Chapter 11: Aggregate Demand I: Building the IS-LM Model

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Chapter 11: Aggregate Demand I: Building the IS-LM Model

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Introduction

Great Depression of the 1930's

- Worst year: 1933
- Unemployment rate: 25 %
- Real GDP 30 % lower than in 1929.

Keynes (1936): The General Theory of Employment, Interest, and Money

- Low aggregate demand is responsible for low income and high unemployment.

What affects aggregate demand(AD)?

- Chapter 10: AD is explained by using "only" the quantity equation.
- $M \downarrow$ *or* $V \downarrow \quad \Rightarrow \quad AD \downarrow$
- Goal of this chapter: Identify those factors which shift the aggregate demand curve.
- In chapter 10: Government – or to be more precise – the central bank has only one policy instrument (=only one tool): Monetary policy
- In chapter 11: In a recession, the government can also use fiscal policy:
  - Increase government spending ($G \uparrow$) or
  - decrease taxes ($T \downarrow$).

In this chapter: Derive the IS-LM model

- IS-LM model is *the* leading interpretation of Keynes' theory.
- IS-LM model was not developed by Keynes but by Hicks (1937).
- Goal of the model: Explain GDP *for a given price level*.
- Two interpretations of the IS-LM model:
  - What causes income to change – in the short run – when prices are fixed?
  - What influences aggregate demand?

IS and LM: What does the abbreviation stand for?

- IS: (Investment, Savings): Goods market equilibrium condition: $I = S$
- LM: What influences supply (=Money supply) and demand for money (=Liquidity demand), and hence the money market equilibrium?
- Goods market determines GDP (Y).
- Money market determines the interest rate (r).
- But there is also an interdependency between both markets:
  - A change in GDP affects money demand.
  - A change in the interest rate affects investment.

Actual and planned expenditure & unplanned inventories

- Actual expenditure (=GDP, Y): The amount households, firms and the government spend on goods and services.
- Planned expenditure: The amount households, firms and the government would like to spend on goods and services.
- What is the difference?

$$Y - PE = I^{unplanned} \tag{1}$$

Actual and planned expenditure & unplanned inventories

$$Y - PE = I^{unplanned}$$

- Firms can have unplanned inventories when their sales do not meet their expectations.

$$Y > PE \quad \Rightarrow I^{unplanned} > 0 \tag{2}$$

- Companies build up inventories (stocks). Since it is unplanned (=unwanted), companies will reduce production in the next period:

$$Y \downarrow > PE \quad \Rightarrow I^{unplanned} \downarrow \tag{3}$$

Planned expenditure (PE)

$$PE = C + I + G \tag{4}$$

- Consumption function:

$$C = c_0 + c_1 \cdot (Y - T) \tag{5}$$

- with $1 > c_1 > 0$: Marginal propensity to consume (MPC).
- Investment is exogenous $I = \bar{I}$
- Government expenditure and Taxes are exogenous:

$$G = \bar{G} \quad and \quad T = \bar{T} \tag{6}$$

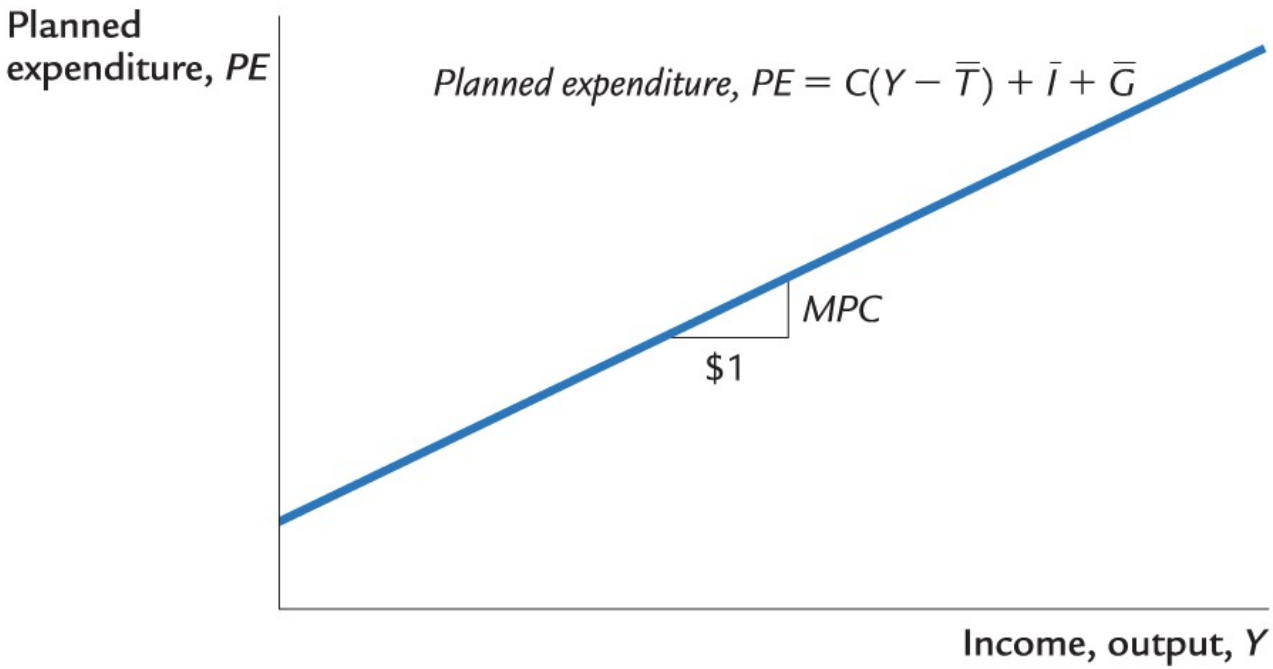
Planned expenditure (PE)

$$PE = C + I + G$$

- Combining all functions leads to:

$$PE = c_0 + c_1 \cdot (Y - \bar{T}) + \bar{I} + \bar{G} \tag{7}$$

Planned expenditure as a function of income



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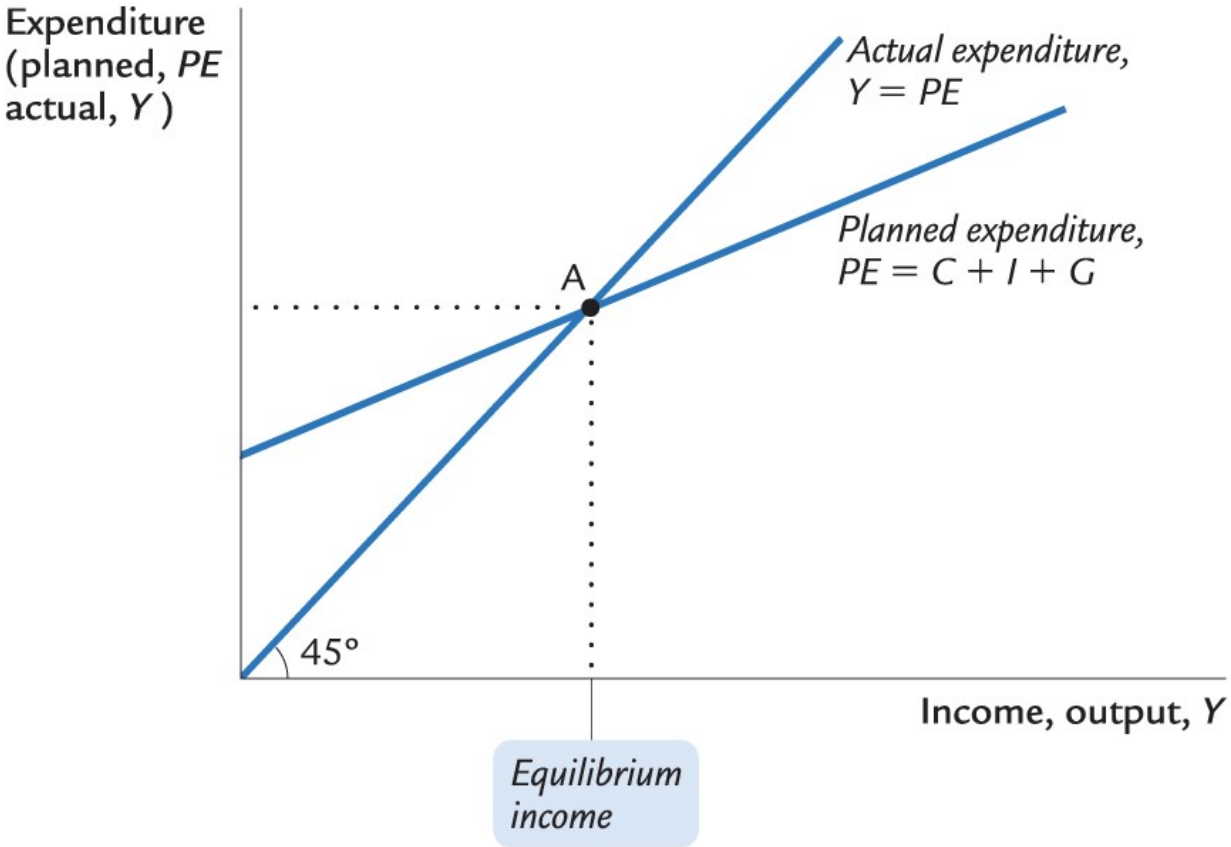
The economy in equilibrium

Actual expenditure = Planned expenditure $\Rightarrow$ $Y = PE$



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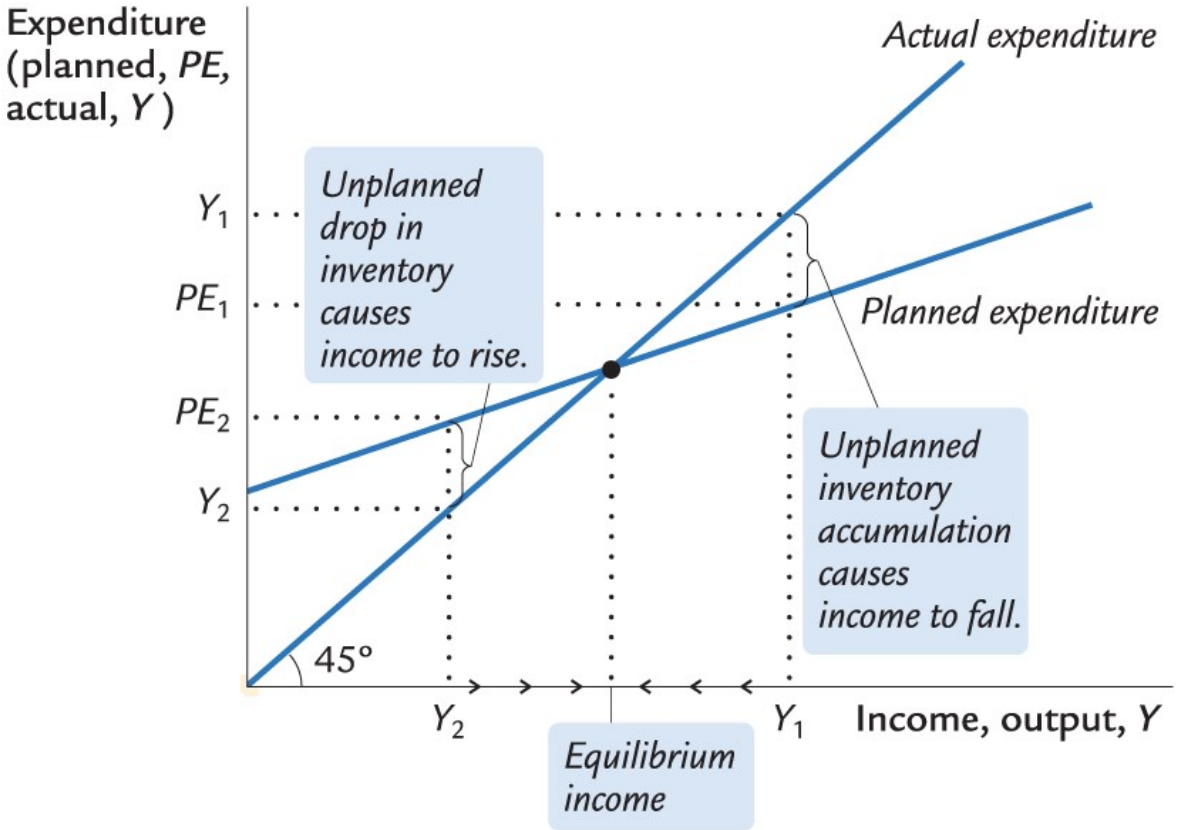
Adjustment process



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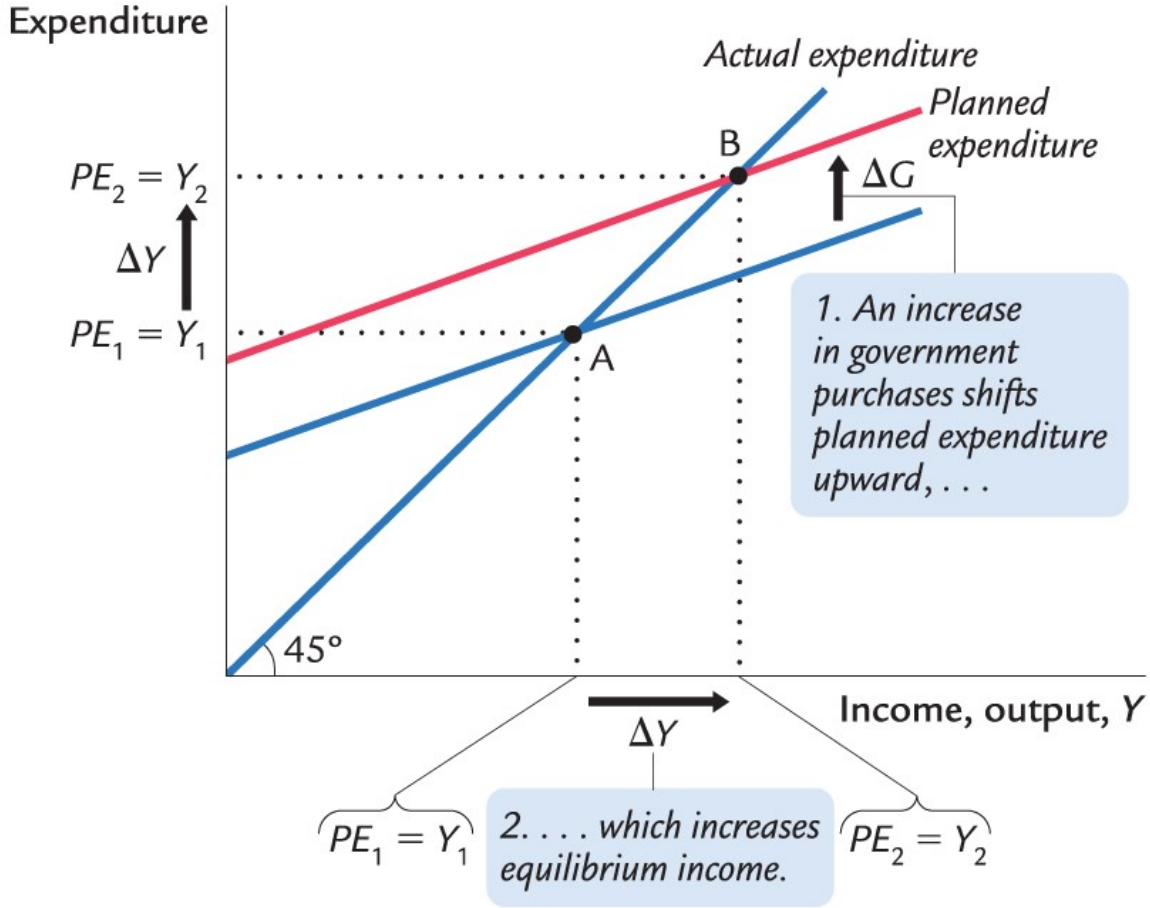
Increase in government expenditure in the Keynesian cross



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Income multiplier of an increase in government spending

Please have a look at Footnote 3: Mathematical note (p. 312)

$$PE = c_0 + c_1 \cdot (Y - \bar{T}) + \bar{I} + \bar{G} \tag{8}$$

Under consideration of the equilibrium condition ($Y = PE$):

$$Y = c_0 + c_1 Y - c_1 \bar{T} + \bar{I} + \bar{G} \tag{9}$$

$$dY = dc_0 + c_1 dY - c_1 d\bar{T} + d\bar{I} + d\bar{G} \tag{10}$$

- The autonomous component of consumption is constant, it does not change.
- Therefore, the change in the autonomous component is zero: $dc_0 = 0$.
- Investment is constant, it does not change.
- Therefore, the change in investment is zero: $d\bar{I} = 0$.

Income multiplier of an increase in government spending

$$dY = dc_0 + c_1 dY - c_1 d\bar{T} + d\bar{I} + d\bar{G}$$

- Taxes are constant, they do not change.
- Therefore, the change in taxes is zero: $d\bar{T} = 0$.

$$dY = c_1 dY + d\bar{G} \quad \Rightarrow \quad dY - c_1 dY = d\bar{G} \tag{11}$$

$$(1 - c_1) \cdot dY = d\bar{G} \quad \Rightarrow \quad dY = \frac{1}{1 - c_1} \cdot d\bar{G} \tag{12}$$

$$\frac{dY}{d\bar{G}} = \frac{1}{1 - c_1} > 0 \tag{13}$$

Income multiplier of an increase in government spending

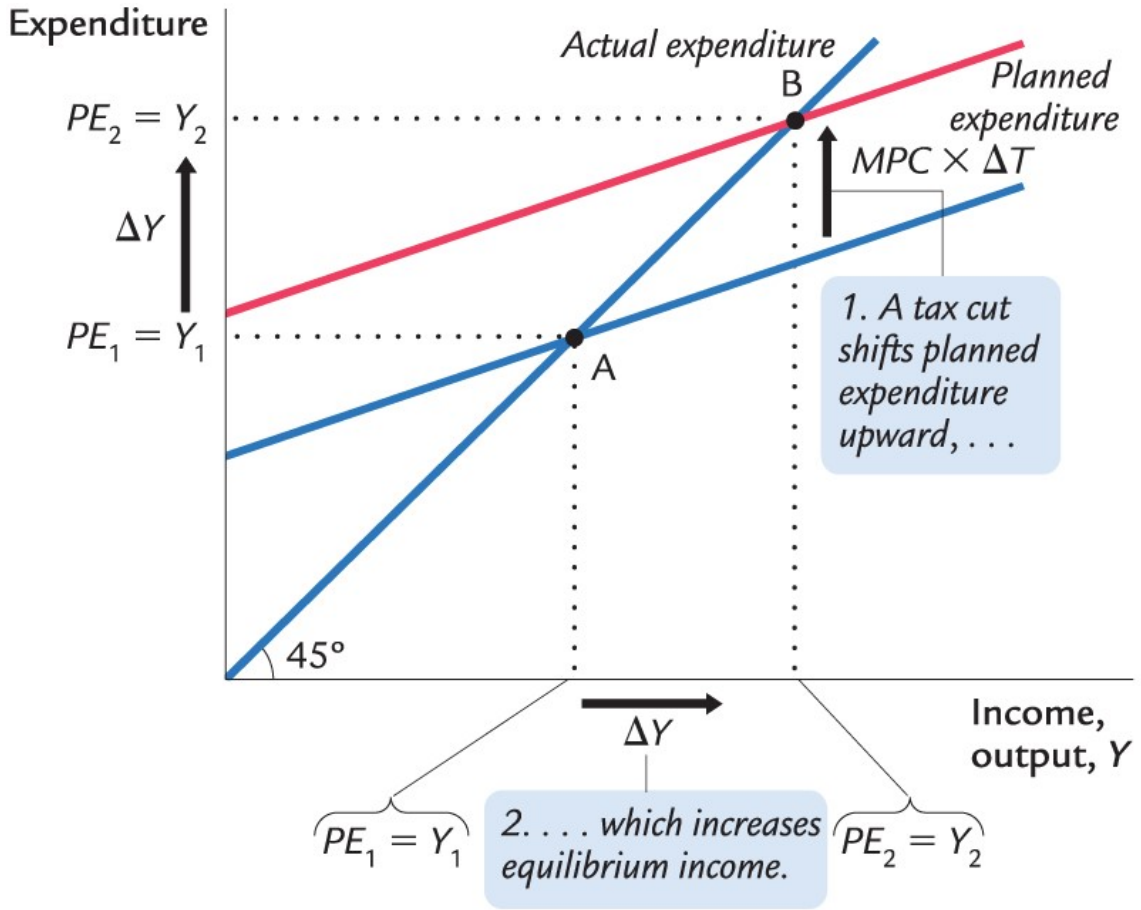
$$\frac{dY}{d\bar{G}} = \frac{1}{1 - c_1} > 0$$

- In case that $c_1 = 0.6$:

$$\frac{dY}{d\bar{G}} = \frac{1}{1 - c_1} = \frac{1}{1 - 0.6} = \frac{1}{0.4} = 2.5 \tag{14}$$

- The income multiplier of an increase in government spending takes the value of 2.5.
- When the government increases government spending by unit, income increases by 2.5 units.

An decrease in taxes in the Keynesian cross



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Income multiplier of an increase in taxes

Please have a look at Footnote 4: Mathematical note (p. 313)

$$dY = dc_0 + c_1 dY - c_1 d\bar{T} + d\bar{I} + d\bar{G} \tag{15}$$

$$dY = c_1 dY - c_1 d\bar{T} \quad \Rightarrow \quad dY - c_1 dY = -c_1 d\bar{T} \tag{16}$$

$$(1 - c_1) \cdot dY = -c_1 d\bar{T} \quad \Rightarrow \quad dY = -\frac{c_1}{1 - c_1} \cdot d\bar{T} \tag{17}$$

$$\frac{dY}{d\bar{T}} = -\frac{c_1}{1 - c_1} < 0 \tag{18}$$

Income multiplier of an increase in taxes

$$\frac{dY}{d\bar{T}} = -\frac{c_1}{1-c_1} < 0$$

- In case that $c_1 = 0.6$:

$$\frac{dY}{d\bar{T}} = -\frac{c_1}{1-c_1} = -\frac{0.6}{1-0.6} = -\frac{0.6}{0.4} = -1.5 \qquad (19)$$

- The income multiplier of an increase in taxes takes the value of -1.5.
- When the government increases taxes by unit, income decreases by 1.5 units.

Case study: Cutting taxes to stimulate the economy: The Kennedy and Bush tax cuts

Two effects:

- Supply-siders: Cuts in income taxes increases the incentive to work.
- Larger labor force, more labor ($L \uparrow$), higher output:

$$Y \uparrow = F(K, L \uparrow) \tag{20}$$

- Demand-siders: Income tax cuts leads to higher disposable income.
- This will simulate consumption and increase aggregate demand.

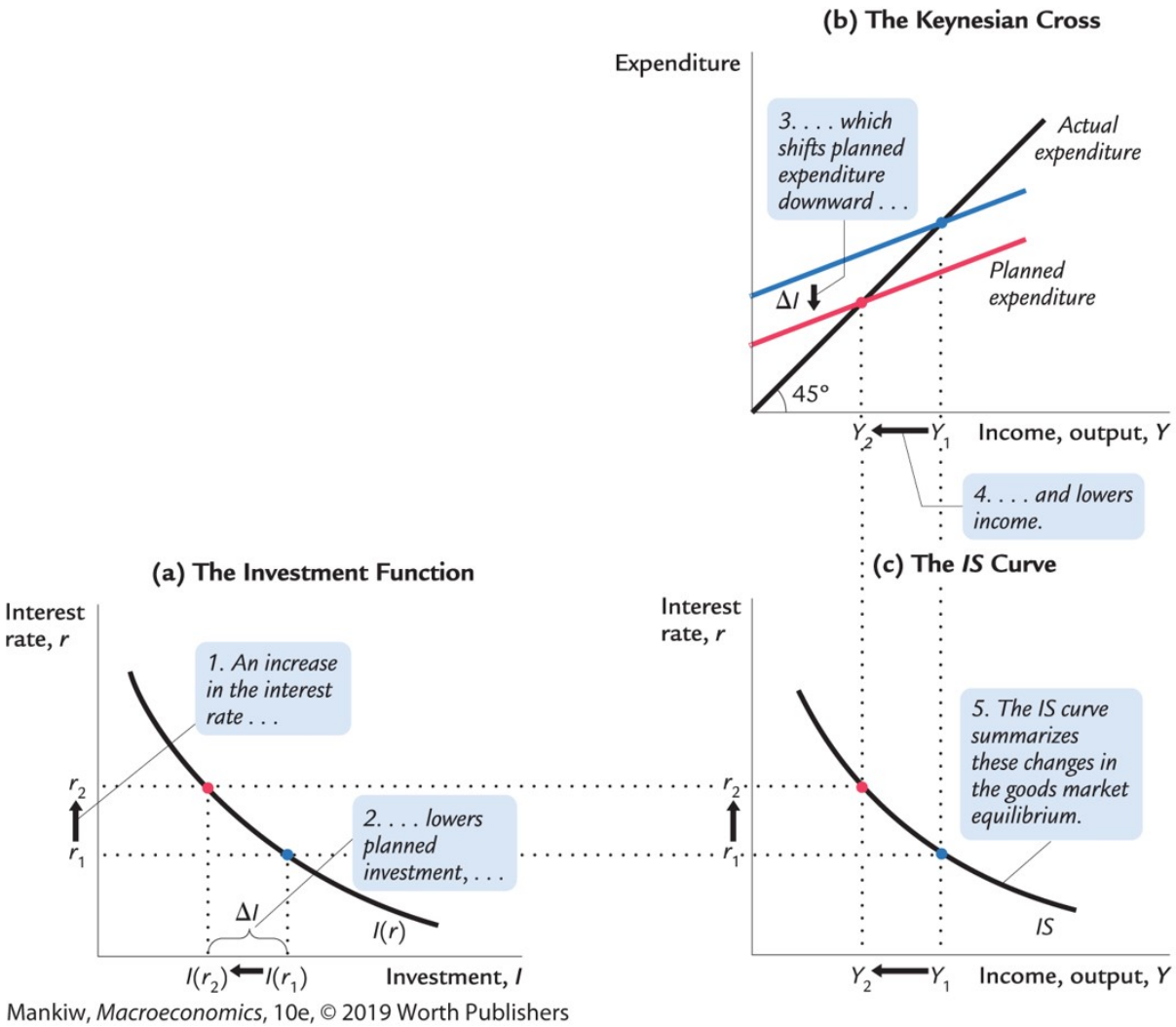
$$C \uparrow = c_0 + c_1 \cdot (Y - T \downarrow) \tag{21}$$

Adjusting the investment function

- Let's abolish the assumption that investment is exogenous.
- Let's once more assume that investment function depends on the interest rate:

$$I = I(r) \tag{22}$$

Deriving the IS curve



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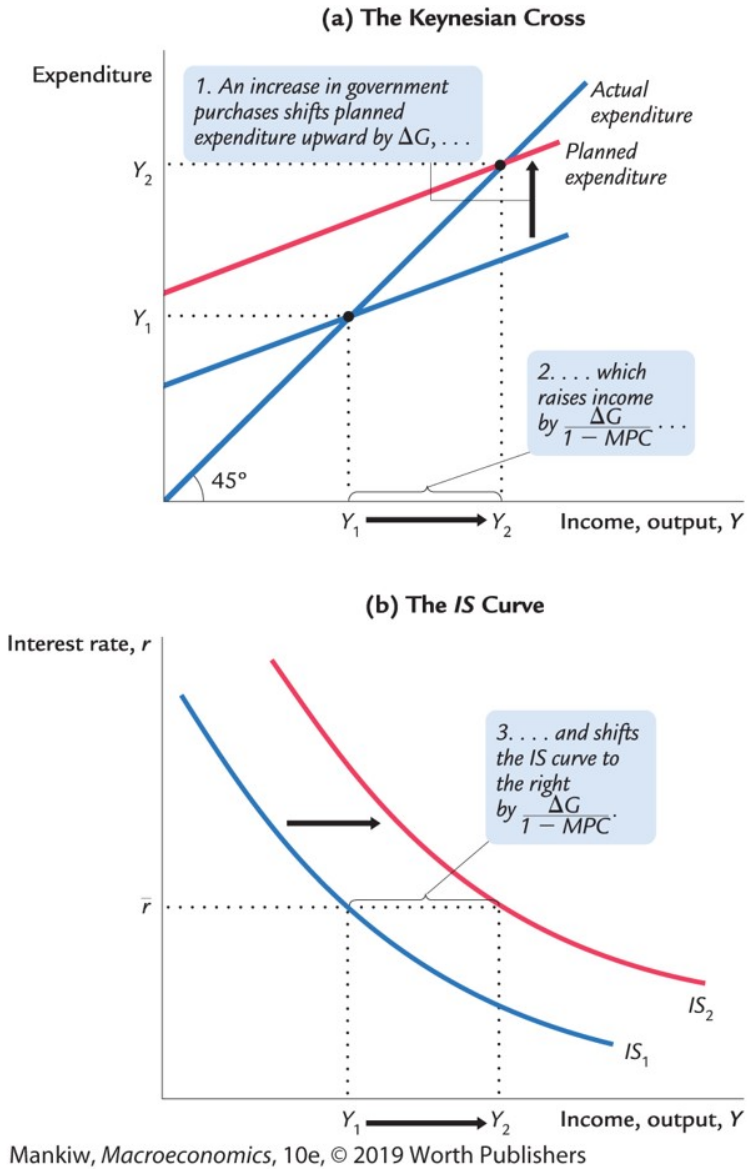
How fiscal policy shifts the IS curve



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Summary

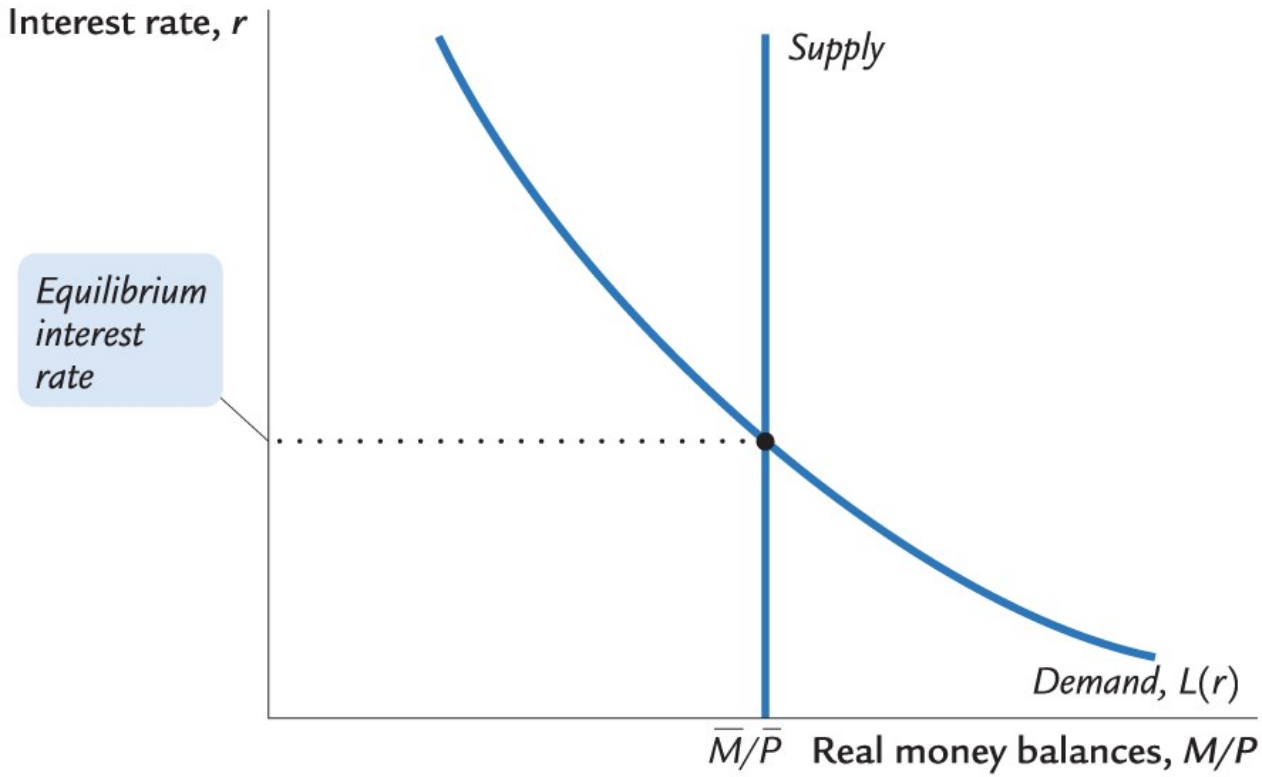
- The IS curve shows the combination of the interest rate and income that are consistent with an equilibrium in the goods market.
- The IS curve is drawn for a given amount of government spending and a given amount of taxes.
- Changes in fiscal policy that raise the demand for goods shift the IS curve to the right.
- Changes in fiscal policy that reduce the demand for goods shift the IS curve to the left.

Real money supply

$$(M/P)^s = \frac{\bar{M}}{\bar{P}} \tag{23}$$

- Nominal money supply (M) is an exogenous variable chosen by the central bank.
- The price level (P) is exogenous, because prices are predetermined.
- Intuition: What is *real* money supply?
  - In the Lolek and Bolek example
  - Nominal money supply was equal to $M = 4$ EUR.
  - The price level was equal to $P = 2$ EUR/beer.
  - Real money supply is equal to: $\frac{M}{P} = \frac{4 \text{ EUR}}{2 \text{ EUR/beer}} = 2$ beer
  - *"The real money supply in circulation is large enough to buy 2 beers."*

The theory of liquidity preference



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- Real money supply is a vertical line in an interest rate - real money balances - diagram.

Real money demand

$$(M/P)^d = L(r) \tag{24}$$

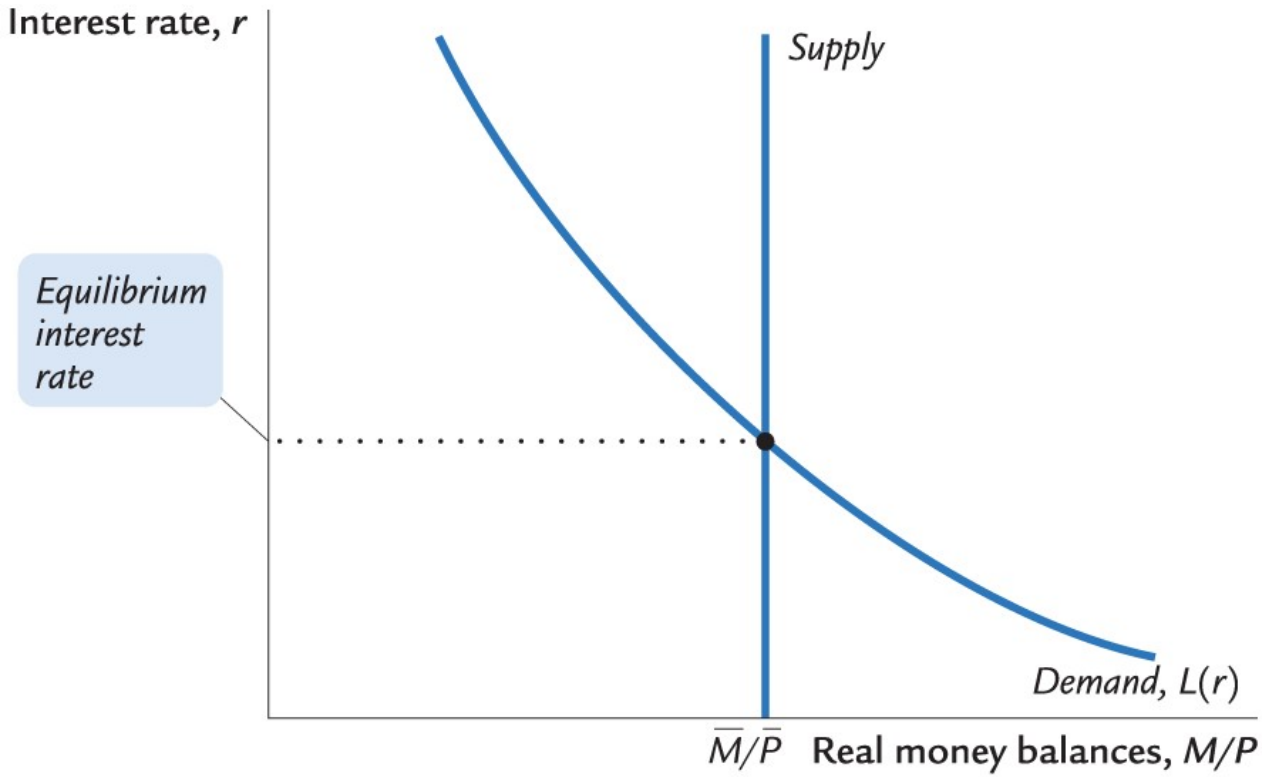
- At a later point in the textbook (p. 325):

$$(M/P)^d = L(r, Y) \tag{25}$$

- Money demand varies negatively with the interest rate:
- The higher the interest rate, the lower money demand.
- Money demand varies positively with the income level:
- The higher the income level, the higher money demand.
- Numerical example: (p. 331):

$$(M/P)^d = Y - 50 \cdot r \tag{26}$$

The theory of liquidity preference



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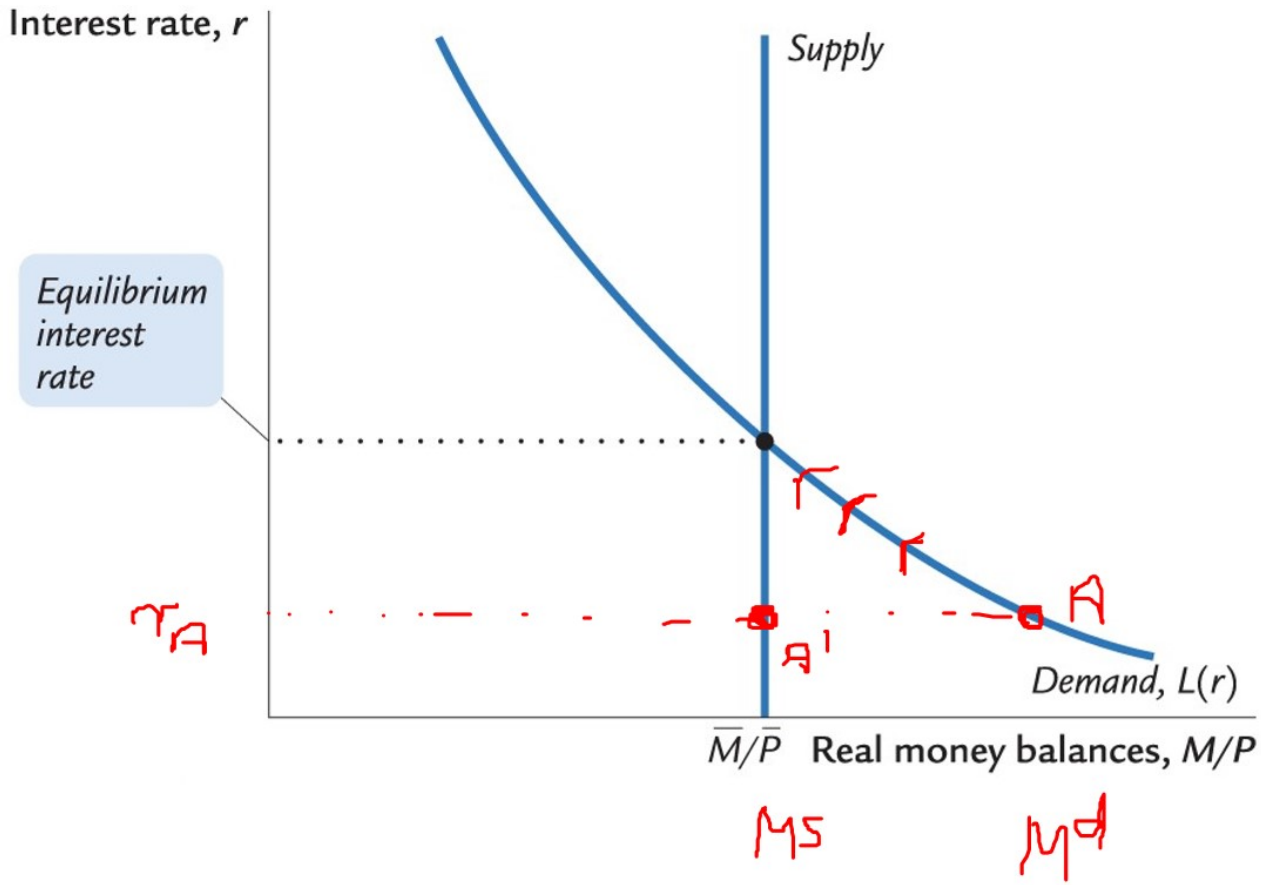
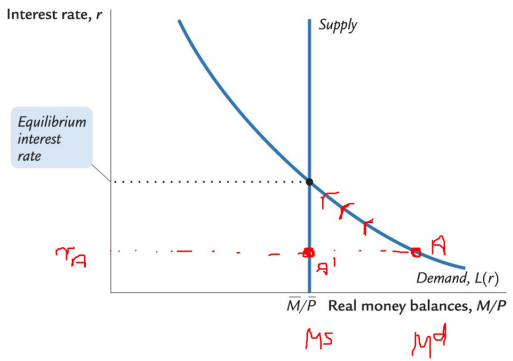
- Real money demand is downward sloping in an interest rate - real money balances - diagram.

Disequilibrium and adjustment process



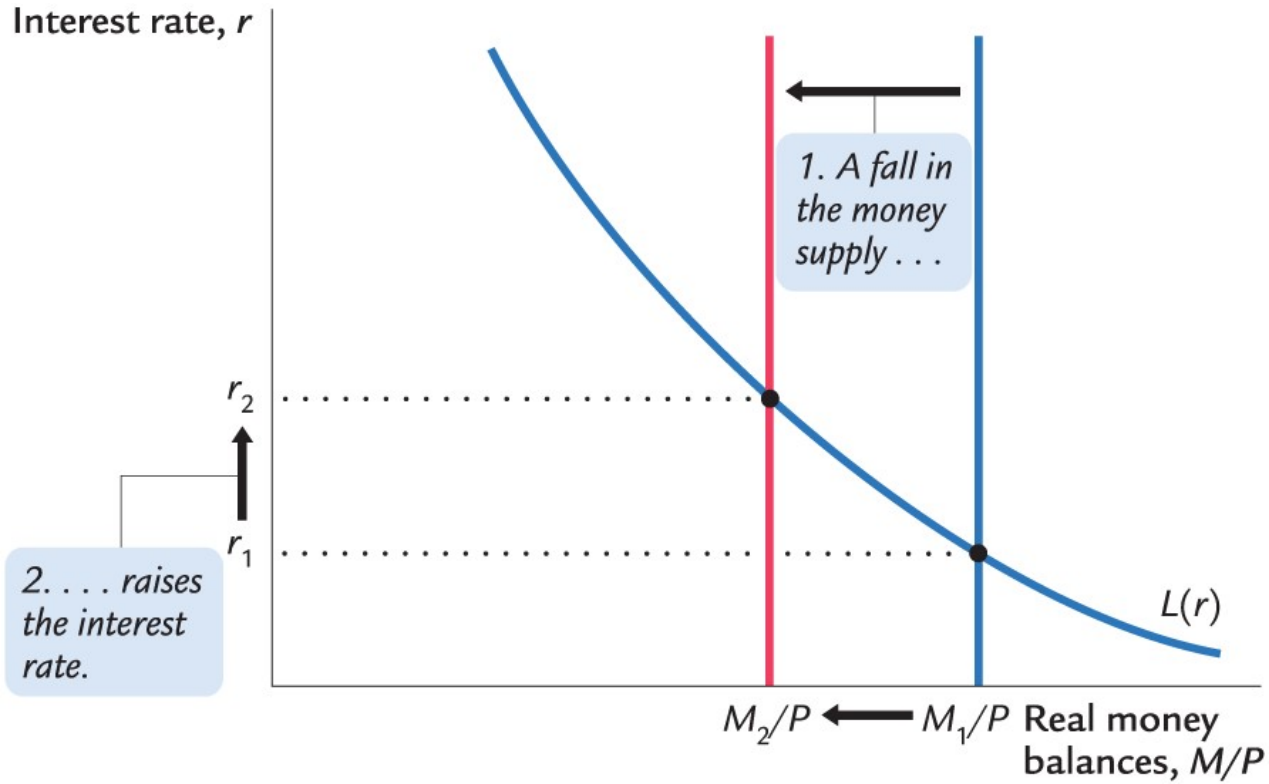
Disequilibrium and adjustment process (p. 323)

"Obtain money by selling bonds"



- In scenario A: Money demand is larger than money supply.
- Households: We want more money!
- Where can we get money: Sell bonds at the bond market.
- Bond supply larger than bond demand. Bond prices decrease. Interest rate increases.
- Increase in interest rate decreases money demand.

A reduction in money supply in the theory of liquidity preference



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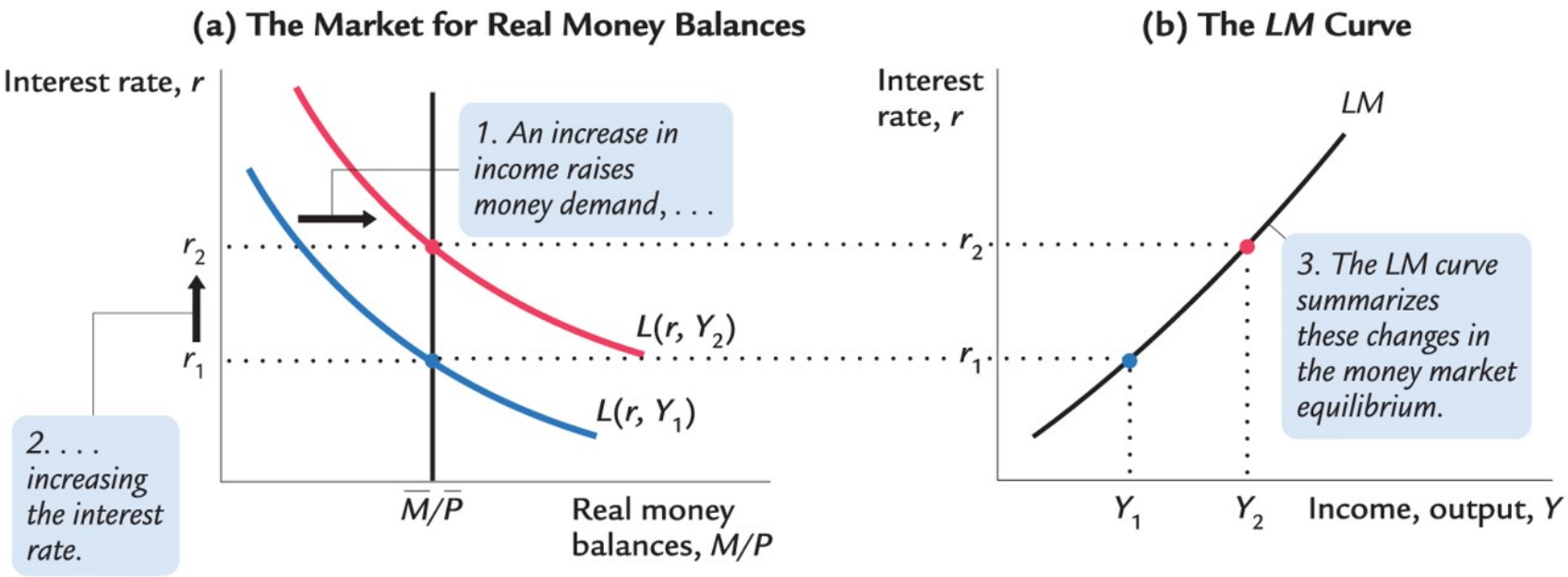
Deriving the LM curve



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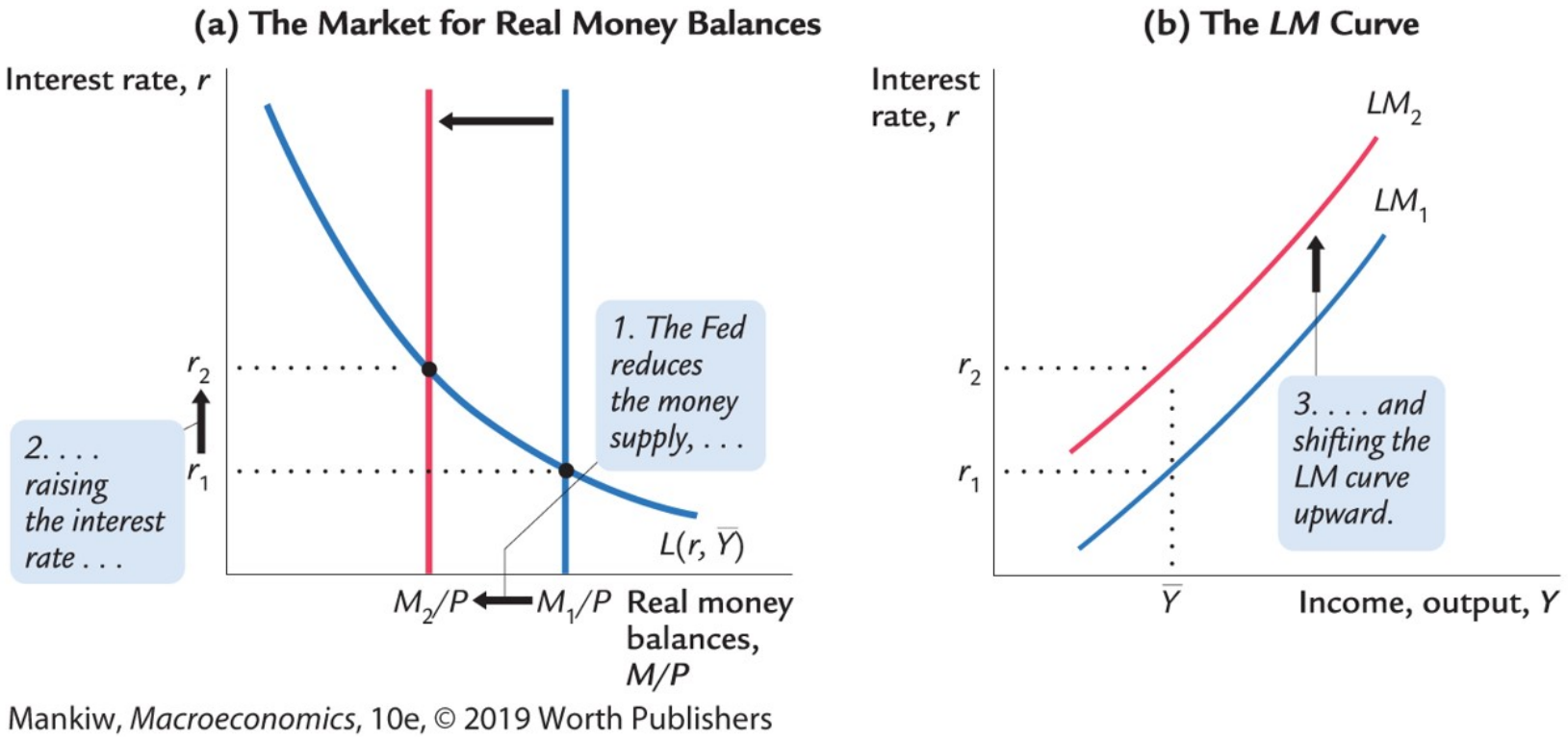
A reduction in the money supply shifts the LM curve upwards



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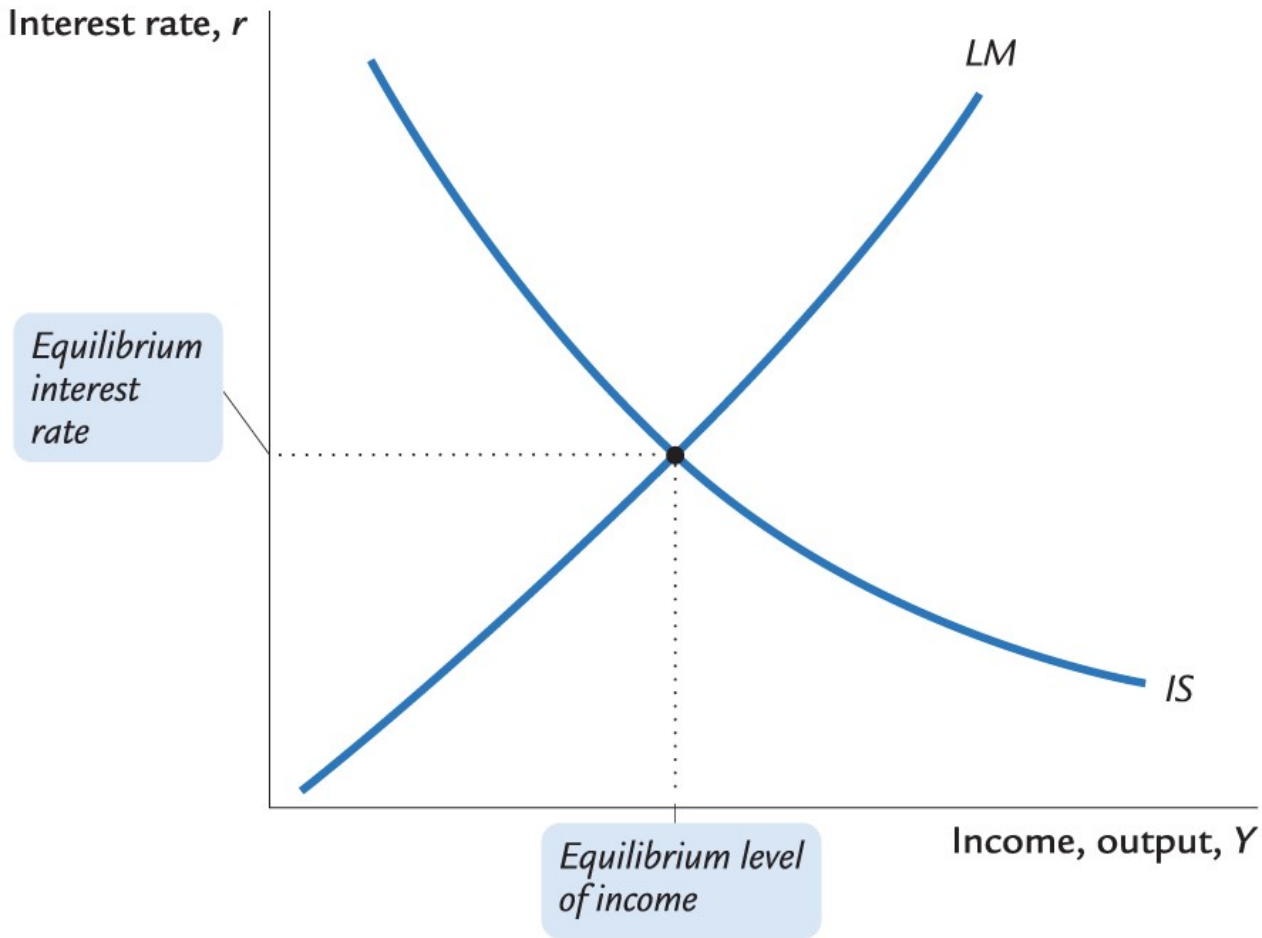
Equilibrium in the IS-LM model



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Summary

$$IS: \quad Y = c_0 + c_1 \cdot (Y - T) + b_0 - b_1 \cdot r + G \tag{27}$$

$$LM: \quad \frac{\bar{M}}{\bar{P}} = d_1 \cdot Y - d_2 \cdot r \tag{28}$$

Numerical example (p. 331)

Numerical example (p. 331)

$$IS: \quad Y = c_0 + c_1 \cdot (Y - T) + b_0 - b_1 \cdot r + G$$

$$LM: \quad \frac{\bar{M}}{\bar{P}} = d_1 \cdot Y - d_2 \cdot r$$

- $Y = C + I + G$
- $C = 50 + 0.75 \cdot (Y - T)$
- $I = 150 - 10 \cdot r$
- $G = 250$ and $T = 200$
- $(M/P)^d = Y - 50 \cdot r$
- $M = 3000$ and $P = 4$

Numerical example (p. 331)

- $Y = C + I + G$
- $C = 50 + 0.75 \cdot (Y - T)$
- $I = 150 - 10 \cdot r$
- $G = 250$ and $T = 200$
- $(M/P)^d = Y - 50 \cdot r$
- $M = 3000$ and $P = 4$

$$IS: \quad Y = 50 + 0.75 \cdot (Y - 200) + 150 - 10 \cdot r + 250 \tag{29}$$

$$LM: \quad \frac{3000}{4} = Y - 50 \cdot r \tag{30}$$

Numerical example (p. 331)

$$IS: \quad Y = 50 + 0.75 \cdot (Y - 200) + 150 - 10 \cdot r + 250 \tag{31}$$

$$Y = 300 + 0.75 \cdot Y - 150 + 150 - 10 \cdot r \tag{32}$$

$$Y - 0.75 \cdot Y = 300 - 10 \cdot r \quad \Rightarrow \quad (1 - 0.75) \cdot Y = 300 - 10 \cdot r \tag{33}$$

$$(0.25) \cdot Y = 300 - 10 \cdot r \tag{34}$$

$$IS: \quad Y = 1200 - 40 \cdot r \tag{35}$$

Numerical example (p. 331)

$$LM: \quad \frac{3000}{4} = Y - 50 \cdot r \tag{36}$$

$$LM: \quad 750 = Y - 50 \cdot r \tag{37}$$

Inserting the right hand side into the LM equation (instead of Y)
$IS: \quad Y = 1200 - 40 \cdot r$

$$750 = 1200 - 40 \cdot r - 50 \cdot r \tag{38}$$

$$450 = 90 \cdot r \quad \Rightarrow \quad r^* = 5 \tag{39}$$

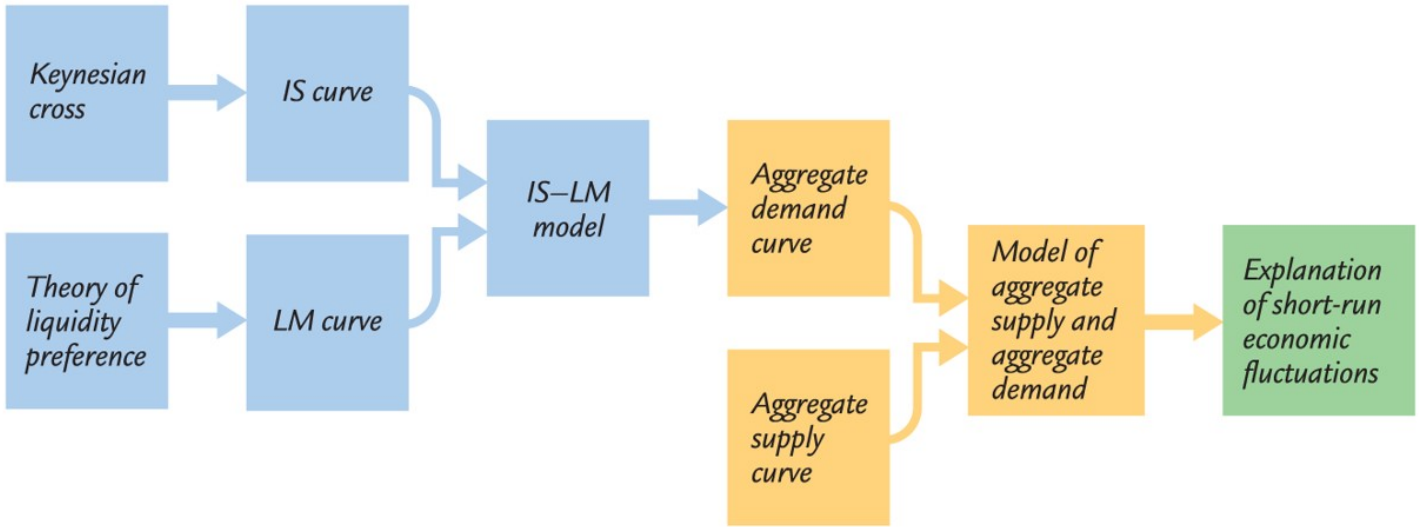
Numerical example (p. 331)

Inserting $r^* = 5$ into IS : $\quad Y = 1200 - 40 \cdot r$

$$Y = 1200 - 40 \cdot 5 = 1000 \quad \Rightarrow \quad Y^* = 1000 \tag{40}$$

Hence, the equilibrium interest rate level is equal to $r^* = 5$. The equilibrium GDP level is equal to $Y^* = 1000$.

The theory of short-run fluctuations



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