change.

The Fed's response to $\Delta G > 0$

- Suppose Congress increases G.
- Possible Fed responses:
  1. hold M constant
  2. hold r constant
  3. hold Y constant
- In each case, the effects of the ΔG are different:

Response 1: hold *M* constant

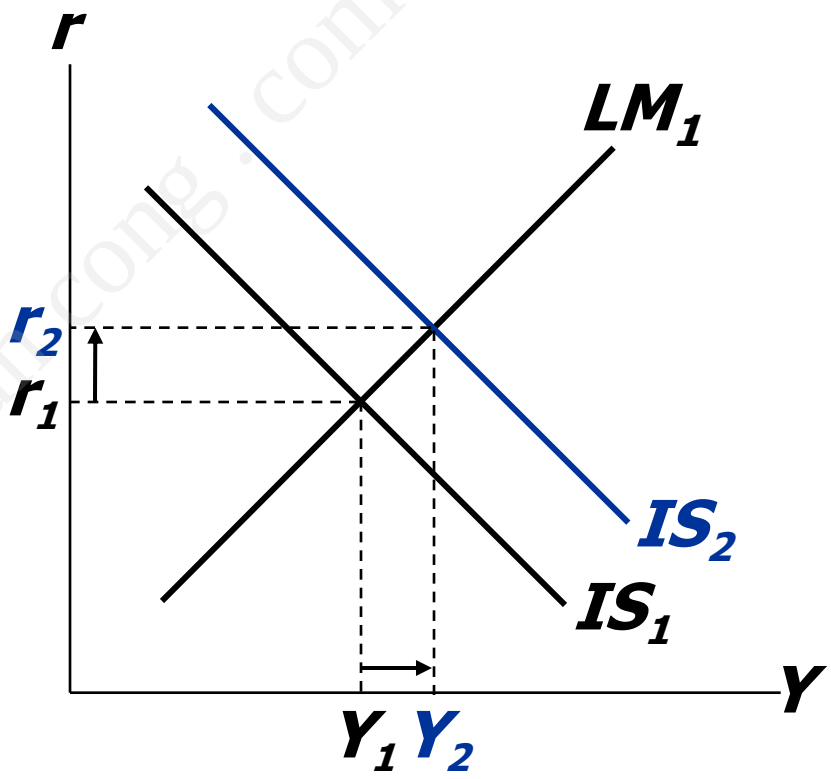
If Congress raises ***G***, the *IS* curve shifts right

If Fed holds ***M*** constant, then *LM* curve doesn't shift.

Results:

$$\Delta Y = Y_2 - Y_1$$

$$\Delta r = r_2 - r_1$$



Response 2: hold *r* constant

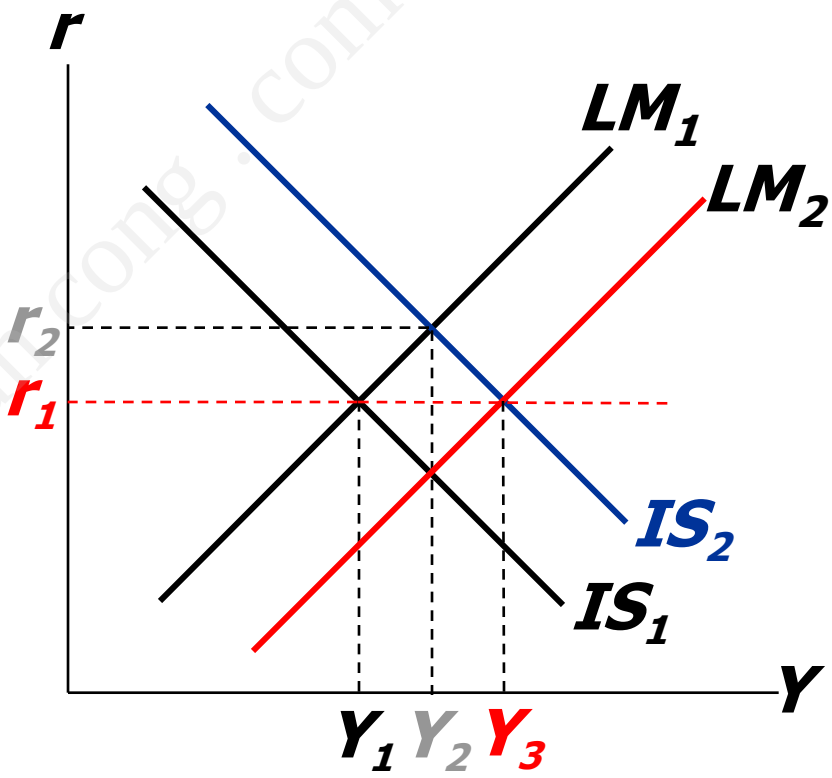
If Congress raises ***G***, the *IS* curve shifts right

To keep ***r*** constant, Fed increases ***M*** to shift *LM* curve right.

Results:

$$\Delta Y = Y_3 - Y_1$$

$$\Delta r = 0$$



Response 3: hold *Y* constant

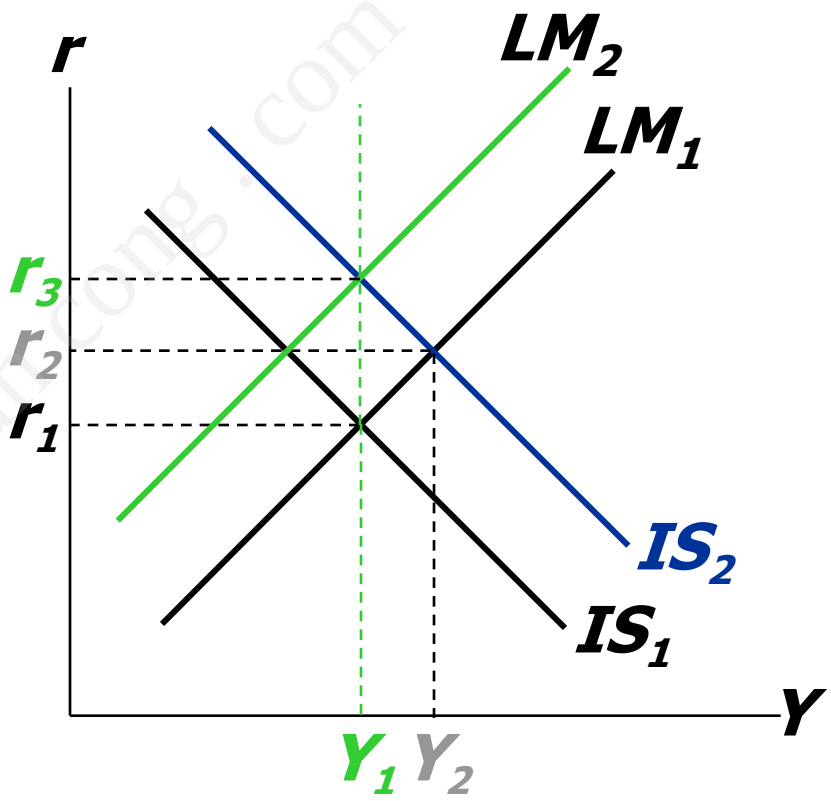
If Congress raises ***G***, the *IS* curve shifts right

To keep ***Y*** constant, Fed reduces ***M*** to shift *LM* curve left.

Results:

$$\Delta Y = 0$$

$$\Delta r = r_3 - r_1$$



Estimates of fiscal policy multipliers

from the DRI macroeconometric model

Assumption about monetary policy	**Estimated value of $\Delta Y/\Delta G$**	**Estimated value of $\Delta Y/\Delta T$**
Fed holds money supply constant	0.60	–0.26
Fed holds nominal interest rate constant	1.93	–1.19

Shocks in the *IS-LM* Model

***IS* shocks**: exogenous changes in the demand for goods & services.

Examples:

- stock market boom or crash
  $\Rightarrow$ change in households' wealth
  $\Rightarrow \Delta \boldsymbol{C}$
- change in business or consumer confidence or expectations
  $\Rightarrow \Delta \boldsymbol{I}$ and/or $\Delta \boldsymbol{C}$

Shocks in the *IS-LM* Model

***LM* shocks**: exogenous changes in the demand for money.

Examples:

- a wave of credit card fraud increases demand for money
- more ATMs or the Internet reduce money demand

CASE STUDY
The U.S. economic slowdown of 2001

~*What happened*~

1. Real GDP growth rate
   1994-2000: 3.9% (average annual)
   2001: 1.2%

2. Unemployment rate
   Dec 2000: 4.0%
   Dec 2001: 5.8%

CASE STUDY
The U.S. economic slowdown of 2001

~Shocks that contributed to the slowdown~

1. Falling stock prices

   From Aug 2000 to Aug 2001: -25%

   Week after 9/11: -12%

2. The terrorist attacks on 9/11
   - increased uncertainty
   - fall in consumer & business confidence

Both shocks reduced spending and shifted the IS curve left.

CASE STUDY
The U.S. economic slowdown of 2001

~The policy response~

1. Fiscal policy
   - large long-term tax cut,
     immediate $300 rebate checks
   - spending increases:
     aid to New York City & the airline industry,
     war on terrorism
2. Monetary policy
   - Fed lowered its Fed Funds rate target
     11 times during 2001, from 6.5% to 1.75%
   - Money growth increased, interest rates fell

CASE STUDY
The U.S. economic slowdown of 2001

~What's happening now~

- In the first quarter of 2002, Real GDP grew at an annual rate of 6.1%, suggesting recession had ended.
- Though since then growth has been slower, around 2%.
- In its news release in July 2003, the NBER Business Cycle Dating Committee declared the ending date for the recessions as November 2001.

What is the Fed's policy instrument?

What the newspaper says:
"the Fed lowered interest rates by one-half point today"

What actually happened:
The Fed conducted expansionary monetary policy to shift the LM curve to the right until the interest rate fell 0.5 points.

The Fed targets the Federal Funds rate:
it announces a target value,
and uses monetary policy to shift the LM curve
as needed to attain its target rate.

What is the Fed's policy instrument?

Why does the Fed target interest rates instead of the money supply?

1) They are easier to measure than the money supply
2) The Fed might believe that *LM* shocks are more prevalent than *IS* shocks. If so, then targeting the interest rate stabilizes income better than targeting the money supply.

IS-LM and Aggregate Demand

- So far, we've been using the *IS-LM* model to analyze the short run, when the price level is assumed fixed.
- However, a change in ***P*** would shift the *LM* curve and therefore affect ***Y***.
- The **aggregate demand curve** (*introduced in chap. 9*) captures this relationship between ***P*** and ***Y***

Deriving the *AD* curve

Intuition for slope of *AD* curve:

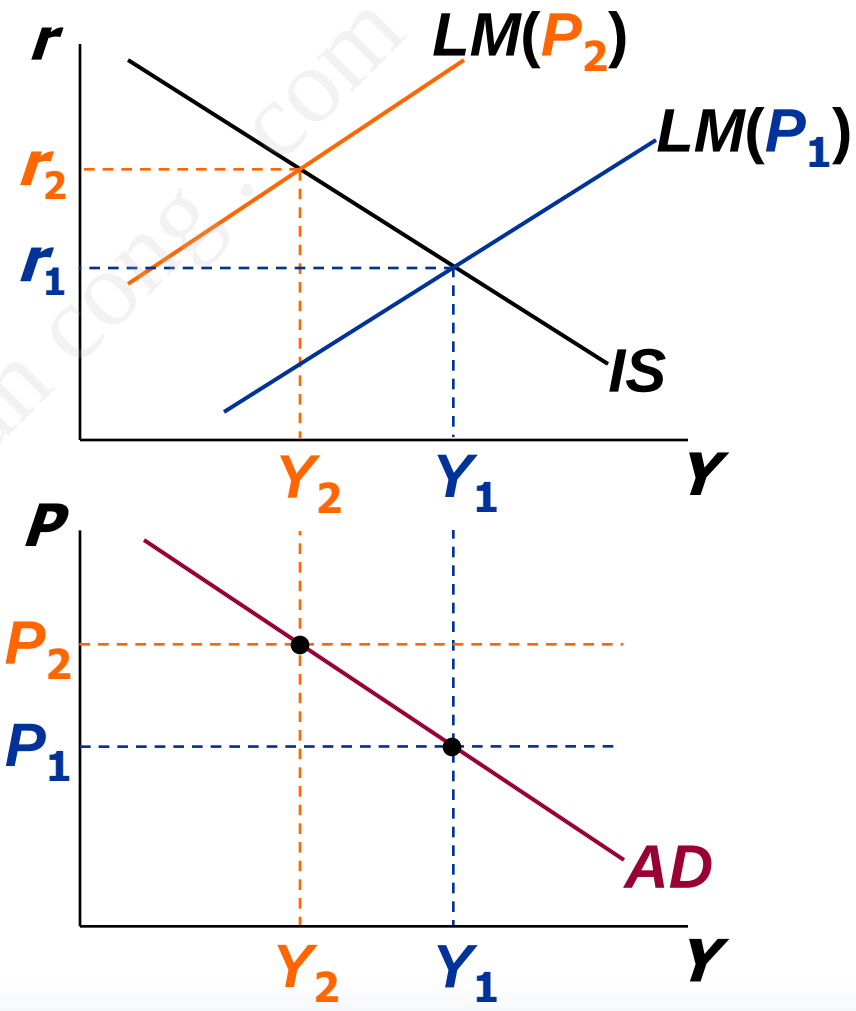
$\uparrow P \Rightarrow \downarrow(M/P)$

$\Rightarrow$ *LM* shifts left

$\Rightarrow \uparrow r$

$\Rightarrow \downarrow I$

$\Rightarrow \downarrow Y$



Monetary policy and the *AD* curve

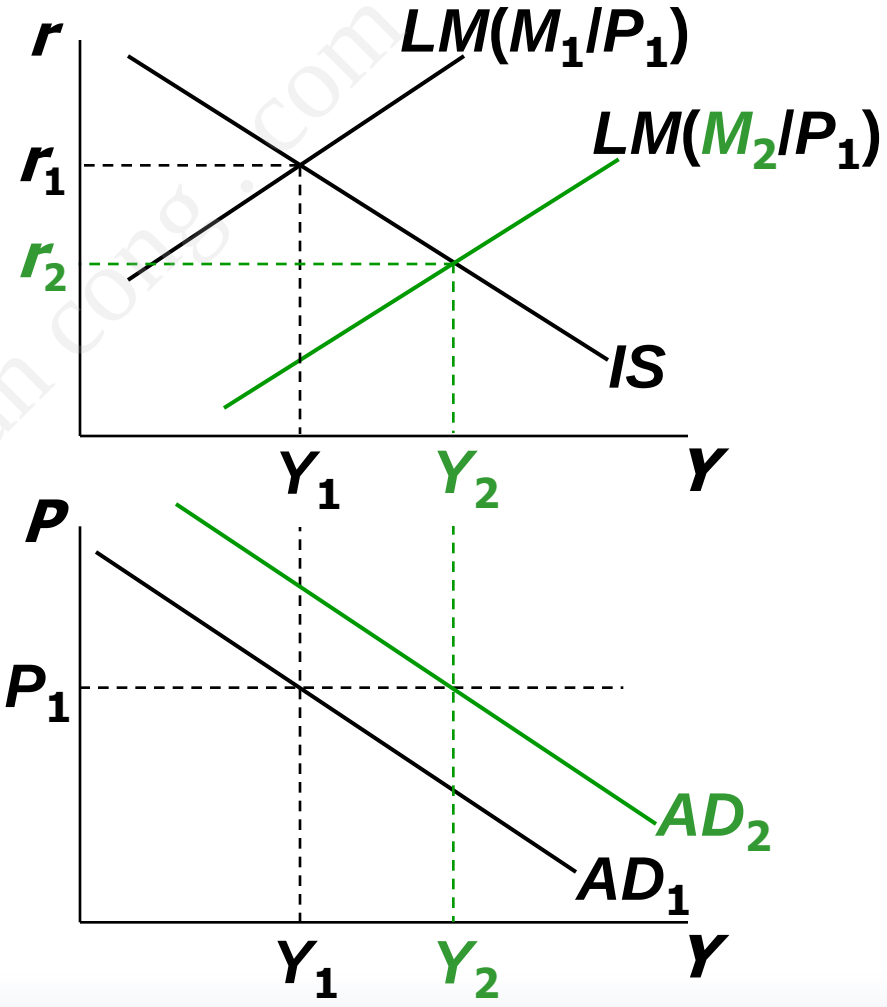
The Fed can increase aggregate demand:

$\uparrow M \Rightarrow LM$ shifts right

$\Rightarrow \downarrow r$

$\Rightarrow \uparrow I$

$\Rightarrow \uparrow Y$ at each value of P



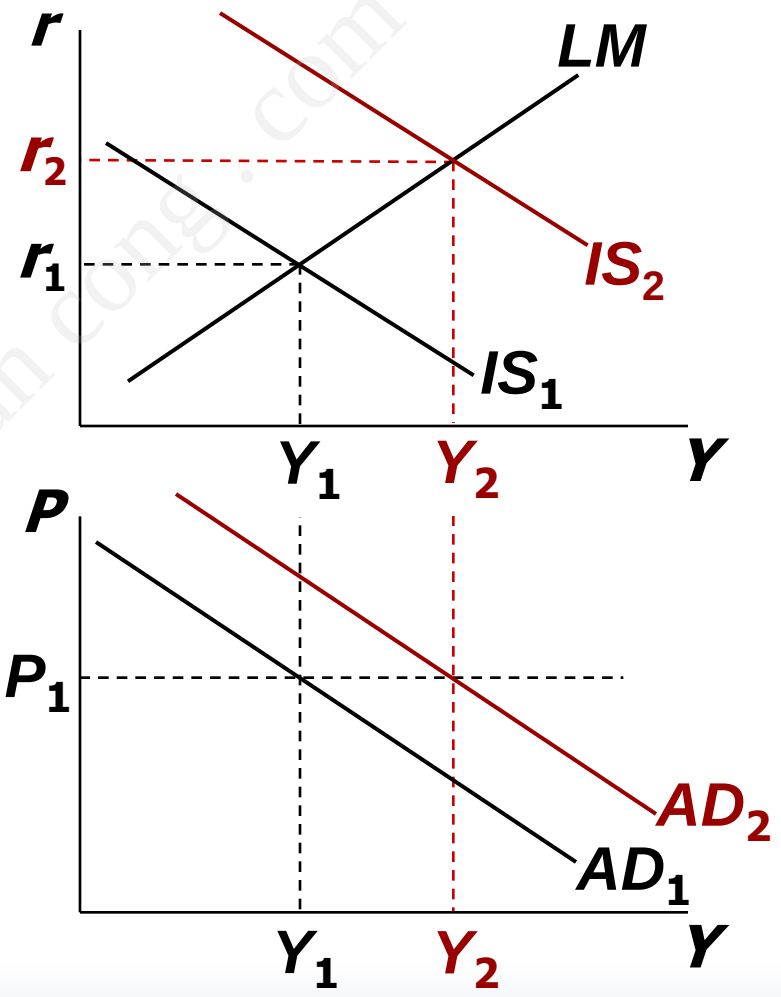
Fiscal policy and the *AD* curve

Expansionary fiscal policy
($\uparrow G$ and/or $\downarrow T$)
increases agg. demand:

$\downarrow T \Rightarrow \uparrow C$

$\Rightarrow$ IS shifts right

$\Rightarrow \uparrow Y$ at each value of P



Deriving AD curve with algebra

Suppose the expenditure side of the economy is characterized by:

$$C = \bar{C} + b(Y - T) \qquad 0 < b < 1$$

$$I = \bar{I} - dr \qquad d > 0$$

$$G = \bar{G}, \quad T = \bar{T}$$

where: b & d are some numbers,

$\bar{C}$ is the 'autonomous part of consumption'

and $\bar{I}$ is 'autonomous investment'

Deriving AD curve with algebra

Use the goods market equilibrium condition

$$Y = C + I + G$$

$$Y = \overline{C} + b(Y - \overline{T}) + \overline{I} - dr + \overline{G}$$

Solve for Y:

$$Y - bY = \overline{C} - b\overline{T} + \overline{I} - dr + \overline{G}$$

$$(1 - b)Y = \overline{C} + \overline{I} + \overline{G} - b\overline{T} + \overline{I} - dr$$

$$IS: Y = \left(\frac{\overline{C} + \overline{I}}{1 - b}\right) + \left(\frac{1}{1 - b}\right)\overline{G} - \left(\frac{b}{1 - b}\right)\overline{T} - \left(\frac{d}{1 - b}\right)r$$

A line relating Y to r with slope $-d/(1-b)$

Can see multipliers here: rise in Y taking r as given.
But r is an endogenous variable and it will change…

Deriving AD curve with algebra

Use the money market to find a value for r:

As done for the LM curve previously, suppose the money market is characterized by:

$$M/P^d = eY - fr \qquad e > 0, f > 0$$

$$M/P^s = \overline{M}/P$$

Equilibrium in money market requires:

$$M/P^s = M/P^d$$

So LM: $\overline{M}/P = eY - fr$

or write as: $r = \left(\frac{e}{f}\right)Y - \left(\frac{1}{f}\right)\frac{\overline{M}}{P}$

Line with slope = e/f

Deriving AD curve with algebra

Now combine the two, substituting in for r:

$$\text{IS: } Y = \left(\frac{\bar{C} + \bar{I}}{1 - b}\right) + \left(\frac{1}{1 - b}\right)\bar{G} - \left(\frac{b}{1 - b}\right)\bar{T} - \left(\frac{d}{1 - b}\right) r$$

$$\text{LM: } r = \left(\frac{e}{f}\right) Y - \left(\frac{1}{f}\right)\frac{\bar{M}}{P}$$

$$Y = \left(\frac{\bar{C} + \bar{I}}{1 - b}\right) + \left(\frac{\bar{G}}{1 - b}\right) - \left(\frac{b\bar{T}}{1 - b}\right) - \left(\frac{d}{1 - b}\right)\left(\left(\frac{e}{f}\right) Y - \left(\frac{1}{f}\right)\frac{\bar{M}}{P}\right)$$

Solve for Y. For convenience, define a term:

$$z = f / [f + de / (1 - b)], \quad \text{so } 0 < z < 1$$

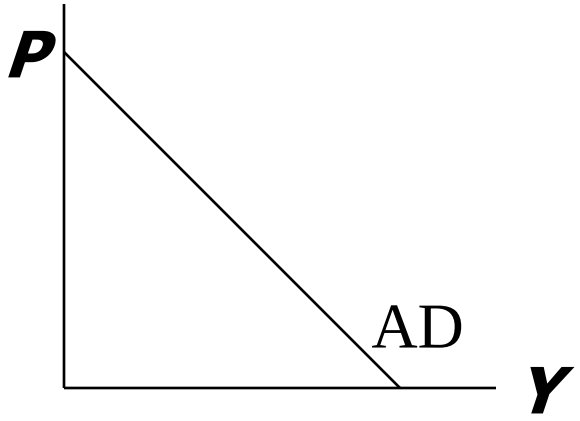
$$Y = z\left(\frac{\bar{C} + \bar{I}}{1 - b}\right) + \left(\frac{z}{1 - b}\right)\bar{G} + \left(\frac{-zb}{1 - b}\right)\bar{T} + \left(\frac{d}{f\ 1 - b + de}\right)\frac{\bar{M}}{P}$$

Deriving AD curve with algebra

$$Y = z\left(\frac{\bar{C} + \bar{I}}{1 - b}\right) + \left(\frac{z}{1 - b}\right)\bar{G} + \left(\frac{-zb}{1 - b}\right)\bar{T} + \left(\frac{d}{f\,(1 - b) + de}\right)\frac{\bar{M}}{P}$$

$$\text{where } z = f / [f + de / (1 - b)], \qquad 0 < z < 1$$

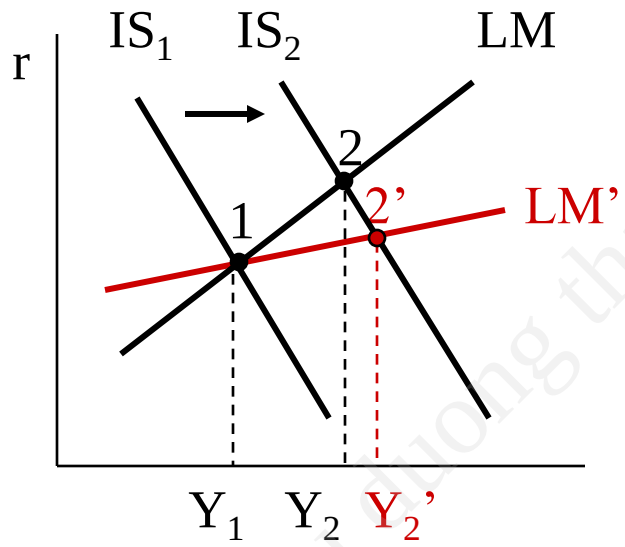
This implies a negative relationship between output (Y) and price level (P): an Aggregate Demand curve.



This math can help reveal under what conditions monetary and fiscal policies will be most effective…

Policy Effectiveness

Fiscal policy is effective (***Y*** will rise much) when:
1) LM flatter (***f*** large or ***e*** small, so ***z*** near 1)



As the rise in ***G*** raises Y,

the increase in money demand does not raise ***r*** much:
-small e:M^d not responsive to Y
-large f: M^d is responsive to r

so investment is not crowed out as much.

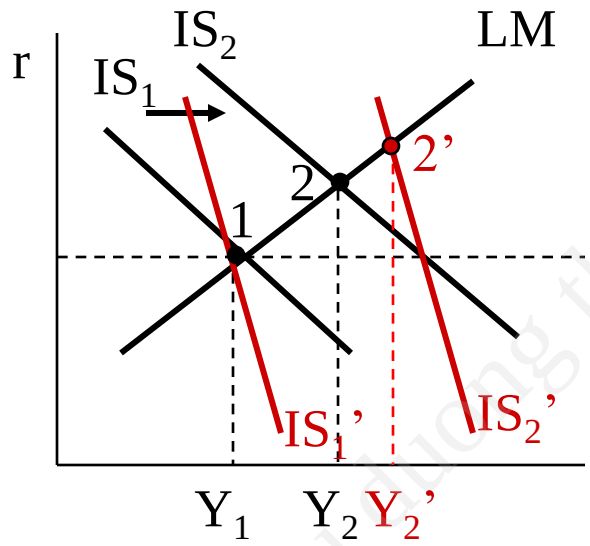
$$Y = z\left(\frac{\bar{C} + \bar{I}}{1 - b}\right) + \left(\frac{z}{1 - b}\right)\bar{G} + \left(\frac{-zb}{1 - b}\right)\bar{T} + \left(\frac{d}{f\,(1 - b) + de}\right)\frac{\bar{M}}{P}$$

$$\text{where } z = f / [f + de / (1 - b)], \qquad 0 < z < 1$$

Policy Effectiveness

Fiscal policy is effective (***Y*** will rise much) when:

2) IS steeper (***d*** small: ***I*** not responsive to ***r***, z near 1)



As the rise in ***G*** raises ***Y***:

investment does not respond much to the rising ***r*** coming from the money market,

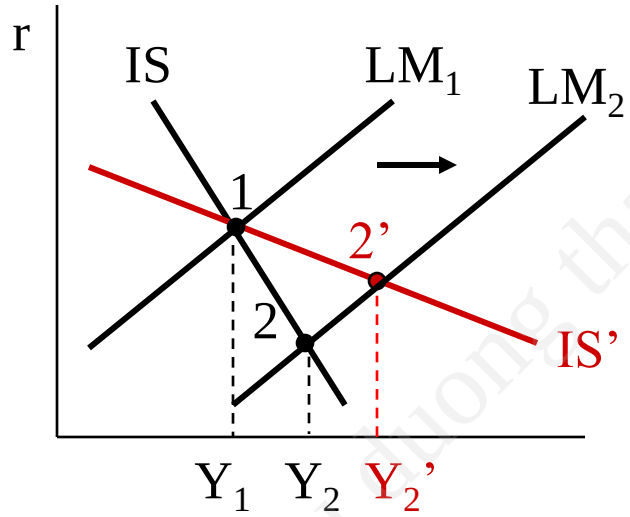
so investment is not crowed out as much.

$$Y = z\left(\frac{\bar{C} + \bar{I}}{1 - b}\right) + \left(\frac{z}{1 - b}\right)\bar{G} + \left(\frac{-zb}{1 - b}\right)\bar{T} + \left(\frac{d}{f\,(1 - b) + de}\right)\frac{\bar{M}}{P}$$

$$\text{where } z = f / [f + de / (1 - b)], \qquad 0 < z < 1$$

Policy Effectiveness

Monetary policy is effective (***Y*** will rise much) when:
1) IS flatter (***d*** large: Investment is responsive to ***r***)



As a rise in ***M*** lowers the interest rate (***r***),

investment rises more in response to the fall in ***r***,

so output rises more.

$$Y = z\left(\frac{\bar{C} + \bar{I}}{1 - b}\right) + \left(\frac{z}{1 - b}\right)\bar{G} + \left(\frac{-zb}{1 - b}\right)\bar{T} + \left(\frac{d}{f\,(1 - b) + de}\right)\frac{\bar{M}}{P}$$

$$\text{where } z = f / [f + de / (1 - b)], \qquad 0 < z < 1$$

Policy Effectiveness

Monetary policy is effective (***Y*** will rise much) when:
2) LM steeper (***f*** small: money demand not responsive to ***r***)

A rise in ***M*** requires a large fall in the interest rate (***r***) to make people willing to hold the extra cash.

The large fall in ***r*** raises investment expenditure much, and this raises output much.

(This is hard to show graphically, because ***f*** affects shift as well as slope.)

$$Y = z\left(\frac{\bar{C} + \bar{I}}{1 - b}\right) + \left(\frac{z}{1 - b}\right)\bar{G} + \left(\frac{-zb}{1 - b}\right)\bar{T} + \left(\frac{d}{f\ 1 - b + de}\right)\frac{\bar{M}}{P}$$

$$\text{where } z = f / [f + de / (1 - b)], \qquad 0 < z < 1$$

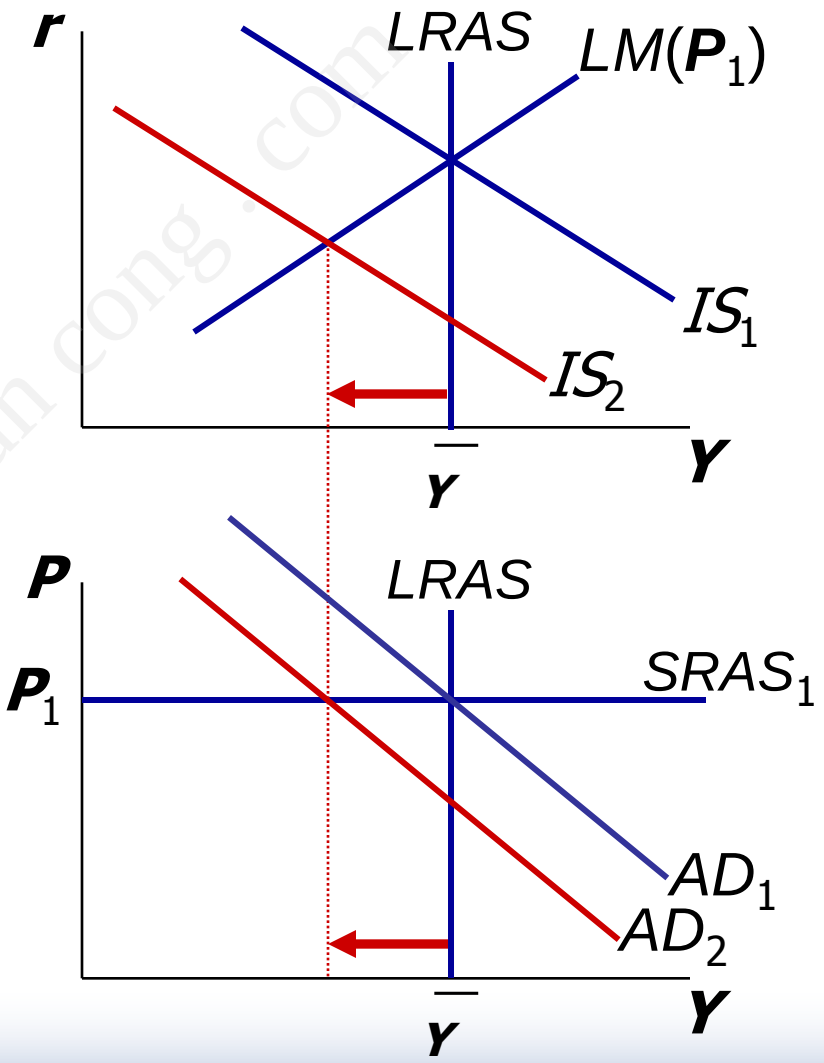
IS-LM and *AD-AS* in the short run & long run

Recall from Chapter 9: The force that moves the economy from the short run to the long run is the gradual adjustment of prices.

In the short-run equilibrium, if	then over time, the price level will
$Y > \bar{Y}$	rise
$Y < \bar{Y}$	fall
$Y = \bar{Y}$	remain constant

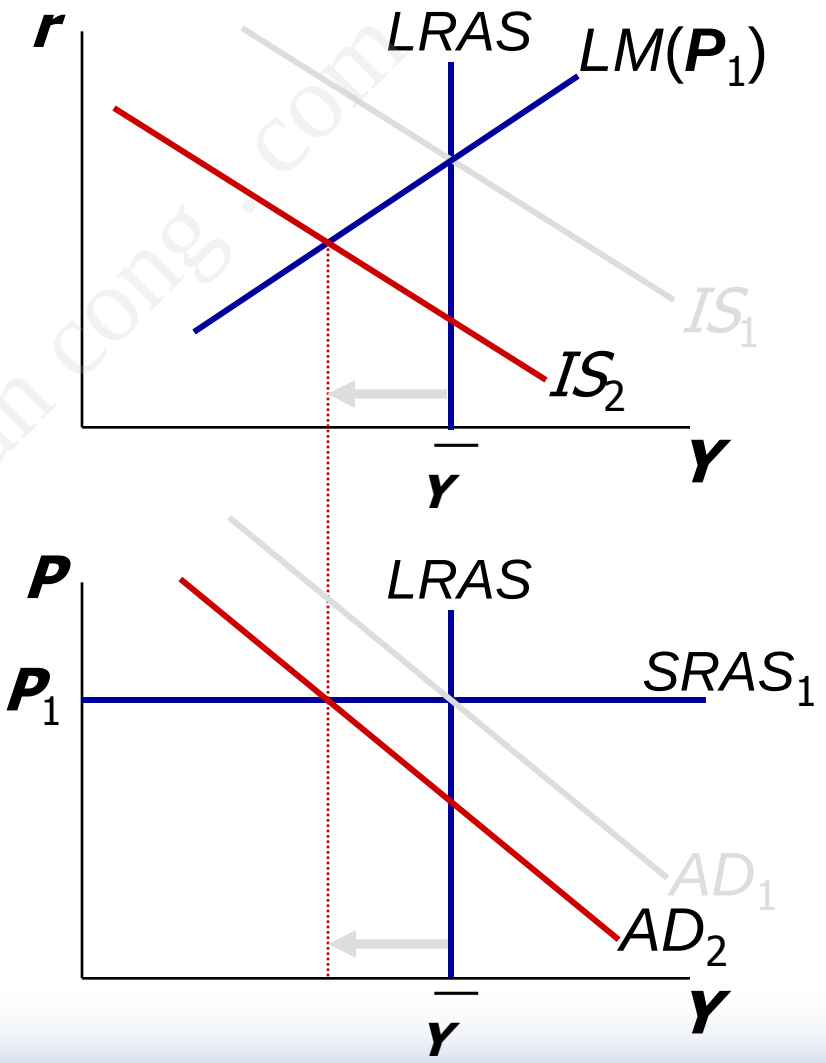
The SR and LR effects of an *IS* shock

A negative *IS* shock shifts *IS* and *AD* left, causing $\boldsymbol{Y}$ to fall.



The SR and LR effects of an *IS* shock

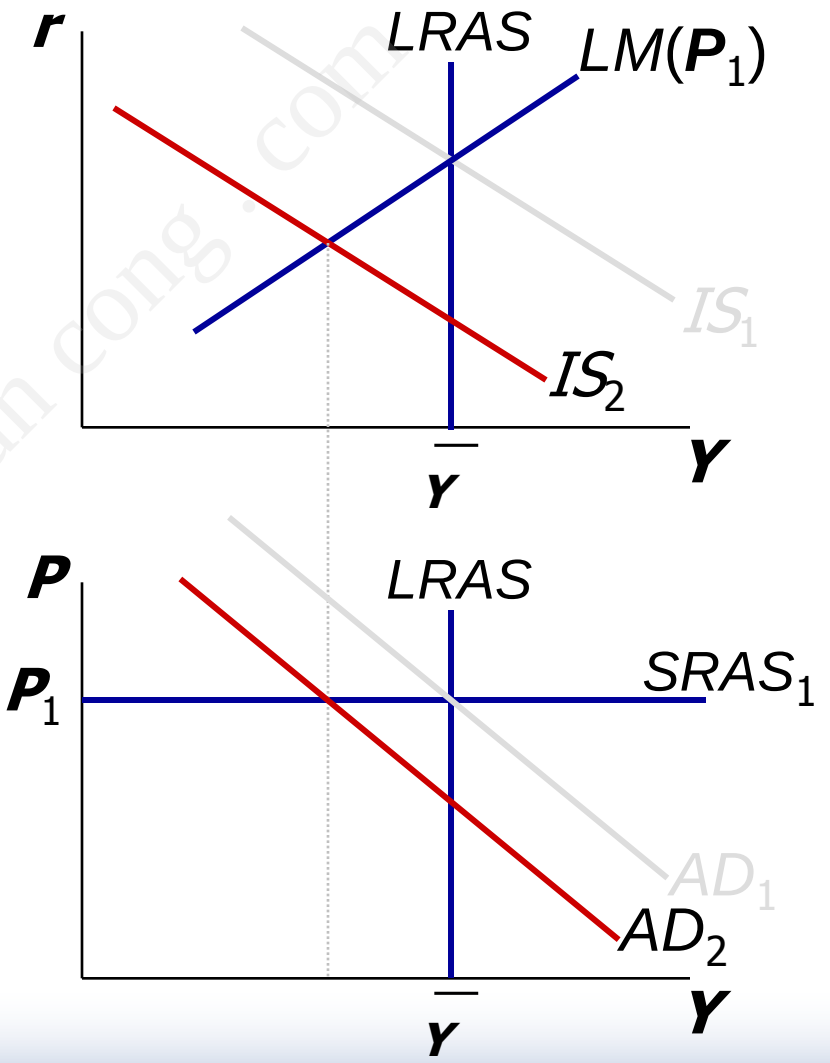
In the new short-run equilibrium, $Y < \bar{Y}$



The SR and LR effects of an *IS* shock

In the new short-run equilibrium, $Y < \bar{Y}$

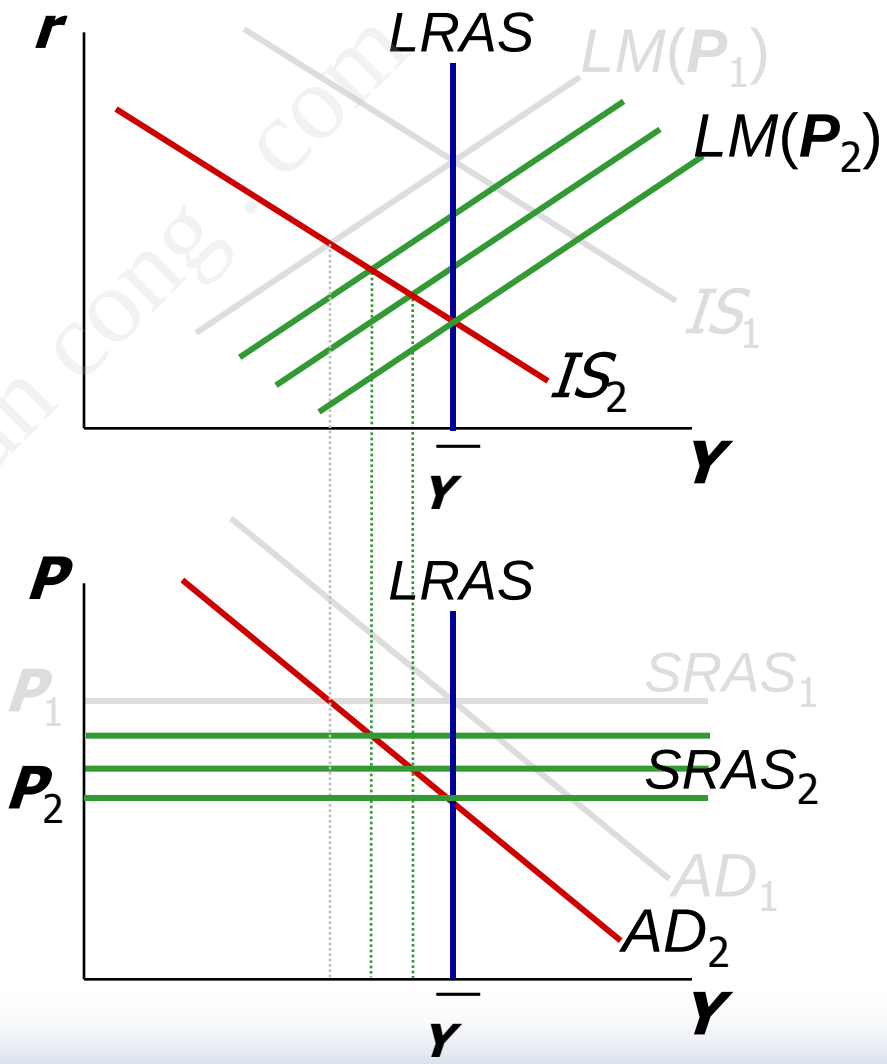
Over time,
P gradually falls,
which causes
- *SRAS* to move down
- M/P to increase, which causes *LM* to move down



The SR and LR effects of an *IS* shock

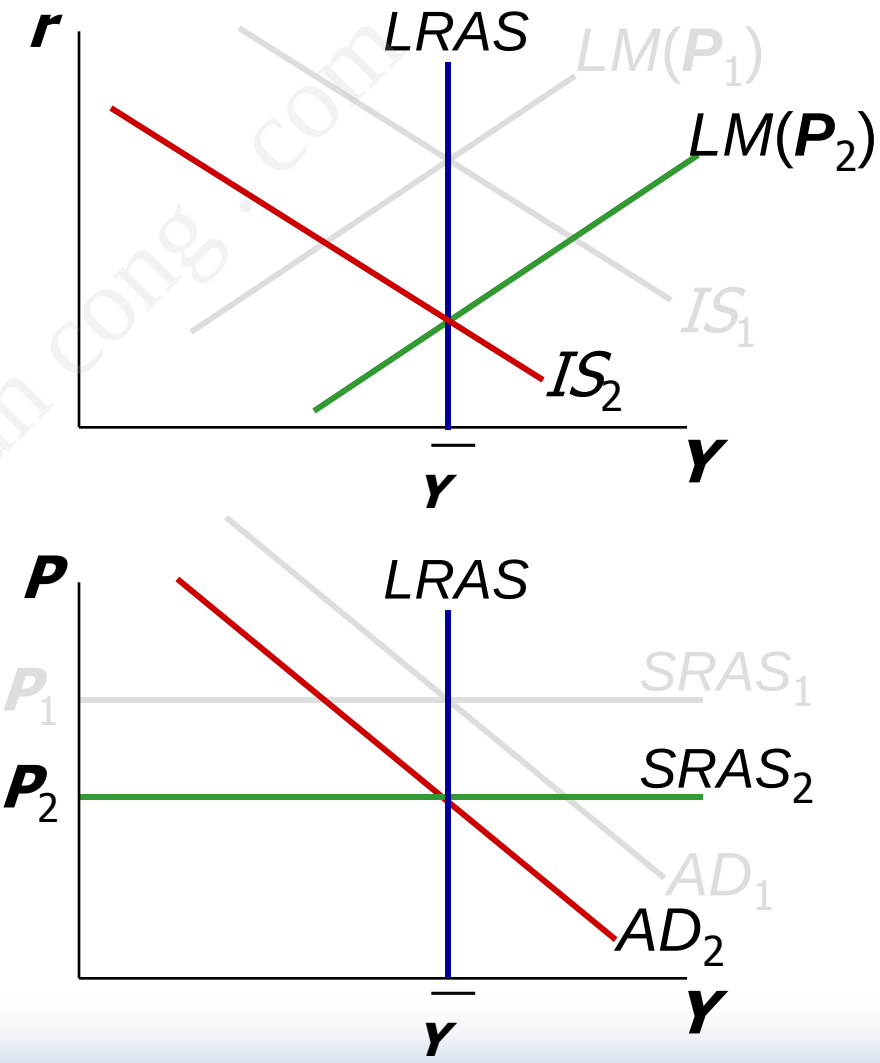
Over time,
P gradually falls,
which causes

- *SRAS* to move down
- ***M/P*** to increase, which causes *LM* to move down



The SR and LR effects of an *IS* shock

This process continues until economy reaches a long-run equilibrium with $Y = \bar{Y}$



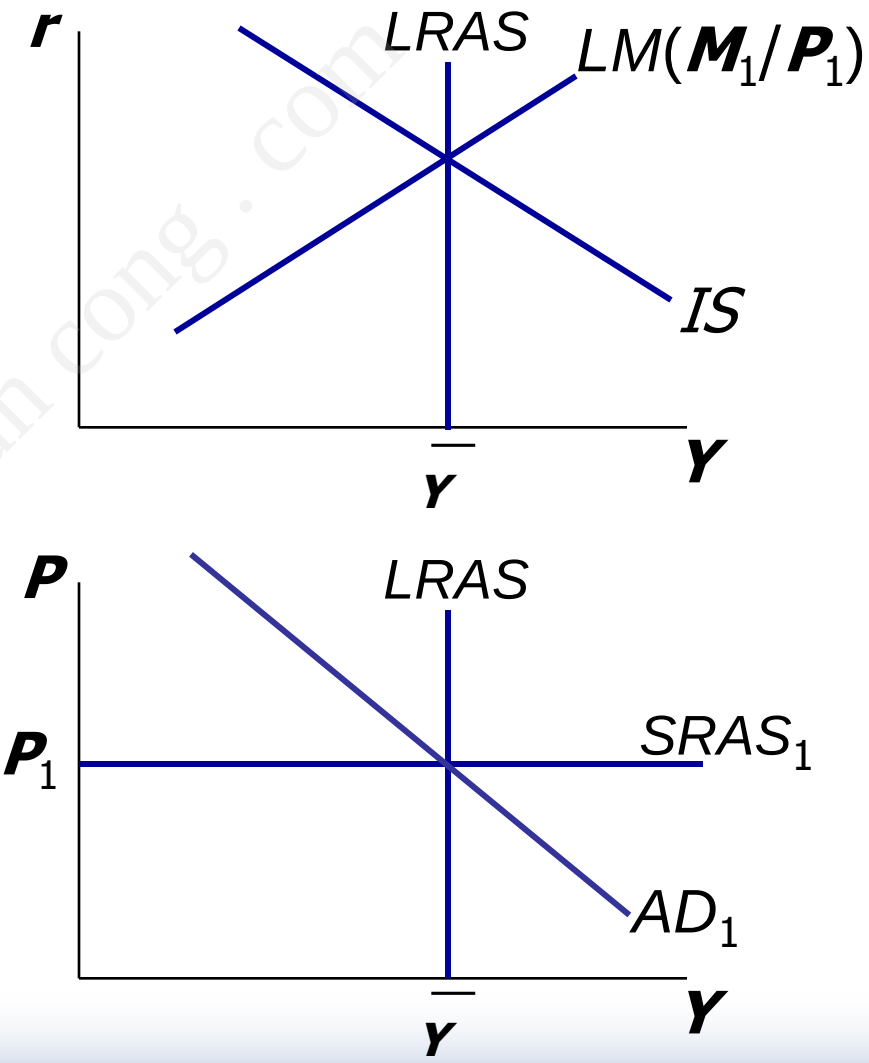
EXERCISE:
Analyze SR & LR effects of ΔM

a. Drawing the *IS-LM* and *AD-AS* diagrams as shown here,

b. show the short run effect of a Fed increases in ***M***. Label points and show curve shifts with arrows.

c. Show what happens in the transition from the short run to the long run. Label points.

d. How do the new long-run equilibrium values compare to their initial values?



EXERCISE: *Short run*

Short run:

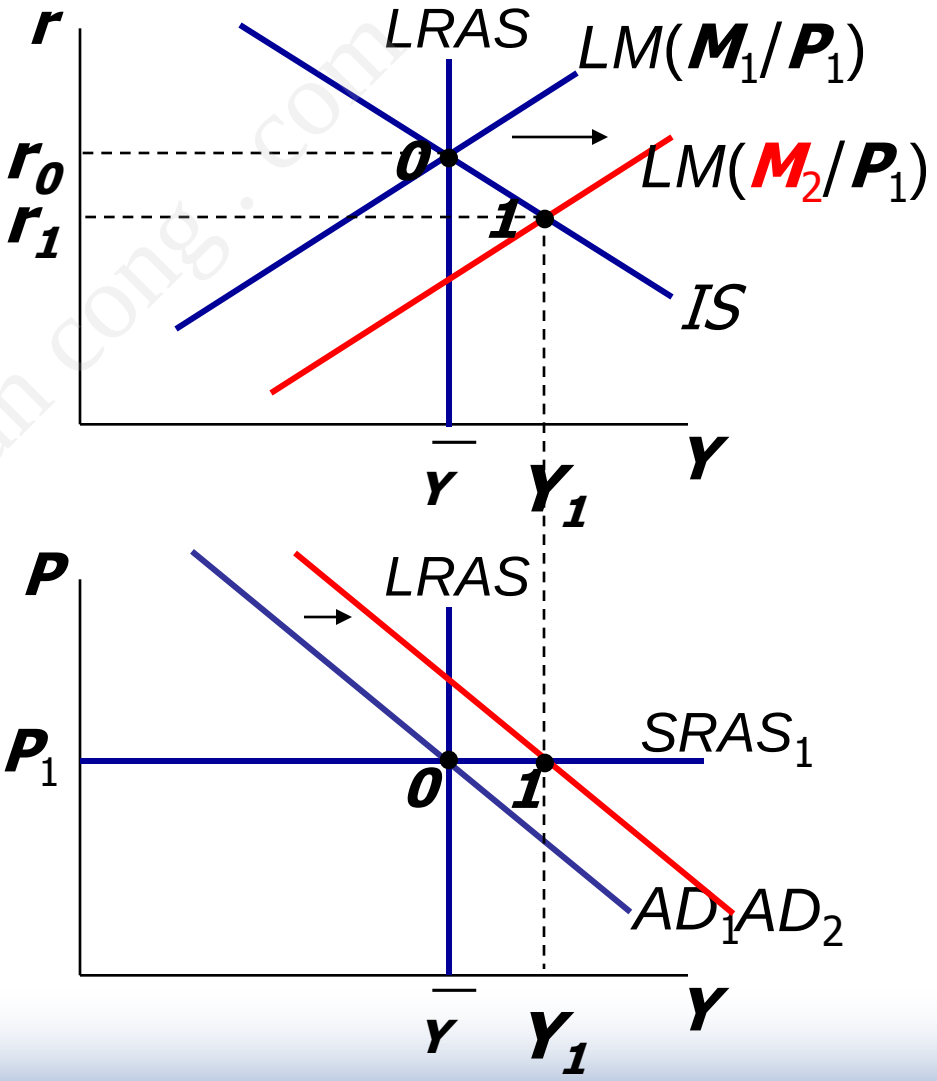
Rise in M raises real money supply in money market and shifts LM curve right.

Also shifts AD curve right.

Equilibrium moves from point 0 to point 1.

Output rises to Y_1.

Note that interest rate falls from r_0 to r_1.



EXERCISE: *Long run*

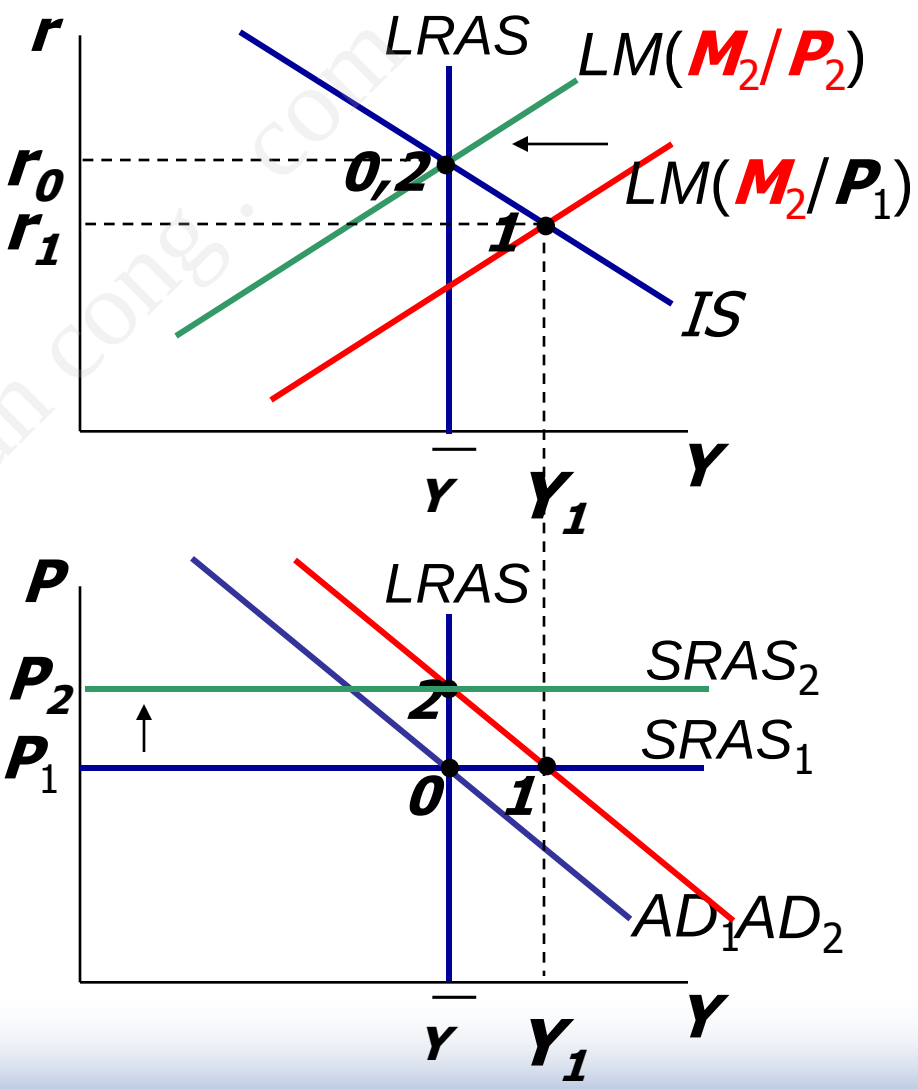
Price rises in proportion to M, from P_1 to P_2,

So real money supply returns to original level: $M_2/P_2 = M_1/P_1$.

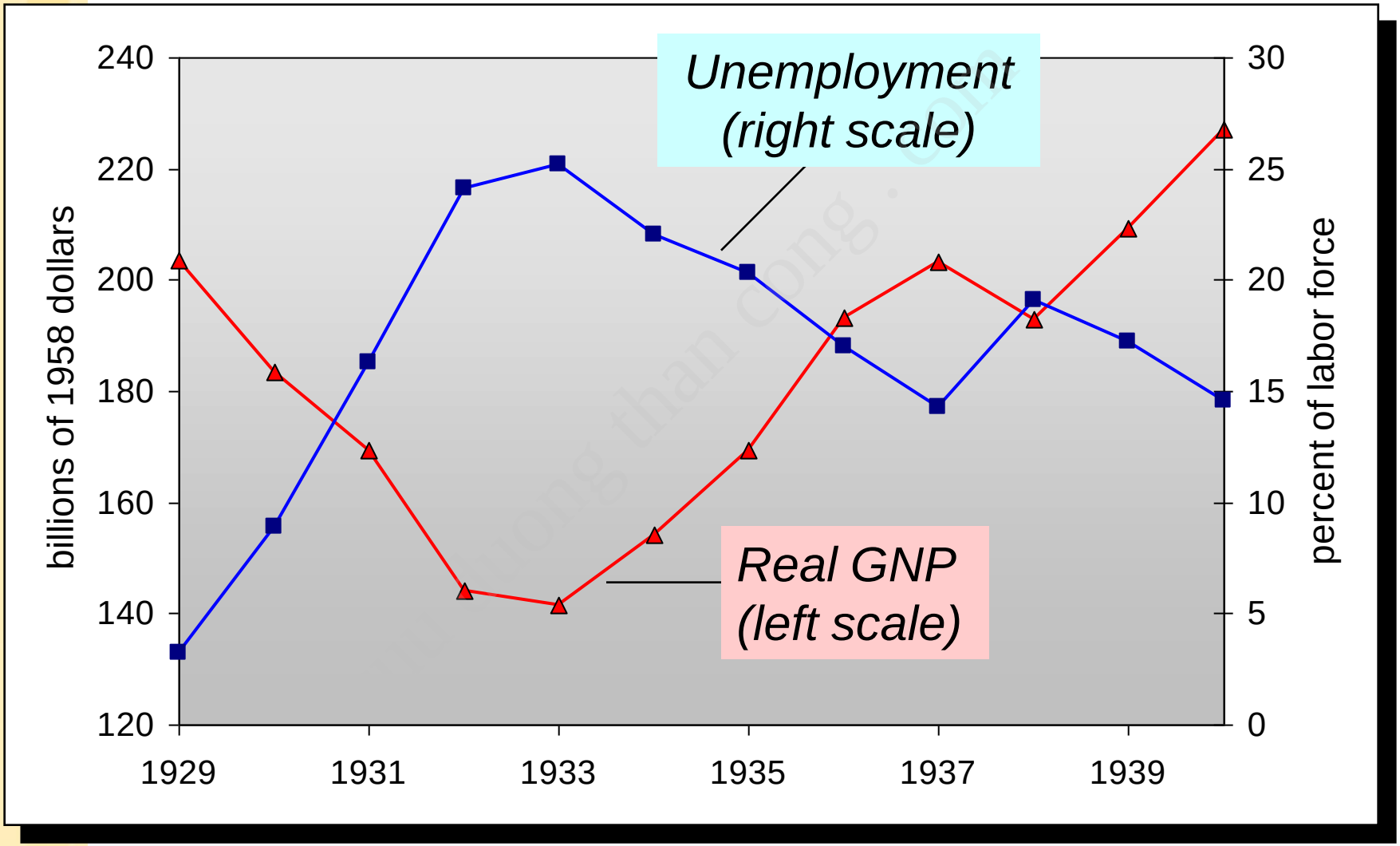
So LM curve returns to original position.

Equilibrium moves from point 1 to point 2.

Output and interest rate return to original levels.



The Great Depression



What Happened During the Great Depression?

Year	Unemployment Rate (1)	Real GNP (2)	Consumption (2)	Investment (2)	Government Purchases (2)
1929	3.2	203.6	139.6	40.4	22.0
1930	8.9	183.5	130.4	27.4	24.3
1931	16.3	169.5	126.1	16.8	25.4
1932	24.1	144.2	114.8	4.7	24.2
1933	25.2	141.5	112.8	5.3	23.3
1934	22.0	154.3	118.1	9.4	26.6
1935	20.3	169.5	125.5	18.0	27.0
1936	17.0	193.2	138.4	24.0	31.8
1937	14.3	203.2	143.1	29.9	30.8
1938	19.1	192.9	140.2	17.0	33.9
1939	17.2	209.4	148.2	24.7	35.2
1940	14.6	227.2	155.7	33.0	36.4

Source: Historical Statistics of the United States, Colonial Times to 1970, Parts I and II (Washington, DC: U.S. Department of Commerce, Bureau of Census, 1975).

Note: (1) The unemployment rate is series D9. (2) Real GNP, consumption, investment, and government purchases are series F3, F48, F52, and F66, and are measured in billions of 1958 dollars. (3) The interest rate is the prime Commercial

Great Depression: Observations

- Real side of economy:
  - Output: falling
  - Consumption: falling
  - Investment: falling much
  - Gov. purchases: fall (with a delay)

Year	Nominal Interest Rate (3)	Money Supply (4)	Price Level (5)	Inflation (6)	Real Money Balances (7)
1929	5.9	26.6	50.6	–	52.6
1930	3.6	25.8	49.3	–2.6	52.3
1931	2.6	24.1	44.8	–10.1	54.5
1932	2.7	21.1	40.2	–9.3	52.5
1933	1.7	19.9	39.3	–2.2	50.7
1934	1.0	21.9	42.2	7.4	51.8
1935	0.8	25.9	42.6	0.9	60.8
1936	0.8	29.6	42.7	0.2	62.9
1937	0.9	30.9	44.5	4.2	69.5
1938	0.8	30.5	43.9	–1.3	69.5
1939	0.6	34.2	43.2	–1.6	79.1
1940	0.6	39.7	43.9	1.6	90.3

Paper rate, 4–6 months, series ×445. (4) The money supply is series ×414, currency plus demand deposits, measured in billions of dollars. (5) The price level is the GNP deflator (1958 = 100), series E1. (6) The inflation rate is the percentage change in the price level series. (7) Real money balances, calculated by dividing the money supply by the price level and multiplying by 100, are in billions of 1958 dollars.

Great Depression: Observations

- Nominal side:
  - Nominal interest rate: falling
  - Money supply (nominal): falling
  - Price level: falling (deflation)

The Spending Hypothesis: *Shocks to the IS Curve*

- asserts that the Depression was largely due to an exogenous fall in the demand for goods & services -- a leftward shift of the *IS* curve
- evidence:
  output and interest rates both fell, which is what a leftward *IS* shift would cause

The Spending Hypothesis: *Reasons for the IS shift*

1. Stock market crash $\Rightarrow$ exogenous $\downarrow C$
   - Oct-Dec 1929: S&P 500 fell 17%
   - Oct 1929-Dec 1933: S&P 500 fell 71%
2. Drop in investment
   - "correction" after overbuilding in the 1920s
   - widespread bank failures made it harder to obtain financing for investment
3. Contractionary fiscal policy
   - in the face of falling tax revenues and increasing deficits, politicians raised tax rates and cut spending

The Money Hypothesis: *A Shock to the LM Curve*

- asserts that the Depression was largely due to huge fall in the money supply
- evidence:
  M1 fell 25% during 1929-33.

But, two problems with this hypothesis:

1. ***P*** fell even more, so ***M/P*** actually rose slightly during 1929-31.
2. nominal interest rates fell, which is the opposite of what would result from a leftward *LM* shift.

The Money Hypothesis Again: *The Effects of Falling Prices*

- asserts that the severity of the Depression was due to a huge deflation:

  P fell 25% during 1929-33.

- This deflation was probably caused by the fall in ***M***, so perhaps money played an important role after all.

- In what ways does a deflation affect the economy?

The Money Hypothesis Again: *The Effects of Falling Prices*

The stabilizing effects of deflation:

- $\downarrow \boldsymbol{P} \Rightarrow \uparrow (\boldsymbol{M/P}) \Rightarrow$ *LM* shifts right $\Rightarrow \uparrow \boldsymbol{Y}$

The Money Hypothesis Again: *The Effects of Falling Prices*

The destabilizing effects of unexpected deflation:

debt-deflation theory

↓***P*** (if unexpected)

⇒ transfers purchasing power from borrowers to lenders

⇒ borrowers spend less, lenders spend more

⇒ if borrowers' propensity to spend is larger than lenders, then aggregate spending falls, the *IS* curve shifts left, and ***Y*** falls

The Money Hypothesis Again: *The Effects of Falling Prices*

The destabilizing effects of expected deflation:

$\downarrow \pi^e$

$\Rightarrow$ $r \uparrow$ for each value of i

$\Rightarrow$ $I \downarrow$ because $I = I(r)$

$\Rightarrow$ planned expenditure & agg. demand $\downarrow$

$\Rightarrow$ income & output $\downarrow$

Why another Depression is unlikely

- Policymakers (or their advisors) now know much more about macroeconomics:
  - The Fed knows better than to let ***M*** fall so much, especially during a contraction.
  - Fiscal policymakers know better than to raise taxes or cut spending during a contraction.
- Federal deposit insurance makes widespread bank failures very unlikely.
- **Automatic stabilizers** make fiscal policy expansionary during an economic downturn.

Chapter summary

1. *IS-LM* model
   - a theory of aggregate demand
   - exogenous: ***M***, ***G***, ***T***,
     P exogenous in short run, ***Y*** in long run
   - endogenous: ***r***,
     Y endogenous in short run, ***P*** in long run
   - *IS* curve: goods market equilibrium
   - *LM* curve: money market equilibrium

Chapter summary

2. AD curve
   - shows relation between ***P*** and the *IS-LM* model's equilibrium ***Y***.
   - negative slope because
     $\uparrow \boldsymbol{P} \Rightarrow \downarrow(\boldsymbol{M/P}) \Rightarrow \uparrow \boldsymbol{r} \Rightarrow \downarrow \boldsymbol{I} \Rightarrow \downarrow \boldsymbol{Y}$
   - expansionary fiscal policy shifts *IS* curve right, raises income, and shifts *AD* curve right
   - expansionary monetary policy shifts *LM* curve right, raises income, and shifts *AD* curve right
   - *IS* or *LM* shocks shift the *AD* curve

CHAPTER THIRTEEN

Aggregate Supply

Learning objectives

- three 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

Three models of aggregate supply

1. The sticky-wage model
2. The imperfect-information model
3. The sticky-price model

All three models imply:

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

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

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

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

The sticky-wage model

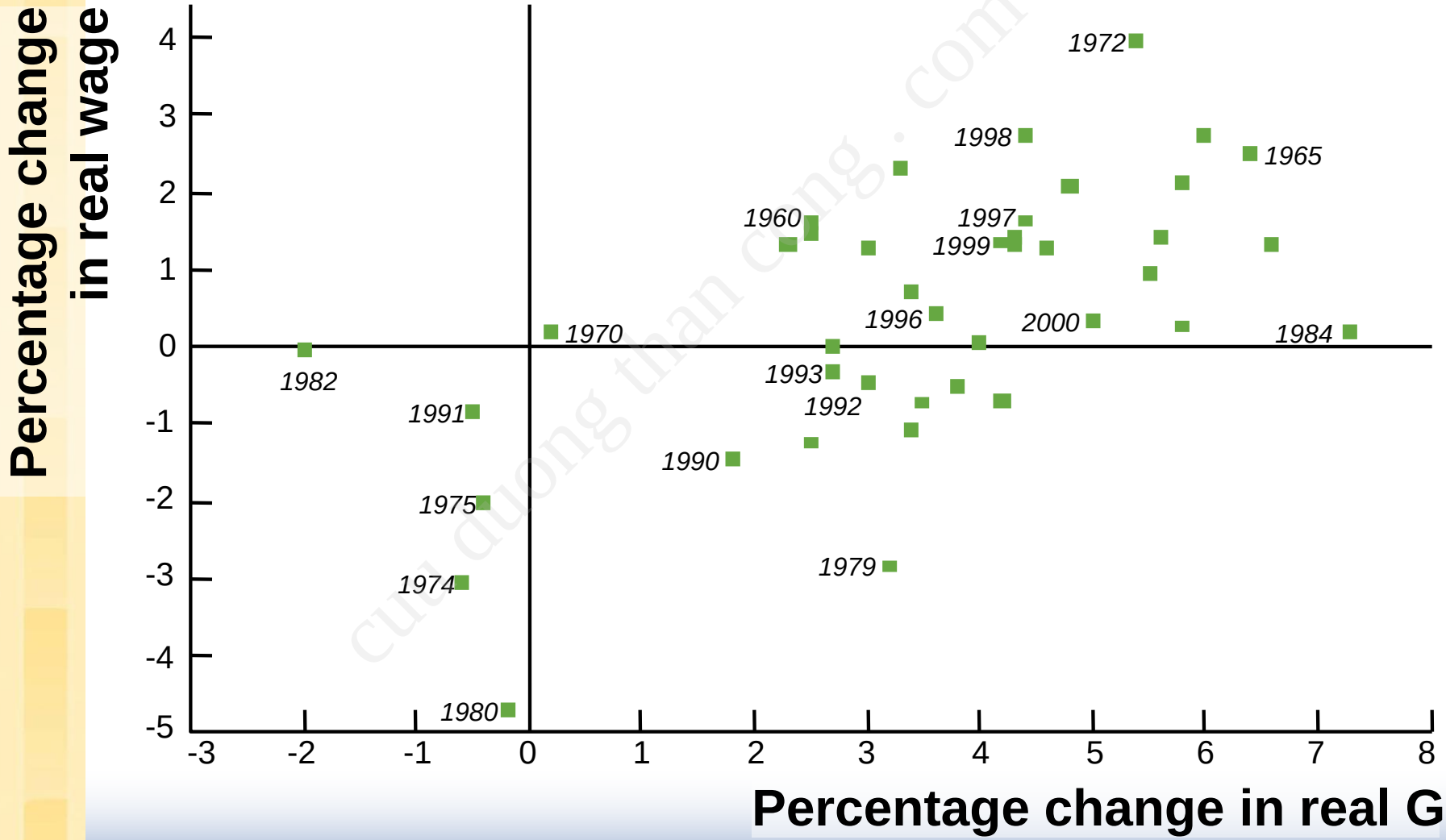
$$\frac{W}{P} = \omega \times \frac{P^e}{P}$$

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

- Implies that the real wage should be *counter-cyclical* , it should move in the opposite direction as output over the course of business cycles:
  - In booms, when ***P*** typically rises, the real wage should fall.
  - In recessions, when ***P*** typically falls, the real wage should rise.
- This prediction does not come true in the real world:

The cyclical behavior of the real wage



The imperfect-information model

Assumptions:

- all wages and prices perfectly flexible, all markets 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

The imperfect-information model

- Supply of each good depends on its relative price: the nominal price of the good divided by the overall price level.
- Supplier doesn't know price level at the time she makes her production decision, so uses the expected price level, P^e.
- Suppose P rises but P^e does not.

  Then 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.

The sticky-price model

- Reasons for sticky prices:
  - long-term contracts between firms and customers
  - menu costs
  - firms do not wish to annoy customers with frequent price changes
- Assumption:
  - Firms set their own prices (e.g. as in monopolistic competition)

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

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

price set by sticky price firms

price set by flexible price firms

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

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

- Divide both sides by s:

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

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 who 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:

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

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

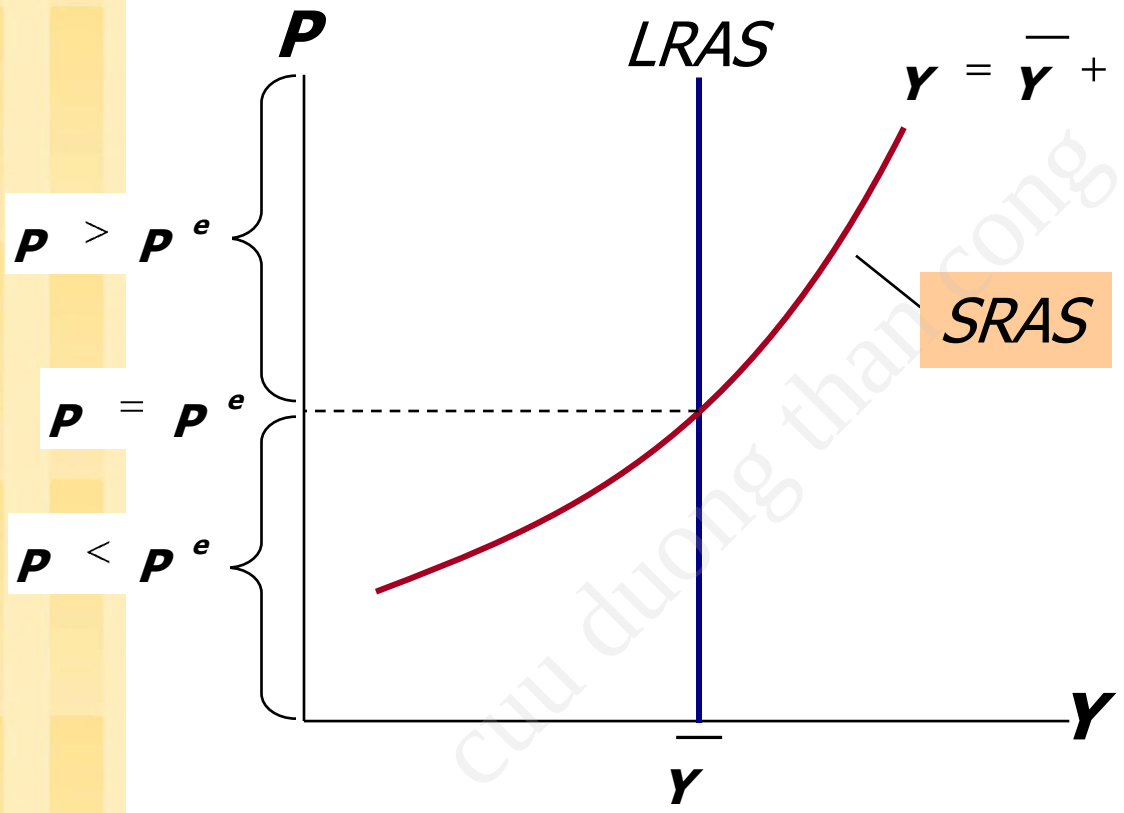
The sticky-price model

In contrast to the sticky-wage model, the sticky-price model implies a pro-cyclical real wage:

Suppose aggregate output/income falls. Then,

- Firms see a fall in demand for their products.
- Firms with sticky prices reduce production, and hence reduce their demand for labor.
- The leftward shift in labor demand causes the real wage to fall.

Summary & implications



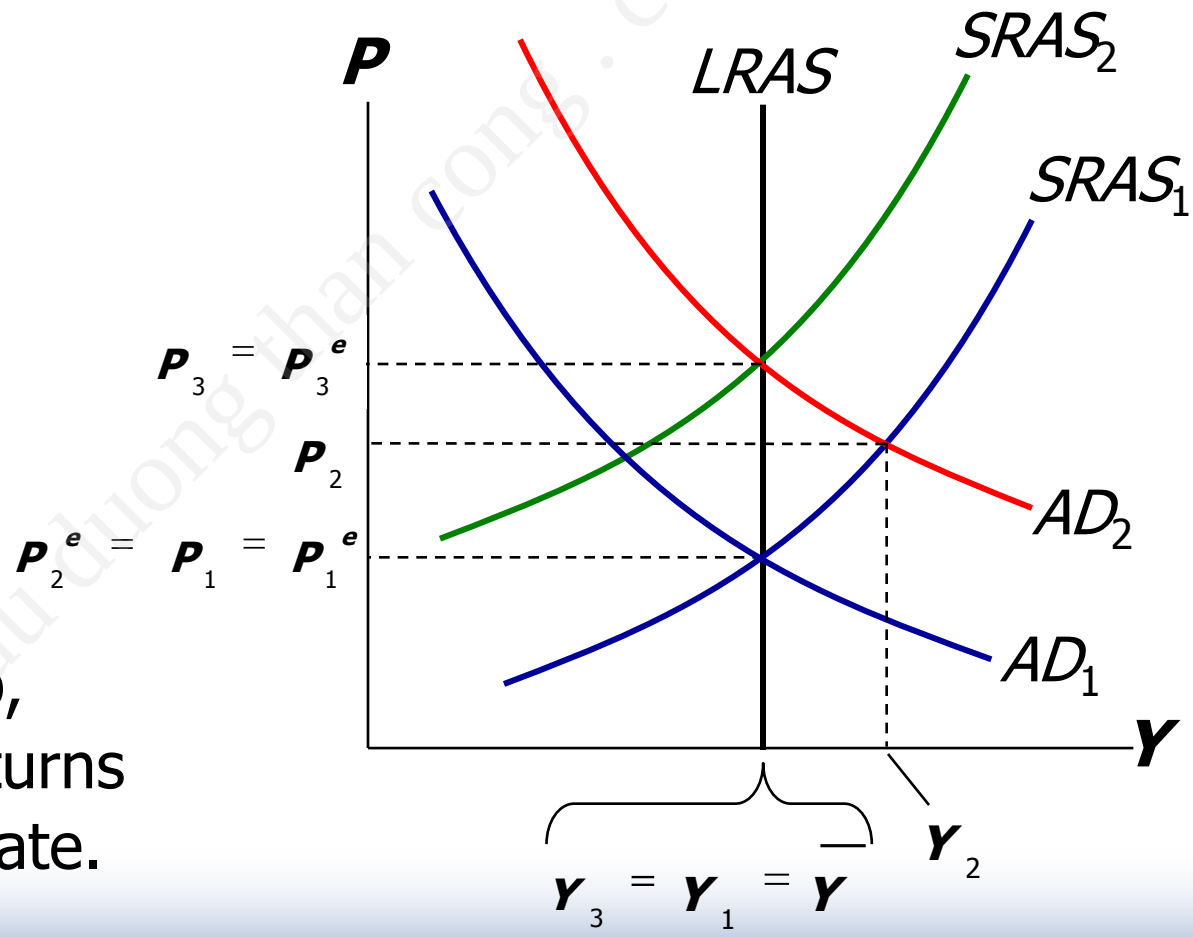
Each of the three models of agg. supply imply the relationship summarized by the *SRAS* curve & equation

Summary & implications

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

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.



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

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

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

Deriving the Phillips Curve from *SRAS*

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

(2) $P = P^e + (1/\alpha)(Y - \overline{Y})$

(3) $P = P^e + (1/\alpha)(Y - \overline{Y}) + v$

(4) $(P - P_{-1}) = (P^e - P_{-1}) + (1/\alpha)(Y - \overline{Y}) + v$

(5) $\pi = \pi^e + (1/\alpha)(Y - \overline{Y}) + v$

(6) $(1/\alpha)(Y - \overline{Y}) = -\beta(u - u^n)$

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

The Phillips Curve and *SRAS*

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

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

- *SRAS* curve:
  output is related to unexpected movements in the price level
- Phillips curve:
  unemployment is related to unexpected movements in the inflation rate

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

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

- 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

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

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

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

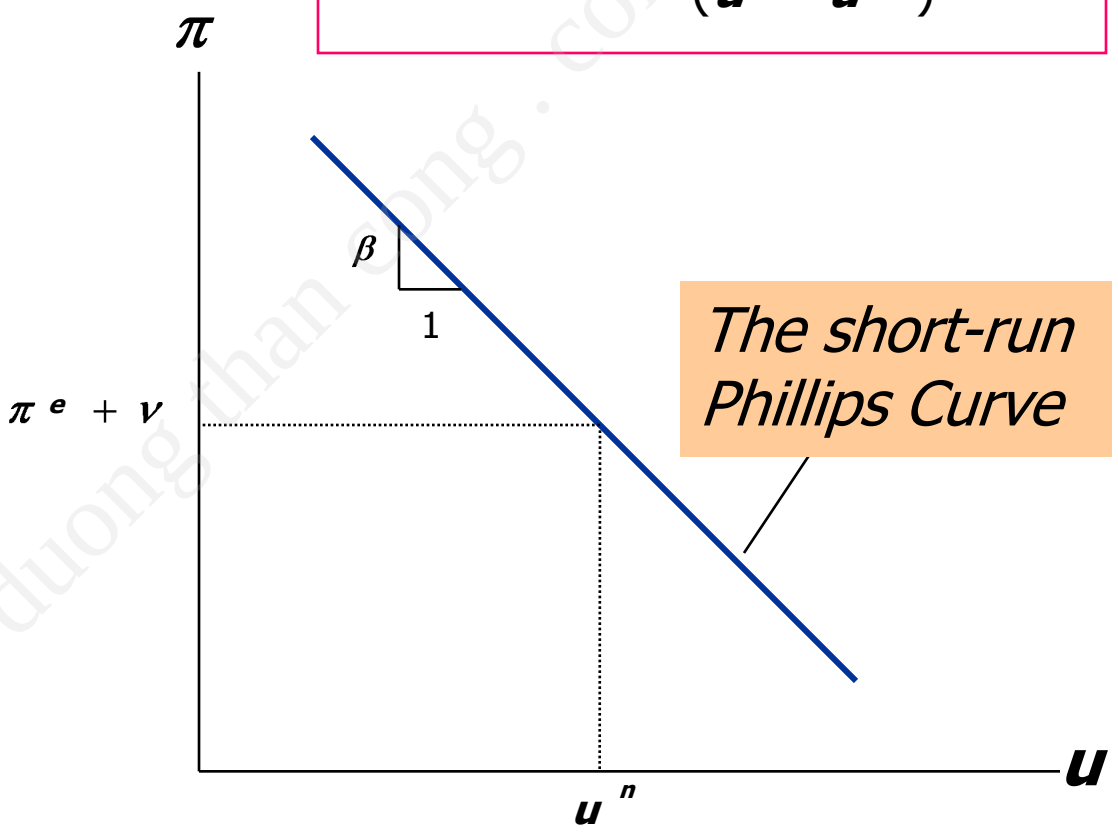
- **demand-pull inflation**: inflation resulting from demand shocks.

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

Graphing the Phillips curve

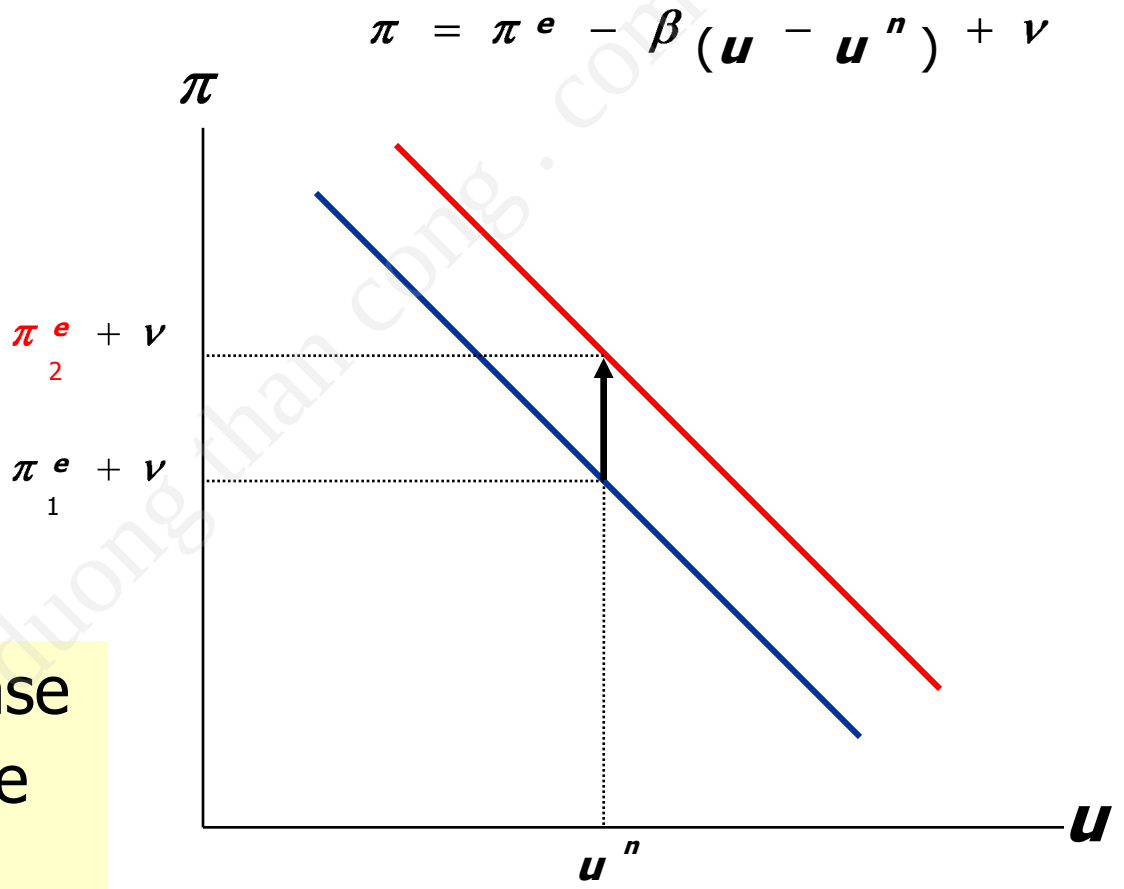
In the short run, policymakers face a trade-off between π and u.

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



Shifting the Phillips curve

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



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

The sacrifice ratio

- To reduce inflation, policymakers can contract agg. 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.
- Estimates vary, but a typical one is 5.

The sacrifice ratio

- Suppose policymakers wish to reduce inflation from 6 to 2 percent.

  If the sacrifice ratio is 5, then reducing inflation by 4 points requires a loss of $4 \times 5 = 20$ percent of one year's GDP.

- This could be achieved several ways, e.g.
  - reduce GDP by 20% for one year
  - reduce GDP by 10% for each of two years
  - reduce GDP by 5% 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.

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.

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%

The sacrifice ratio for the Volcker disinflation

- Previous slide:
  - inflation fell by 6.7%
  - total of 9.5% of cyclical unemployment
- Okun's law:
  each 1 percentage point of unemployment implies lost output of 2 percentage points.
  So, the 9.5% cyclical unemployment translates to 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.

The natural rate hypothesis

Our analysis of the costs of disinflation, and of economic fluctuations in the preceding chapters, 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 (chapters 3-8).

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

Chapter 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 falls below the expected price level.

Chapter 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

Chapter 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

Chapter 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 agg. demand can have permanent effects on output and employment