Money and financial markets

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Outline

Learning objective chapter 4

After you worked through this chapter, you should know

- the factors that influence money demand
- how shocks of the demand or supply of money influence the equilibrium level of the interest rate
- the relationship between bond price and the bond yield (=the interest rate),
- how the central bank uses open market operations to influence money supply
- the role of commercial banks in the transmission mechanism,
- how you can derive the money multiplier in a simple economy – with reserve requirements for checkable deposits but without cash.

Nominal money demand: Assumptions

- Money is needed to complete transactions.
- The higher the number/volume of transaction ($Y \uparrow$) the higher the demand for money ($M^D \uparrow$).
- Bonds have a fixed coupon and yield the interest rate i.
- The higher the interest rate, the higher the opportunity costs of holding money.
- The higher the interest rate ($i \uparrow$) the lower the demand for money ($M^D \downarrow$).

$$M^D = P \cdot (d_0 + d_1 \cdot Y - d_2 \cdot i) \tag{1}$$

Variables

Nominal money demand (M^D money demand) is a function of the following variables and parameters:

$$M^D = P \cdot (d_0 + d_1 \cdot Y - d_2 \cdot i)$$

Exogenous variables

- P: commodity price
- d_0: Autonomous component of money demand
- Y: Income

Endogenous variable

- i: Interest rate

Parameters

- d_1: Income responsiveness of the demand for money
- d_2: Interest rate responsiveness of the demand for money

Nominal money demand: Numerical example

$$M^D = P \cdot (d_0 + d_1 \cdot Y - d_2 \cdot i)$$

$P = 1$
$d_0 = 1000$
$Y = 2000$
$d_1 = 1$
$d_2 = 100$

$$M^D = 1 \cdot (1000 + 1 \cdot 2000 - 100 \cdot i)$$

Money demand function is to be drawn into a diagram, where

- the interest rate is on the vertical axis and
- the money demand on the horizontal axis!

Course of the money demand curve

$$M^D = 1 \cdot (1000 + 1 \cdot 2000 - 100 \cdot i)$$

Axis intercept with horizontal axis (abscissa)

- What value does the demand for money take on when the interest rate = 0?

$$M^D = 1 \cdot (1000 + 1 \cdot 2000 - 100 \cdot 0) = 3000$$

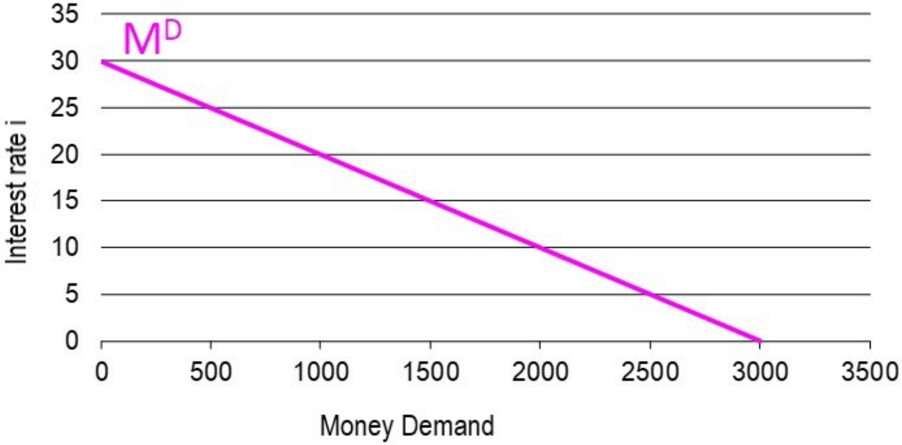
Axis intercept with vertical axis (ordinate)

- At what interest rate level is the demand for money = 0?

$$0 = 1 \cdot (1000 + 1 \cdot 2000 - 100 \cdot i)$$

$$i = 30$$

Money demand



Shifting the money demand curve

A curve shifts if

- when a variable changes,
- which is included in the function,
- but is not indicated on one of the two axes.

The money demand curve shifts to right ($M^D \uparrow$)

- if the price level increases ($P \uparrow$),
- the income increases ($Y \uparrow$) or
- the autonomous component of money demand increases ($d_0 \uparrow$).

Nominal money supply: Assumptions in section 4.2.1

- Private households use only coins & notes (cash) as money, no checkable deposits.
- Central bank provides households with cash (M).
- Central bank *"provides money"*.

$$M^S = M$$

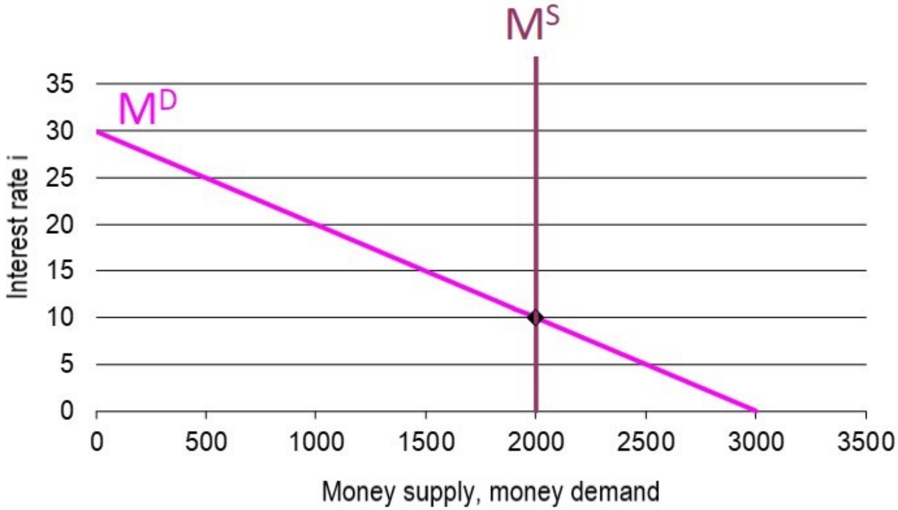
- Numerical example: $M^S = 2000$

Equilibrium condition

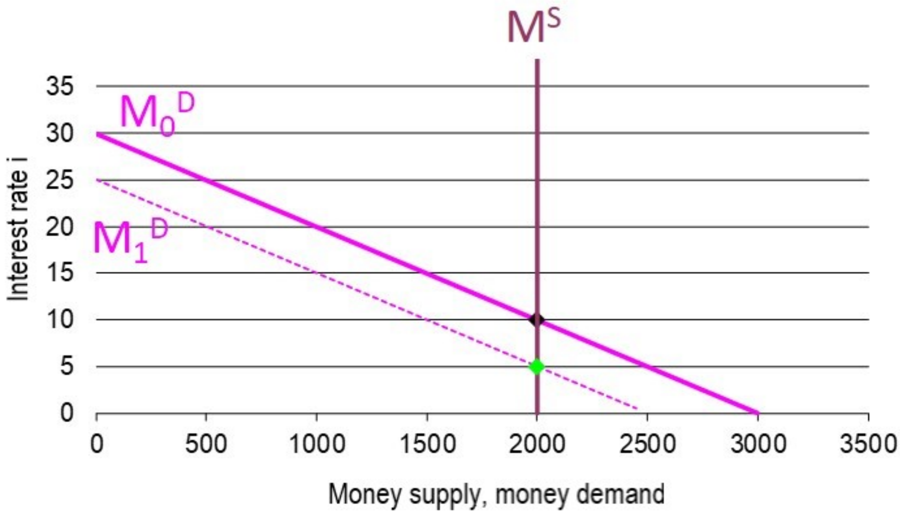
- Money supply = Money demand

$$M = P \cdot (d_0 + d_1 \cdot Y - d_2 \cdot i)$$

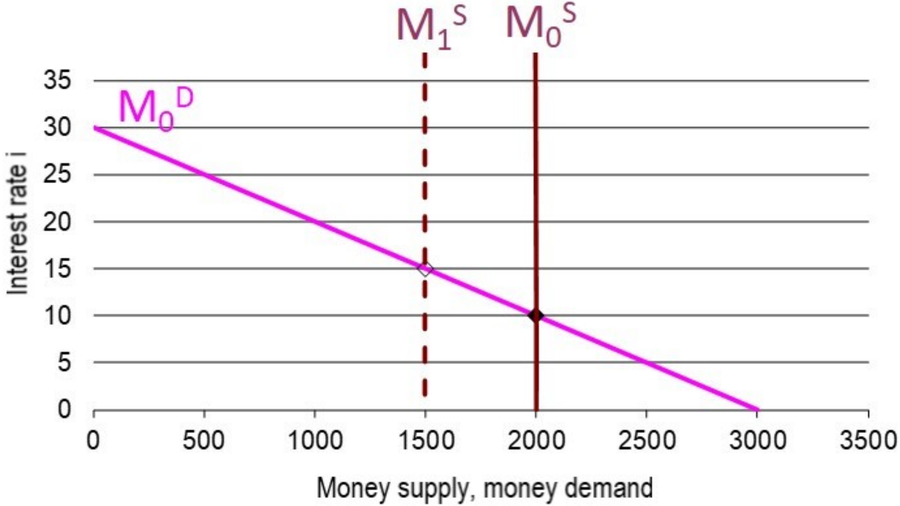
Equilibrium



Income decreases ($dY = -500$)



Money supply decreases ($dM^S = -500 \Rightarrow M_1^S = 1500$)



Central bank controls money supply via open market operations

How does a central bank influences money supply and hence the interest rate?

- Central bank buys bonds from commercial banks.
- Deals are called open market operations (OMO).
- ECB performs OMO in the form of *security repurchase agreement*.
- De jure the central bank is not buying the bonds but ECB provides a loan/liquidity against a collateral.
- Most important OMO: Main refinancing operations (duration 1 week).

Open market operations

Example for an expansionary monetary policy

1. Week: ECB buys 300 bn. € bonds
2. Week: ECB buys 320 bn. € bonds

Example for a contractionary monetary policy

1. Week: ECB buys 300 bn. € bonds
2. Week: ECB buys 280 bn. € bonds

Balance Sheet of the Central Bank

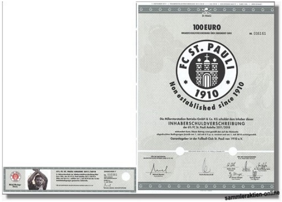
Assets	Liabilities
Bonds	Money supply in circulation (notes and coins)

Relationship between bond prices and bond yields

- In the securities market, it is not the interest rate that is directly determined, but the price of the bond.
- price = price of the securities.
- Effective interest rate (yield) can be derived from price.

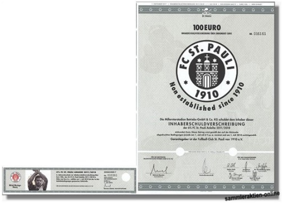
Old and new security: Market value of old security?

OLD



- $i_0 = 10$ %
- Nominal value 100 EUR
- 2011 – 2021
- Remaining duration: 1 year

NEW



- $i_0 = 5$ % (Scenario A)
- Nominal value 100 EUR
- 2020 – 2021
- Duration: 1 year

Relationship between bond prices (P_B) and bond yields (i_B)

Example: There only exist two bonds

- One bond was issued in the past
- Remaining duration today: 1 Year
- Face value 100 €
- Coupon: 10 % ($i_0 = 0.1$)
- Payment in 1 year from now: 110 €
- Yield of the bond (i_B)?

$$i_B = \frac{100 \cdot (1 + i_0) - P_B}{P_B} = \frac{110 - P_B}{P_B}$$

Yield of the bond depends on its current price (Bond Price P_B)

Relationship between bond prices (P_B) and bond yields (i_B)

alternative

- New bond emission, one year duration, Face value 100 €, Coupon = actual interest rate level i

Scenario analysis:

- If $i_B > i$ $\Rightarrow$ Buy bond i_B
  Demand increases $\Rightarrow$ P_B increases
- If $i_B < i$ $\Rightarrow$ Sell bond i_B
  Supply increases $\Rightarrow$ P_B decreases
- If $i_B = i$ $\Rightarrow$ Agents are indifferent, no arbitrage possible

Equilibrium condition $i_B = i$

Relationship between bond prices (P_B) and bond yields (i_B)

Insert equilibrium condition ($i_B = i$) in yield formula and solve for P_B

(2) $$i_B = \frac{100 \cdot (1 + i_0) - P_B}{P_B}$$

(3) $$i = \frac{100 \cdot (1 + i_0) - P_B}{P_B} \quad \Rightarrow \quad i \cdot P_B = 100 \cdot (1 + i_0) - P_B$$

(4) $$i \cdot P_B + P_B = 100 \cdot (1 + i_0) \quad \Rightarrow \quad P_B \cdot (1 + i) = 100 \cdot (1 + i_0)$$

(5) $$P_B = \frac{100 \cdot (1 + i_0)}{1 + i}$$

Relationship between bond prices (P_B) and bond yields (i_B)

$$P_B = \frac{100 \cdot (1 + i_0)}{1 + i} = \frac{100(1 + 0.1)}{1 + i}$$

Scenario analysis:

- If $i = 5$ % $\quad P_B = \frac{100\cdot(1+0.1)}{1+0.05} = 104.76$
- If $i = 10$ % $\quad P_B = \frac{100\cdot(1+0.1)}{1+0.1} = 100$
- If $i = 20$ % $\quad P_B = \frac{100\cdot(1+0.1)}{1+0.2} = 91.67$

Expansionary monetary policy

1. Central bank buys more bonds
2. Demand for bonds increases
3. Market value (Price) increases $\Rightarrow$ interest rate decreases

Restrictive monetary policy

1. Central bank buys fewer bonds
2. Demand for bonds decreases
3. Bond price decreases $\Rightarrow$ interest rate increases

Alternative argumentation:

- Central bank sells bonds
- Supply of bonds increases
- Bond price decreases $\Rightarrow$ interest rate increases

4.4.2 Money multipler

Assumptions until now:

- Central bank determines the money supply directly.
- Commercial banks do not play a role in the transmission mechanism.

New assumptions:

- Only checkable accounts, no money in circulation.
- Minimum reserve requirements ($\theta = 0.02$).
- Central bank buys from one Bank A a bond of value 100 € (monetary bases increases by $H = 100$).

Money multiplier

- Bank A gives a loan to customer A for an amount of 100 €, Agent A transfer the money to customer B at the bank B.
- Agent B leaves the money on his checkable account. Bank B holds 2 % as a minimum reserve requirement and gives a loan of 98 € to agent C. Agent C transfers the money to agent D at bank D
- Agent D leaves 98 € on his checkable account. Bank D holds 2 % as a minimum reserve requirement and gives a loan of 96.04 € to agent E ...

By how much does the money supply increase?

(6) $$M = 100 \text{ €} \cdot (1 + 0.98 + 0.98^2 + \ldots)$$

More formally:

(7) $$M = H \cdot (1 + (1-\theta)^1 + (1-\theta)^2 + (1-\theta)^3 + \ldots + (1-\theta)^{\infty-1} + (1-\theta)^{\infty})$$

If we divide by $(1 - \theta)$ it follows:

(8)
$$\frac{1}{(1-\theta)} M = H \cdot \left(\frac{1}{(1-\theta)} + 1 + (1-\theta)^1 + (1-\theta)^2 + \ldots + (1-\theta)^{\infty-1} \right)$$

By how much does the money supply increase?

$$M = H \cdot (1 + (1-\theta)^1 + (1-\theta)^2 + (1-\theta)^3 + \ldots + (1-\theta)^{\infty-1} + (1-\theta)^{\infty})$$

$$\frac{1}{(1-\theta)} M = H \cdot \left(\frac{1}{(1-\theta)} + 1 + (1-\theta)^1 + (1-\theta)^2 + \ldots + (1-\theta)^{\infty-1} \right)$$

If one forms the difference, the result is:

$$M - \frac{1}{(1-\theta)} M = H \cdot \left(-\frac{1}{(1-\theta)} + (1-\theta)^{\infty} \right) \qquad (9)$$

By how much does the money supply increase?

$$M - \frac{1}{(1-\theta)} M = H \cdot \left(-\frac{1}{(1-\theta)} + (1-\theta)^{\infty} \right) \tag{10}$$

The last term $(1-\theta)^{\infty}$ will converge to zero:

$$\frac{1-\theta-1}{1-\theta} M = -\frac{1}{1-\theta} H \quad \Rightarrow \quad \frac{-\theta}{1-\theta} M = -\frac{1}{1-\theta} H \tag{11}$$

If one multiplies $-\frac{1-\theta}{\theta}$, it results:

$$M = \frac{1}{\theta} H \tag{12}$$

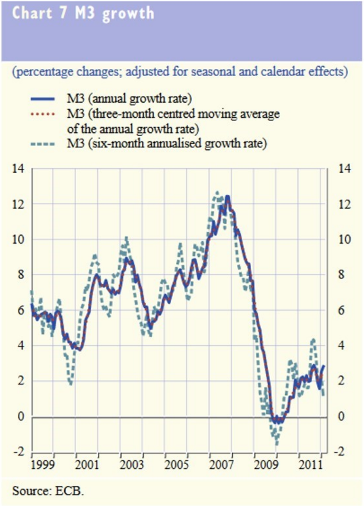
By how much does the money supply increase?

$$M = \frac{1}{\theta} \cdot H \tag{13}$$

- Money supply depends on the minimum reserve requirements (θ) and the monetary base (H).
- The larger the minimum reserve requirements the lower the money multiplier.
- In this model, the money multiplier $\left(\frac{1}{\theta}\right)$ corresponds to the reciprocal of the reserve requirement rate.

$$M = \frac{1}{\theta} \cdot H = \frac{1}{0.02} \cdot 100 = 5000 \tag{14}$$

Growth rate of M3



Minimum reserve requirements

Minimum reserves

The European Central Bank (ECB) requires credit institutions to hold compulsory deposits on accounts with the national central banks (NCBs): these are called "minimum" or "required" reserves. The amount of required reserves to be held by each institution is determined by its reserve base.

In order to determine an institution's reserve requirement, the reserve base is multiplied by the reserve ratio. The ECB applies a uniform positive reserve ratio to most of the balance sheet items included in the reserve base. This reserve ratio was set at 2% at the start of Stage Three of European Economic and Monetary Union (EMU) and is lowered to 1% from 18 January 2012. As noted above, the reserve requirement for each individual