IS-LM Models and More

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Plan of the Chapter

- In this chapter we will analyze the macro-economy and the effects of policies without explicitly deriving them from explicit optimizing models
- Including the IS-LM model, as well as its IS-MP version, and the AD-AS version
- However they lack some important logical steps in the microeconomic analysis of consumer and firm optimizing behavior
- Later on, we will move towards a more complete and micro-founded macroeconomic theory of the business fluctuations （解释GDP短期波动的实际经济周期模型）．

Plan of the Chapter

- Old authoritative Keynesian model:

    IS-LM model

- More modern New-Keynesian restatement:
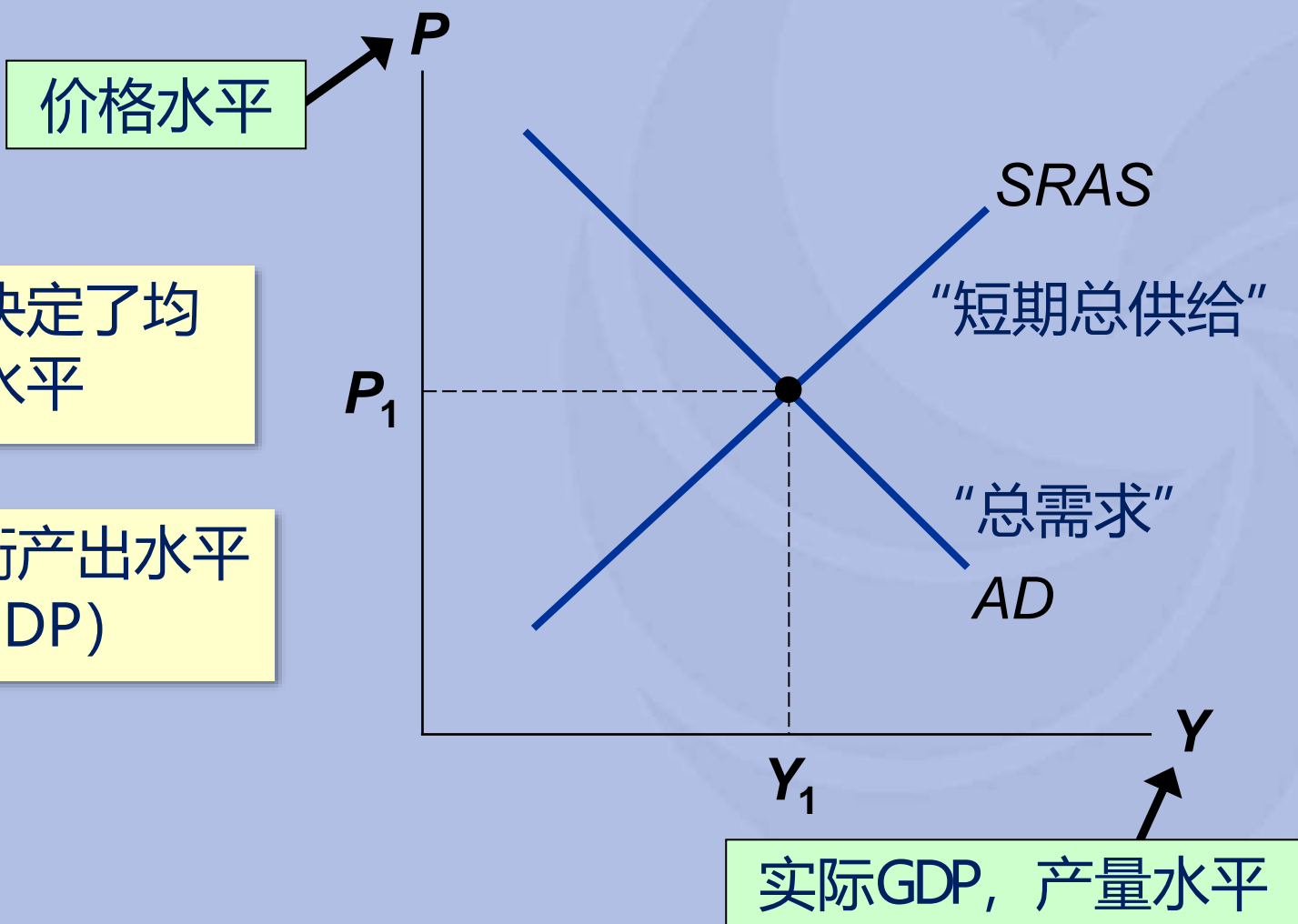
    IS-MP-PC

- Related variants:

    IS-MP and AD-AS

复习AD-AS模型

➢ 古典经济学思想，特别是古典二分法，将变量分为两组：

- 实际变量：比如，数量、相对价格
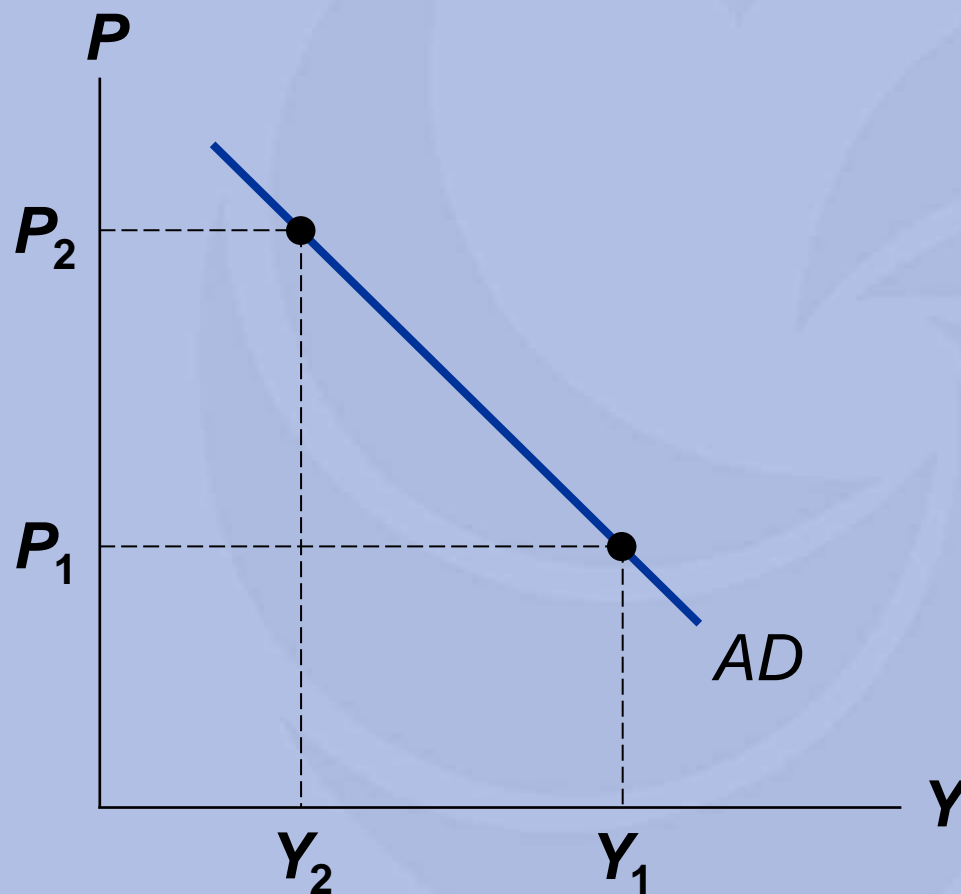- 名义变量：比如，工资、价格等，以货币计量

➢ 货币中性：货币供应量的变化影响名义变量，但不影响实际变量。

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复习AD-AS模型

- 大多数经济学家认为，古典经济理论研究的是长期经济，而不是短期经济。

- 在短期内，名义变量（如货币供应量）的变化会影响实际变量（如实际GDP或失业率）。

- 为了对短期经济进行分析，我们使用AD-AS模型。

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总需求与总供给模型

价格水平

该模型决定了均衡价格水平

以及均衡产出水平（实际GDP）

P

$SRAS$

"短期总供给"

P_1
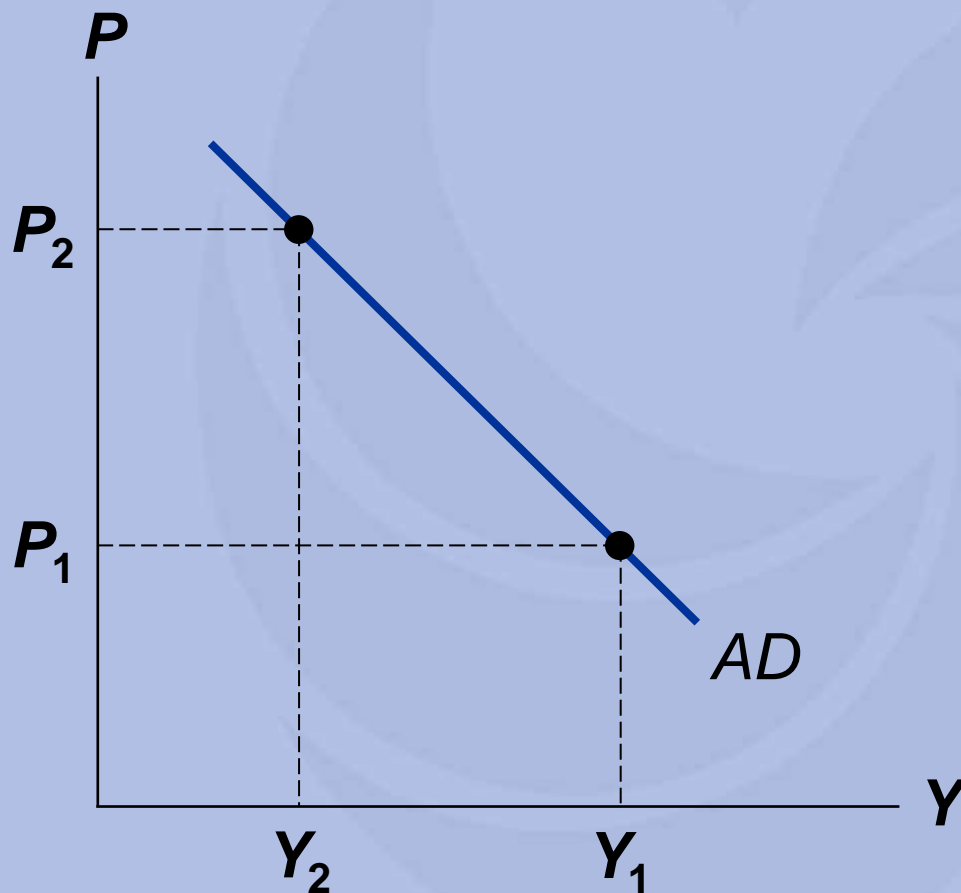
"总需求"

AD

Y

Y_1

实际GDP，产量水平

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总需求（AD）曲线

AD曲线给出了在一系列价格水平下，均衡的总需求水平。

为什么AD曲线是向下倾斜的

Y = C + I + G + NX

- 假设G是由政府决定的一个常数。
- 要理解需求曲线的斜率为何是负的，就必须明白P的变化是如何影响C、I和NX大小的。

财富效应（P和C）

➢ 假设P上升：

  ▪ 人们持有同样的货币能购买到的商品更少，
    因此实际财富更低。

  ▪ 人们感到更穷。

➢ 结果：C 下降。

利率效应（P和I）

➤ 假设P上升：

- 购买同样的商品需要更多的货币。

- 为了得到这些货币，人们会出售债券或其他资产，这将导致资产价格下降。

- 资产价格下降导致利率上升。

➤ 结果：投资I下降（投资和利率是反向变动）。

➤ 利率效应：利率和价格水平反方向变动。
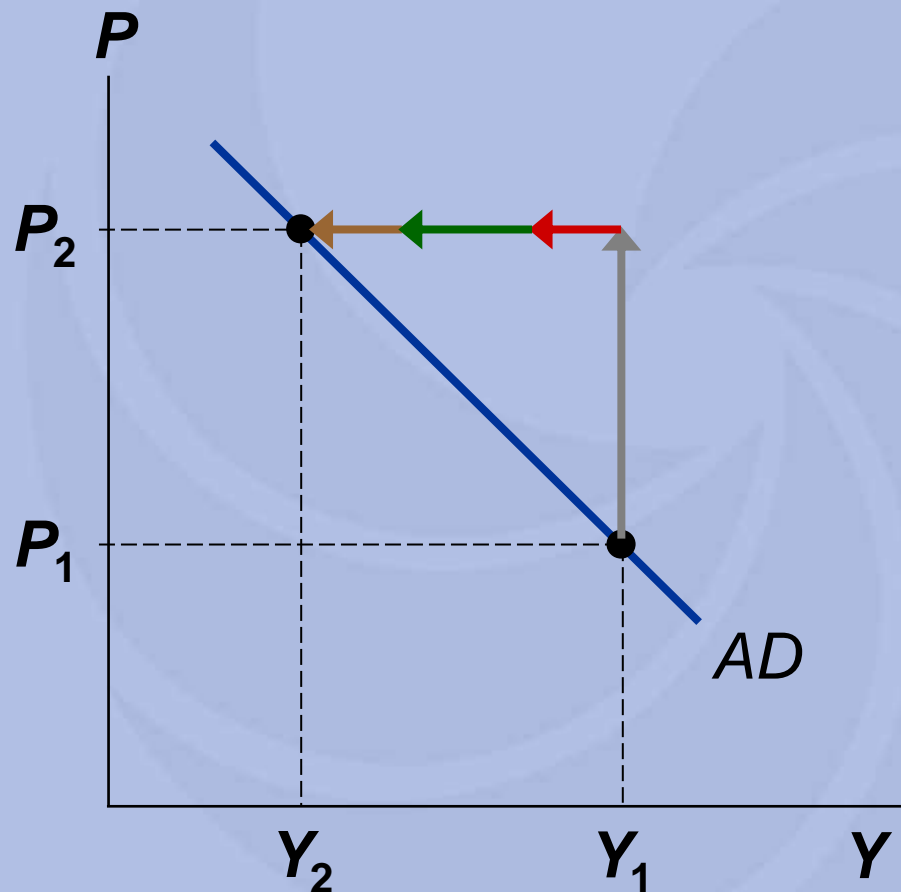
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汇率效应（P和NX）

➢ 假设P上升：

- 上一页指出国内利率上升（利率效应）。
- NCO（资本外流）下降，因此人民币汇率升值。
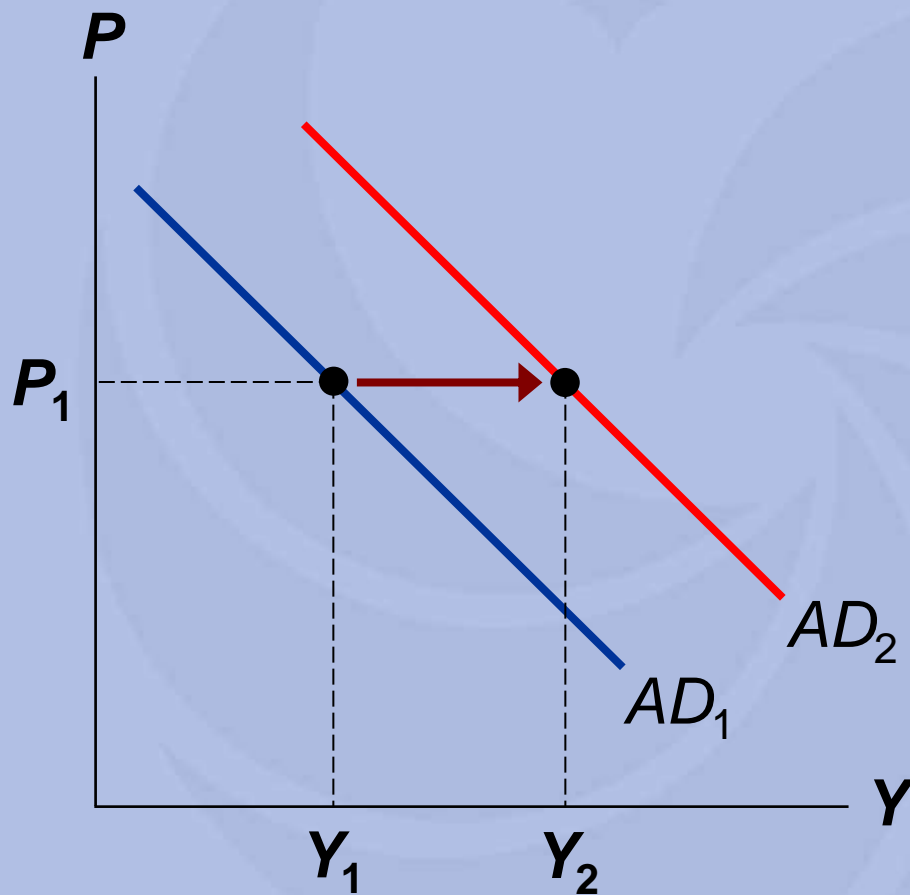- 出口减少，进口增加：因为中国向海外出口的商品价格更高，而进口商品对于中国居民来说将更便宜。

➢ 结果：净出口NX下降。

AD曲线向下倾斜的原因：总结

P上升减少了AD，因为：

- **财富效应** (消费C下降)
- **利率效应** (投资I下降)
- **汇率效应** (净出口NX下降)

为什么AD曲线会平移

- 任何改变C、I、G或NX的事件（P的变化除外）都会平移AD曲线。

- 例如：
  股市繁荣会让家庭感觉更富有，因此消费水平C增加，AD曲线右移到AD₂。

为什么AD曲线会平移

- ➢ **C 的变化**
  - 股市繁荣/崩溃
  - 消费倾向：居民在消费与储蓄之间权衡
  - 政府税收的增减
  - 货币供应量的增加和缩减
- ➢ **I 的变化**
  - 投资者对于经济的预期：乐观/悲观
  - 利率水平（取决于货币政策）
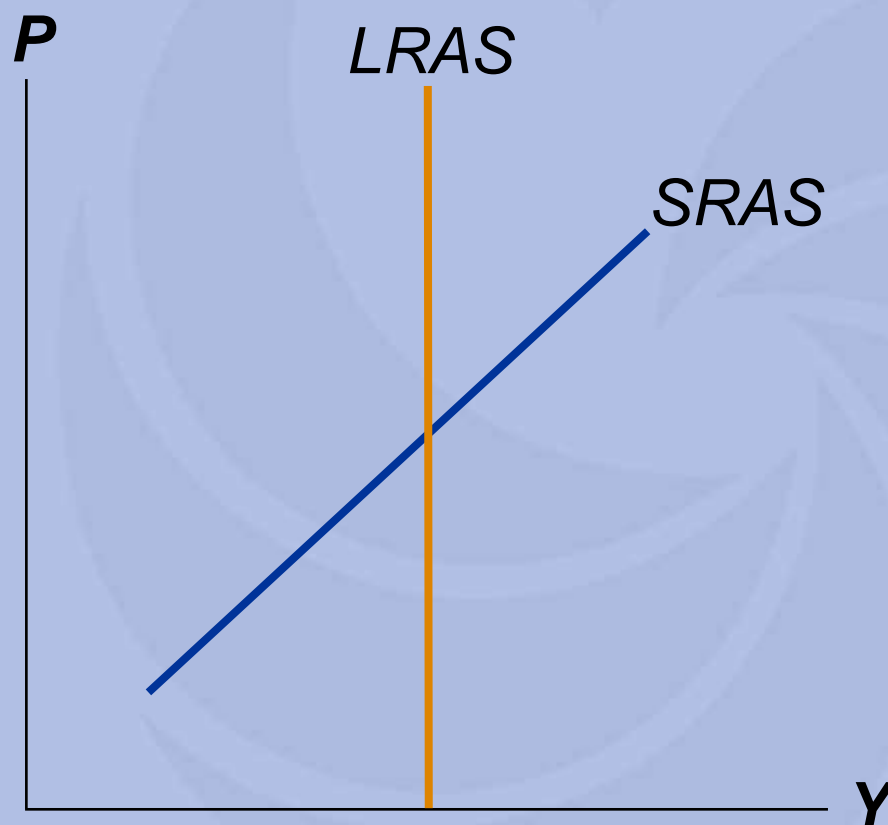 - 投资税收抵免或其他税收优惠

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为什么AD曲线会平移

➤ **G的变化**

- 中央政府支出，如国防支出、国道高速路等
- 地方政府支出，如当地道路、学校、医院等

➤ **NX的变化**

- 国外的繁荣/衰退
- 贸易壁垒
- 外币的升值/贬值

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总供给（AS）曲线

➢ AS曲线给出了在每个价格水平下，整个社会的厂商所愿意供给的产品总量。

➢ AS曲线的形状：

- 短期AS曲线（SRAS）向上倾斜
- 长期AS曲线（LRAS）垂直于横坐标

P

LRAS

SRAS

Y

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短期总供给曲线 (SRAS)

- 短期内：SRAS曲线是向上倾斜的

- 短期内（1-2年）：P的增加会导致供应量的增加。

P

$SRAS$

P_2

P_1

$Y_1 \longrightarrow Y_2$

Y
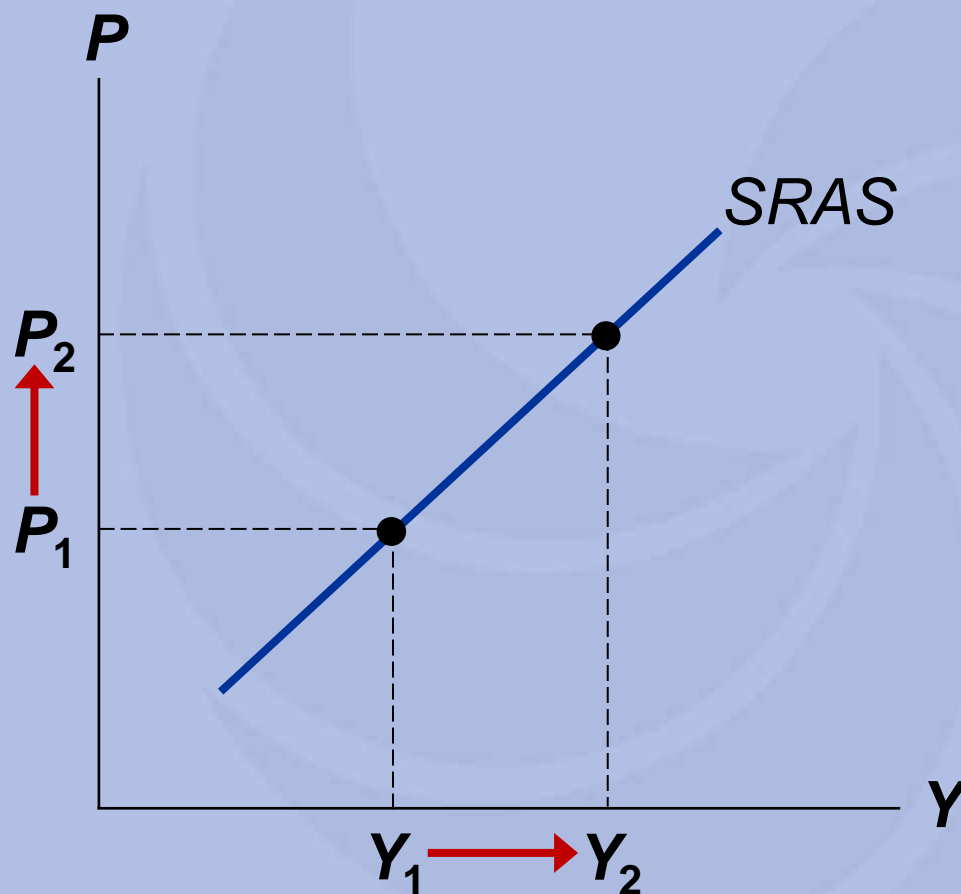
The IS Curve

- In closed economy, the national macroeconomic identity is $Y=C+I+G$, which holds by definition
- In fact, statistically speaking, investment I also includes the <u>involuntary inventory accumulation</u> of unsold firm products
- Keynes (1936), Hicks (1937), etc. instead interpret $Y=C+I+G$ as an equilibrium relationship between aggregate supply and aggregate demand in the goods market, which only holds if GDP (Y) and the real interest rate (r) are linked in a specific way, represented by the IS curve
- In this interpretation, Y is production output, C is households consumption, I is investment <u>voluntarily</u> undertaken by private firms, and G is <u>exogenously</u> given public expenditure
- This **<u>excludes</u>** <u>involuntary inventory accumulation</u> from I, hence the above identity may not always hold.

The IS Curve

- Let us assume that *C* is planned by consumers based on disposable income, while *I* is planned by firms based on the real interest rate (*r*).

- More in detail, we assume that planned *C* increases with *Y* net of taxes (*T*), while planned *I* decreases with the real interest rate *r*

- Hence the goods market equilibrium is

  $Y = C(Y\text{-}T) + I(r) + G$ (1)

  Here：G and *T* are the only variables independent of *Y* and *r,* that is exogenous to the private sector.

The IS Curve

For simplicity, let's assume a linear consumption function: $C(Y-T) = c \times (Y-T)$

   $0<c<1$ is a constant, called "the marginal propensity to consumption"(边际消费倾向)

We can now solve eq. (1) for Y and get:

   $Y = [I(r) + G - cT]/(1-c)$ (2)

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The IS Curve

- Given the real interest rate *r*, private firms investment *I(r)* is determined

- Given public expenditure *G* and government taxes *T* , the exogenous components of demand, *G-cT*, are determined

- *I(r)+G-cT:*   sum of all the <u>non-income dependent</u> components of aggregate demand

The IS Curve

- The multiplier 1/(1-c) is larger than 1，and determines the level of output needed to satisfy the sum of income dependent and income independent aggregate demand

- Equilibrium national income Y has to be equal to

  $$[I(r) + G - cT]/(1-c)$$

- If r decreases，the goods market equilibrium level of Y increases, and vice versa

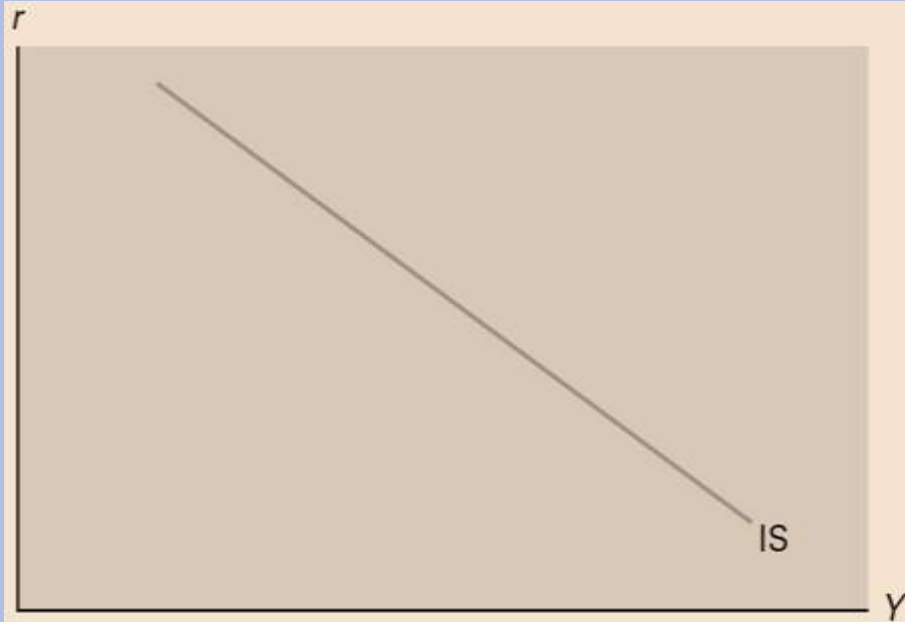- Hence we can define as IS Curve（Investment-Saving）as the locus of (Y,r) points such that the goods market is in equilibrium.

The IS Curve

- Equilibrium national income Y has to be equal to

  Y=[I(r) + G - cT]/(1-c)

- 政府支出乘数： 1/(1-c) , 如果c=0.5，则乘数等于2.0

- 政府税收乘数： -c/(1-c) , 如果c=0.5，则乘数等于-1.0

- 为什么政府税收乘数小于政府支出乘数?

- 举例：如果政府征收1亿元的税收，用于1亿元的政府支出（可以是公共消费也可以是公共投资），则对于政府公共预算的影响是？对于实际GDP的影响是？

The IS Curve

Figure 6.1 The IS curve

The IS curve shows the different combinations of Y and r under which the goods market is in equilibrium; i.e., the following condition holds:

$$Y = C(Y - T) + I(r) + G.$$

The IS Curve

- This theory implicitly assumes that firms will always produce all the goods demanded

  $Y = C(Y-T) + I(r) + G$

  左边是供给（结果），右边是需求（原因）

- This theory lacks micro-foundations especially on the production side

- It can work mainly in periods of recessions, when there are enough spare capacity and unemployed workers that can readily be mobilized to increase production.

The LM Curve

- Assume that money is analogous to a paper **currency** issued by the central bank（CB）.
  - Money is denominated in an arbitrary unit, such as a "yuan" or "dollar".
  - In **nominal** terms.
  - Paper money earns no interest.

The LM Curve

- The sum of the individual holdings of money equals the aggregate quantity of money in the economy.
  - Assume, for now, that this aggregate quantity of money supply, M^s, is a given constant.
  - The total money held by all households（货币需求）must end up equaling this constant（货币供给）.

The LM Curve

- The Money Market
  - The price in this market, denoted by *P*, expresses the number of currency that exchange for one unit of goods.
  - We call *P* the **price level**.

The LM Curve

- Money is useful to be spent on transactions (consumption, investment, etc.) and therefore money demand increases with Y

- Holding money means foregoing nominal interest incomes on other forms of wealth - like bonds

- Hence money demand decreases with the nominal interest rate i

- We can then write real money demand as a function $L(Y,i)$, increasing in Y and decreasing in i.

The LM Curve

- The Money Market Equilibrium condition is therefore:

$$M^s/P = L(Y, i\,) \qquad\qquad (3)$$

- For now, **we assume constant prices (no inflation)**, that is, there is no difference between the nominal and the real interest rate: $r=i$

- Hence we can rewrite (3) as

$$M^s/P = L(Y, r\,) \qquad\qquad (4)$$

The LM Curve

- Note that *L(Y,r)* increases in *Y* and decreases in *r*

- But in the money market equilibrium condition it has to be equal to a constant, M^s/P

- Hence any increase in *Y* - which raises money demand - needs to be offset by a corresponding increase in *r* - which reduces money demand – in order for the money market to remain in equilibrium.

The LM Curve

- Therefore there is implicitly an POSITIVE relationship between *Y* and *r*

- The graphical representation of this relationship is the LM curve (**L:** Mondy demand, **M:** Money Supply), which plots all the points *(Y,r)* such that the money market is in equilibrium.
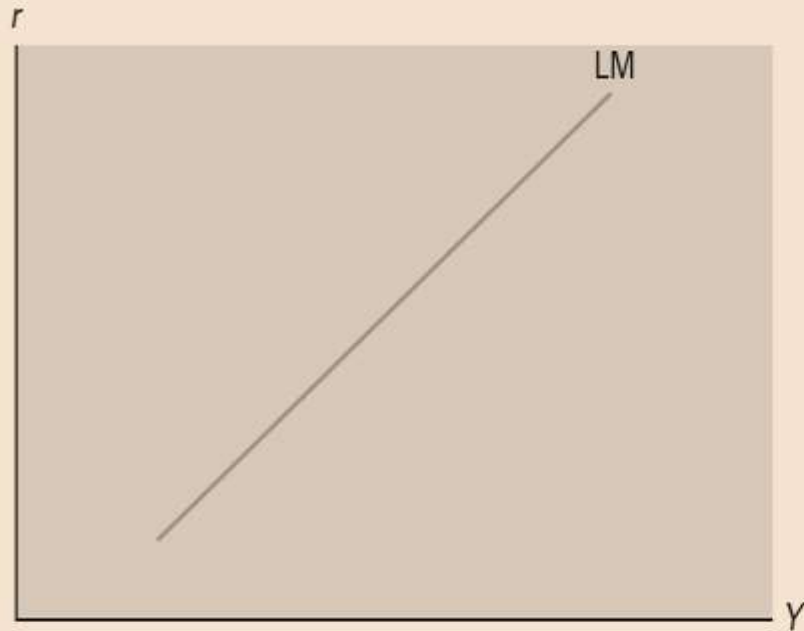
The LM Curve

Figure 6.2 The LM curve

The LM curve shows the different combinations of y and r under which the money market is in equilibrium; i.e., the following condition holds: $M^s/P = D(Y,r)$.

Macroeconomic Equilibrium

- In macroeconomic equilibrium, both markets – for goods and for money – must be in equilibrium

- Aggregate supply of goods = Aggregate Demand for goods (**IS curve**)

$$Y = [I(r) + G - cT]/(1-c)$$

- Supply of Money = Demand for Money (**LM curve**)

$$M^s/P = L(Y,r)$$

- This system of equations uniquely determines the equilibrium value of Y (denoted Y^*) and of r (denoted r^*)

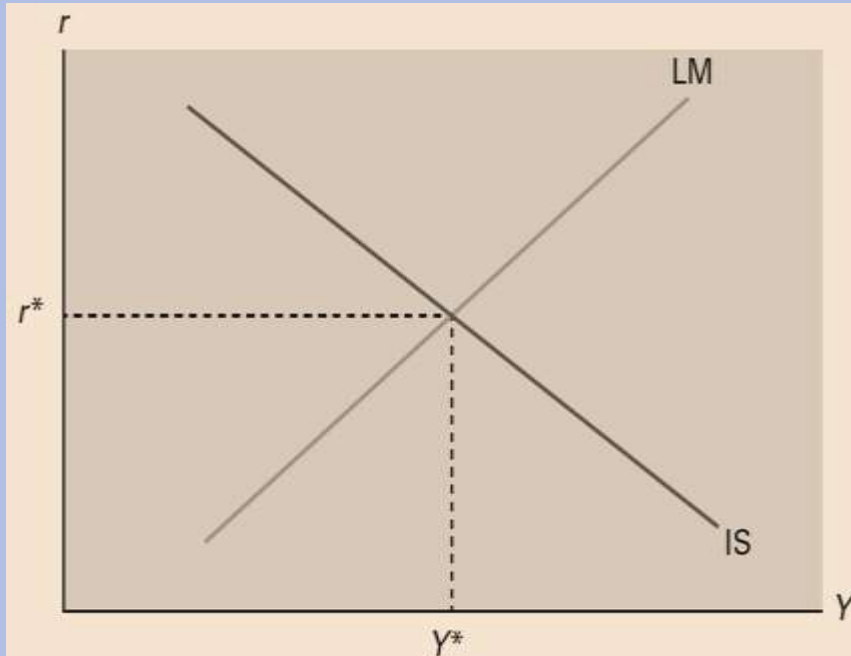- Graphically it is represented by the following figure:

Macroeconomic Equilibrium

Figure 6.3 The IS-LM model

The intersection of the IS and LM curves shows the equilibrium level of output, Y*, and the equilibrium interest rate, r*, in the economy.

Macroeconomic effects of expansionary fiscal policy
(扩张性财政政策）

- <mark>An increase in public expenditure, *G*:</mark> shift up the IS curve (IS 曲线右移，为什么？参考IS曲线方程）and lead to another equilibrium with higher GDP level Y^* and higher interest rate level r^*

- **<u>CHANNEL</u>**: more public expenditure *G* raises aggregate demand, → encourages firms to employ and produce more ($Y^* \uparrow$), → raises the demand for money and lowers the demand of bonds, → bonds sales and price to decrease, → bonds return to increase ($r^* \uparrow$).

Macroeconomic effects of expansionary fiscal policy
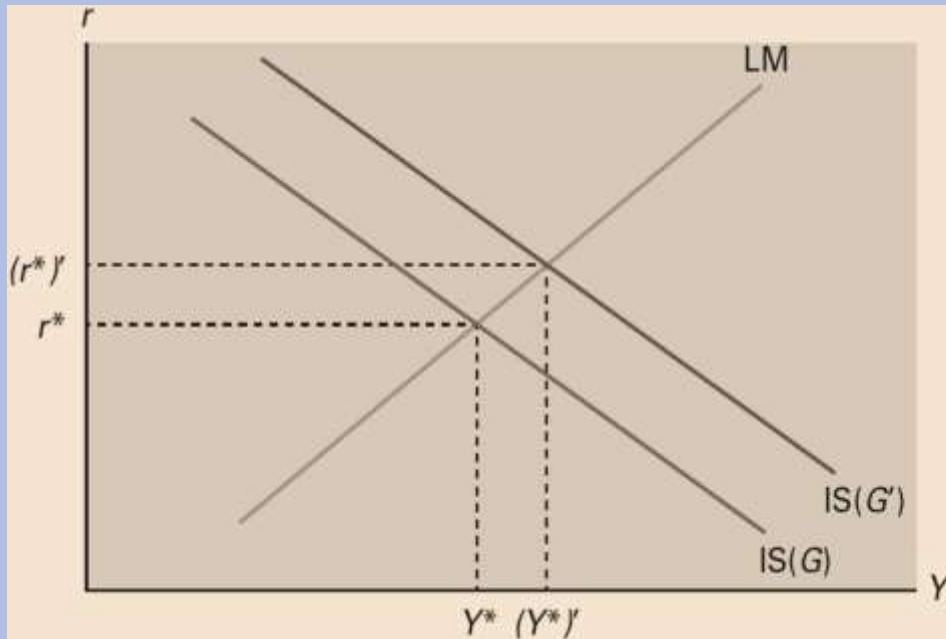
Figure 6.4 Effects of increasing G in the IS-LM model

An increase in G shifts the IS curve to the right, giving rise to a higher equilibrium level of output (Y*)' and a higher equilibrium interest rate (r*)'.

Macroeconomic effects of expansionary fiscal policy

- This mechanism works only if there are enough underutilized resources (physical capital and labour), so that firms will meet the increased private or public demand with an increased production

- Hence it mainly works during recessions when the prices and wages are rather low.

Investor Sentiment Fluctuations

- It is possible that similar shifts in the IS curve are driven by changes in the "investor sentiment（投资者情绪）", denoted ϵ

- We could incorporate such psychological factors into the investment function, by writing $I(r, \epsilon)$ as an increasing function of "sentiment" parameter ϵ

- More optimistic investors (higher ϵ) will then shift the IS curve up and lead to higher Y^* and r^*

- More pessimistic investors (lower ϵ) will shift the IS curve down and lead to lower Y^* and r^*

- Hence optimistic or pessimistic sentiments will be confirmed by their macroeconomic consequences

Macroeconomic effects of expansionary fiscal policy
(扩张性货币政策）

- The central bank can print money to buy government bonds, which will increase the total supply of money, M^s , causes the LM curve to move rightwards.（为什么右移？参考LM的方程）

- CHANNEL: increase the bond price (cost) and decrease the interest rate r （即便不是为了买入债券，印钱同样会增加货币供应，降低利率), $\rightarrow$ firm investment, I, will rise, $\rightarrow$ aggregate demand rises, $\rightarrow$ the equilibrium value of output, $Y^*\uparrow$, while the equilibrium interest rate, $r^*\downarrow$.

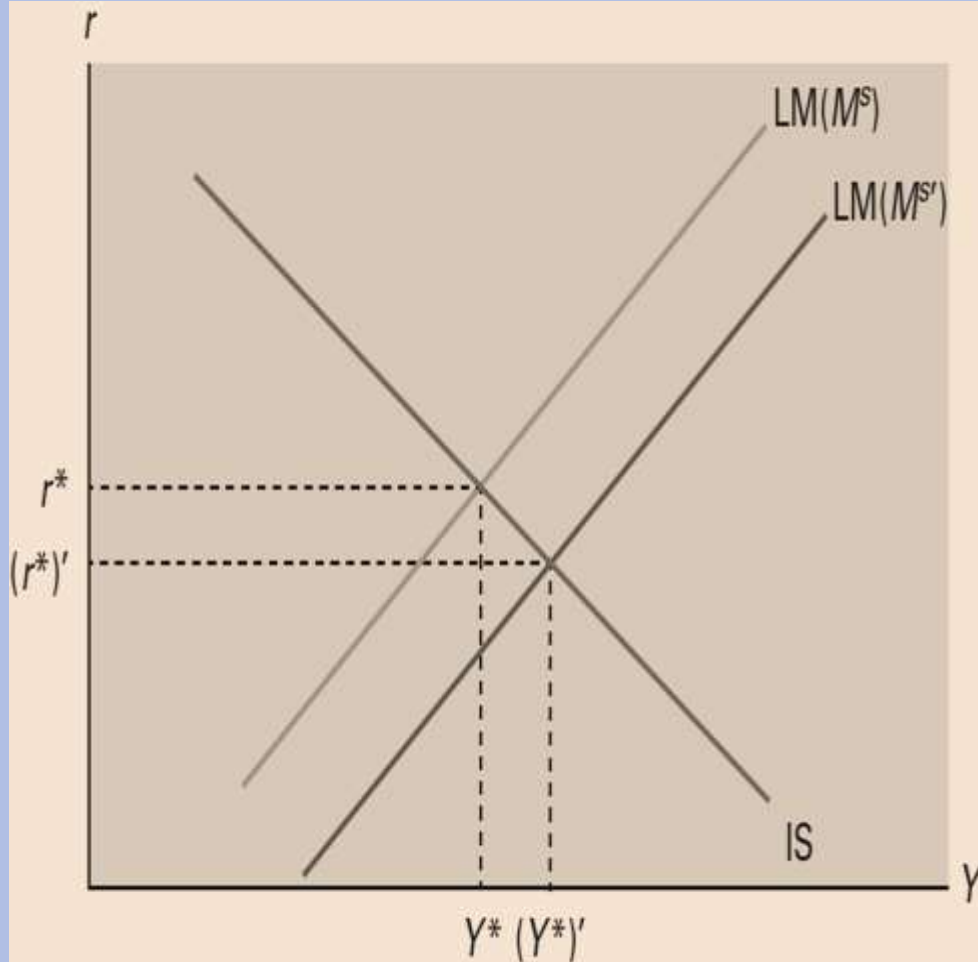# Macroeconomic effects of expansionary monetary policy

Figure 6.5 Effects of increasing M^s in the IS-LM model

An increase in M^s shifts the LM curve to the right, giving rise to a higher equilibrium level of output $(Y^*)'$ and a lower equilibrium interest rate $(r^*)'$.

Macroeconomic effects of expansionary monetary policy

- Sometimes this mechanism does not work

- In particular, when the interest rate is already too low, so it cannot decrease any further（零利率下限）

- Then expansionary monetary policy will no longer be effective: the economy will be in a "liquidity trap" （流动性陷阱）

- The economy may has to absorb any new money injections when the interest rate is close to zero.(当利率为零，流动性会被全部吸收，而不在经济中流转)

- 想一想：如果利率几乎为零，是不是bonds价格在最高点？此时只有下降的可能，谁还去买？大家都会持币，因此流动性不在经济中流转。

Macroeconomic effects of expansionary monetary policy
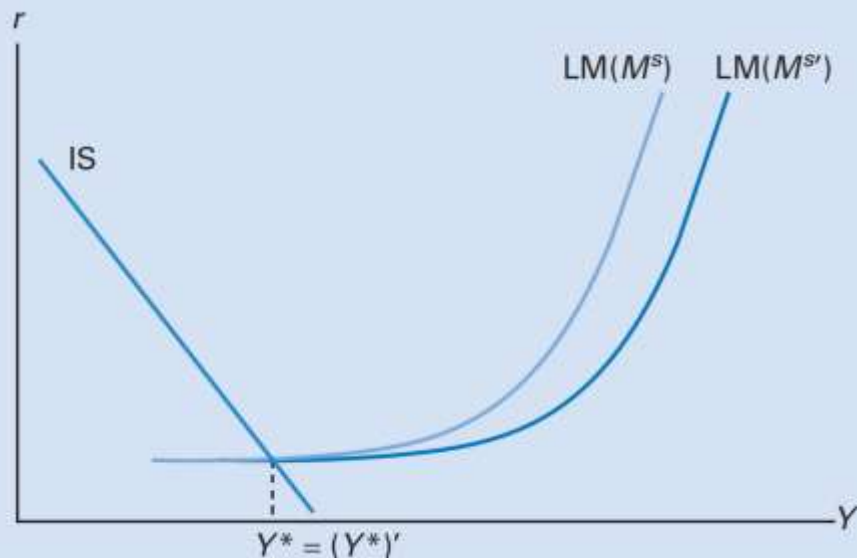
Figure 6.6 Effects of increasing M^s under a liquidity trap

An increase in M^s shifts the LM curve to the right but leaves the output level unchanged because the intersection of the two curves is at the horizontal part of the LM curve.

流动性陷阱导致扩张性货币政策相对失效！

现在央行怎么办？可以继续，因为货币增发导致通货膨胀，即使名义利率是零，但是实际利率会不断下降，企业投资的实际成本下降，有可能会增加投资。

The IS-MP Model

- Criticism of the IS-LM model:
  - Central Banks instead usually sets the interest rate when conducting monetary policy

- The more modern IS-MP model assumes that the interest rate r is directly set by the Central Bank

- We will then assume the following MP rule: $r = \bar{r}$

- This simple MP is like a horizontal LM curve
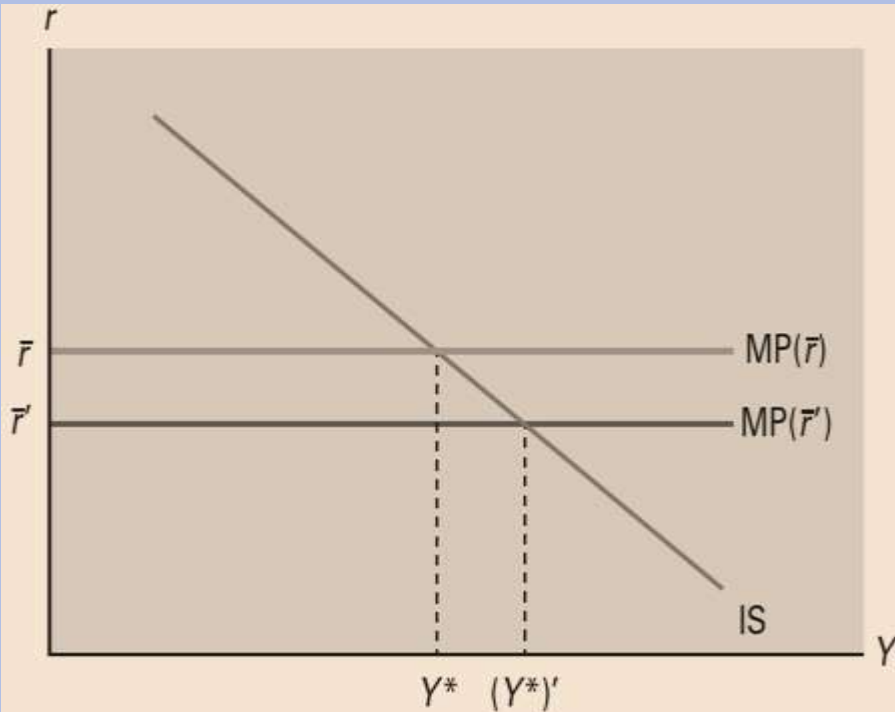- 注, **MP**: **M**onetary **P**olicy

IS-MP Model

- We assume that the IS curve is still valid
- Hence the goods market equilibrium now becomes:

$$Y = [I(\bar{r}) + G - cT]/(1-c)$$

- An increase in the policy interest rate $\bar{r}$ leads to an upward shift of the MP line

.. and viceversa:

IS-MP

Figure 6.7 Effects of decreasing $\bar{r}$ in the IS-MP model

A decrease in $\bar{r}$ shifts down the MP curve, giving rise to a higher equilibrium level of output $(Y^*)'$.

IS-MP

- More realistic MP rule: 泰勒原则

  - The Central Bank reacts aggressively to the inflation rate:

    - $r = \bar{r} + \rho(\pi - \bar{\pi})$

    - $\bar{\pi}$ is the inflation target of the central bank

    - $\rho > 0$ implies that the CB increases the real interest rate when inflation increases

    - Hence the policy nominal interest rate $i = r + \pi$ increases more than one-for-one with inflation

IS-MP

- Plugging the new MP into the IS function gives:

$$Y = \{I[\bar{r} + \rho(\pi - \bar{\pi})] + G - cT\}/(1-c) \qquad (6.9)$$

- Hence GDP is a decreasing function of the inflation rate π – which, by raising r, lowers I
- Eq. (6.9) is also interpreted as an aggregate demand (AD) function
- In fact, demanded Y decreases in current prices, P_t, given past prices, P_{t-1}, because $\pi = (P_t - P_{t-1})/P_{t-1}$

AD-AS Model

- PC (Phillips Curve, 菲利普斯曲线): the trade-off between inflation and the unemployment.

$$\text{Unemp. rate} = \text{Natural rate of unemp.} - a\left(\text{Actual inflation} - \text{Expected inflation}\right)$$

Short run
CB can reduce u-rate below the natural u-rate by making inflation greater than expected.

Long run
Expectations catch up to actual inflation, u-rate goes back to natural u-rate no matter inflation is high or low.

AD-AS Model

- 这里，我们考虑一个PC方程的变种
  - Let us assume this version of the PC:
    - $\pi = \pi^e + \vartheta(Y - \bar{Y})$ (6.7)
    - π^e is the expected rate inflation
    - $\bar{Y}$ is the long-run level of output
    - $\Theta>0$ is the sensitivity of inflation to the business cycle
  - Positive (negative) deviations of output from its long-run level trigger positive (negative) deviations of the inflation rate from its expected value
  - We will assume extrapolative expectations: $\pi^e = \pi_{t-1}$
    <mark>(外推法预期</mark>：expectation that a trend will continue)

AD-AS Model

- The AD function is usually complemented with an aggregate supply (AS) function taken directly from the PC:

  - $\pi = \pi_{t-1} + \vartheta(Y - \bar{Y})$ 　　　　　　　　　(6.10)

  – Given last period inflation expectations are pinned down

  – Above-normal output can be produced only at higher prices

AD-AS Equilibrium
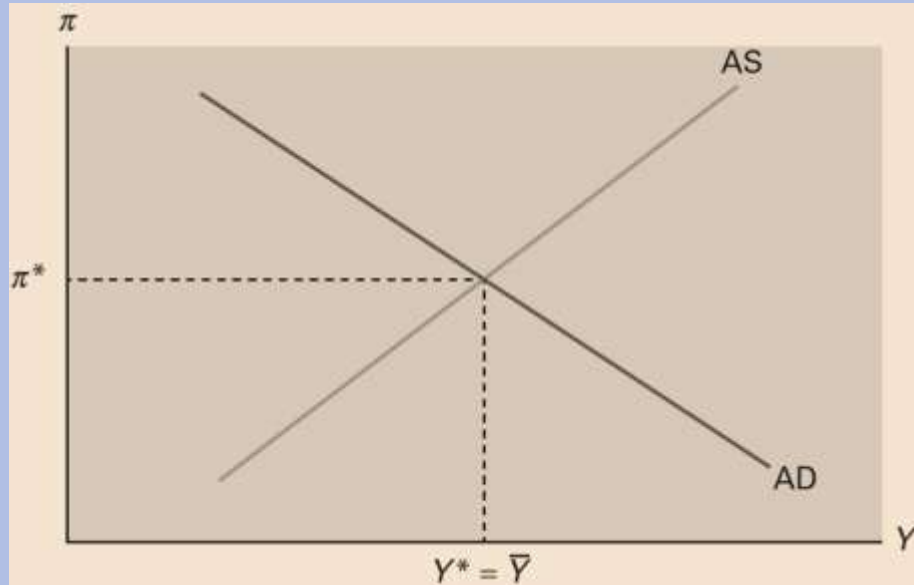


Figure 6.8 The AS-AD diagram

The intersection of the AS and AD curves shows the equilibrium level of output and the equilibrium inflation rate in the economy.

Deflationary Monetary Policy
(紧缩性货币政策）

在通货膨胀比较严重的情况下,根据泰勒原则：

- If the Central Bank decreases the inflation target $\bar{\pi}$, the policy interest rate r increases for all levels of π, which reduces $I(r)$ and aggregate demand for all levels of π

- Therefore the AD curve shifts down

- The resulting macroeconomic equilibrium will have a lower output and a lower inflation rate

- As in the Figure:

Deflationary Monetary Policy
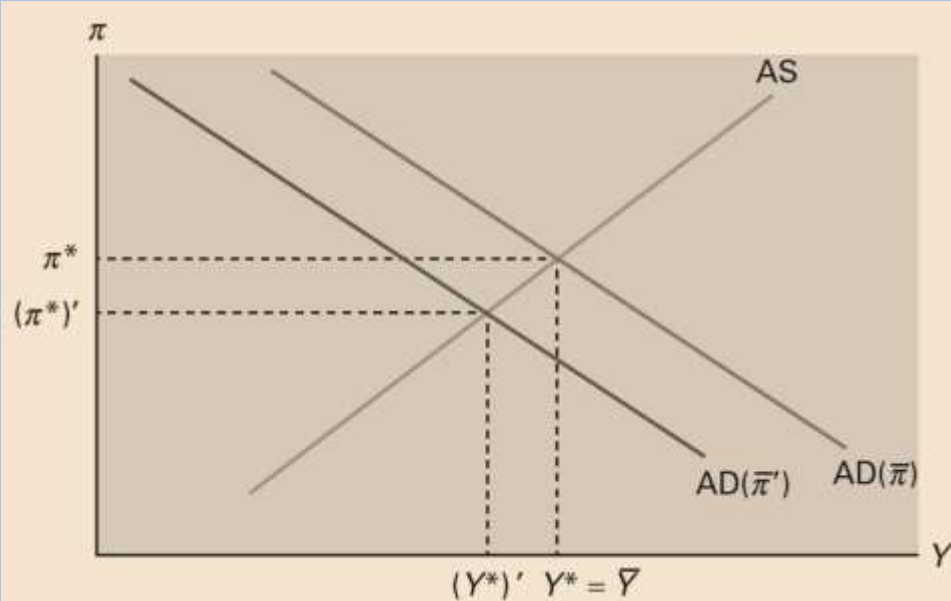
Figure 6.9 Short-run effects of disinflation

A decrease in $\bar{\pi}$ shifts down the AD curve, which gives rise to a decrease in the equilibrium level of output and inflation rate in the short run.

Deflationary Monetary Policy

- In the next period inflation expectations will change to a lower level

- Hence the aggregate supply (AS) curve will be lower than before

- Consequently the new macroeconomic equilibrium will have a higher output than in the past period

- Eventually, absent other shocks, Y should return to its long-run level $\bar{Y}$ as in the figure:

Deflationary Monetary Policy
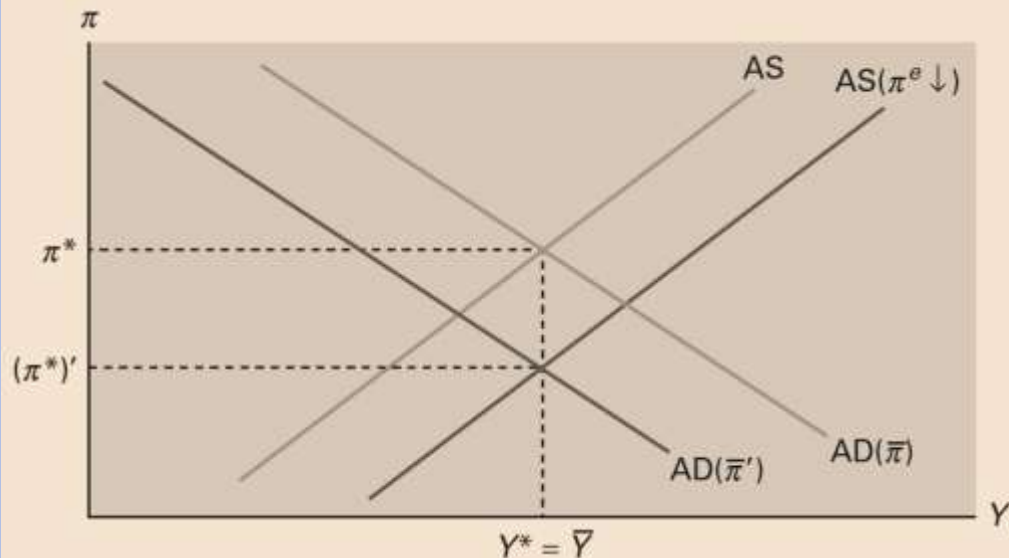
Figure 6.10 Long-run effects of disinflation

The decrease in $\pi^e = \pi_{t-1}$ shifts down the AS curve until the level of output reaches the long-run level.

A Macroeconomics without Microfoundations

- In this chapter we have analyzed the macroeconomy and the effects of policies without explicitly deriving them from explicit optimizing models

- The IS-LM model, as well as their IS-MP, and AD-AS versions are interesting, insightful, and potentially useful

A Macroeconomics without Microfoundations

- However they lack some important logical steps in the microeconomic analysis of consumer and firm behavior

- In the next chapters we will move towards a ==more complete and microfounded== macroeconomic theory of the business fluctuations.