Money Market - Part 2

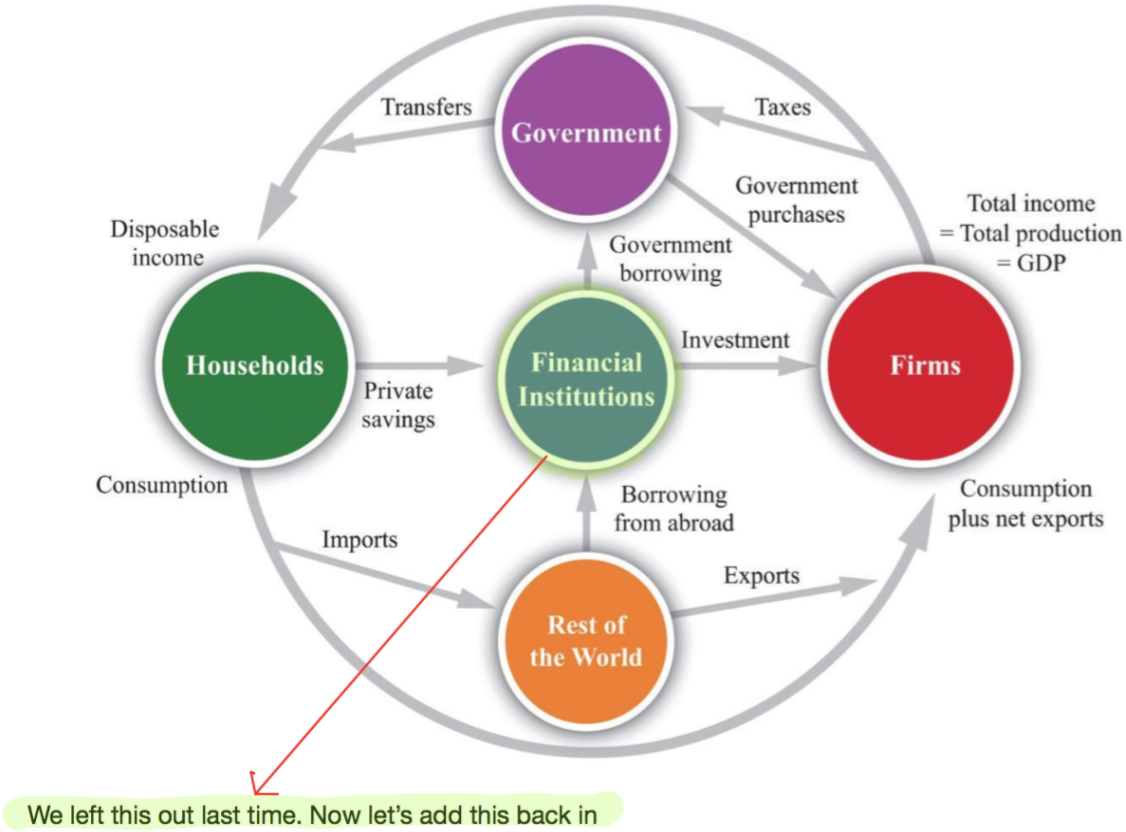
EC 313, Macroeconomics

Alex Li

Book Chapter 4

Overview

Overview


Transfers
Government
Taxes
Government purchases
Total income = Total production = GDP
Disposable income
Government borrowing
Households
Financial Institutions
Investment
Firms
Private savings
Consumption
Borrowing from abroad
Consumption plus net exports
Imports
Exports
Rest of the World
We left this out last time. Now let's add this back in

Overview

In the last lecture, we derived the **LM equation**, which describes the interest rate at the equilibrium of the money market.

$$M = \$Y * L(i)$$

However, we made a simplifying assumption - there are **no commercial banks**, which means there is currency but no checkable deposits.

Also, we talked about the central bank has the power to decide the **money supply**, but we still don't know the mechanism of injecting money into the economy.

Overview

In this lecture, we will go over.

- Adding **Commercial Banks** in our Money Market Model
- Monetary Policy: **Open Market Operations**
- Monetary Policy: **Reserve Requirement**
- Among Commercial Banks: **Reserve Market**
- Monetary Policy: **Discount Rate**
- Monetary Policy: **Interest On Reserves**

Commercial Banks

Commercial Banks

Commercial Banks

What Banks Do?

Commercial Banks are the most important **financial intermediaries** in an economy. A few things to note:

- Commercial Banks **sell** future money (bonds) of **different liquidity with different interest rate** to households. **Commercial Banks themselves are not the source of the now money**.
    - Allen has $6000 left in the bank with **0%** annual interest rate with high liquidity. He is backpacking in Southeast Asia for a year and plans to spend $500 every month.

Commercial Banks

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    - Mary has $1 million saved in the bank with **3%** annual interest rate with low liquidity. According to the contract, she can't use the $1 million for the next 12 months but will receive $1.03 million afterward.

Commercial Banks

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- Commercial Banks **buy** future money (bonds) of **different liquidity with different interest rate** from households and firms, and **this helps increase consumption and investment in the economy**.
    - Alex needs to buy a **road bike** for $5000 (**C**), but he doesn't have enough money right now. He took a loan from a local commercial bank to finance his purchase. The loan requires him to pay the bank $500 every month for the next 12 months.

Commercial Banks

What Banks Do?

Commercial Banks are the most important **financial intermediaries** in an economy. A few things to note:

- Commercial Banks **buy** future money (bonds) of **different liquidity with different interest rate** from households and firms, and **this helps increase consumption and investment in the economy**.
    - Maria has an excellent business idea, and she wants to borrow some money from the bank to realize the idea. After checking her financial status, the local bank decides to give her $1 million to buy **equipments** (**I**) to start, and she needs to pay the bank $1.1 million in a year.

Commercial Banks

Why Banks?

Why do we need these commercial banks as intermediaries?

Why can't Alex borrow money directly from Allen?

- The bank gets to pocket $1000 from this transaction.

Commercial Banks

Why Banks?

Why do we need these commercial banks as intermediaries?

Why can't Alex borrow money directly from Allen?

- The bank gets to pocket $1000 from this transaction.

Why can't Maria borrow money directly from Mary?

- The bank gets to pocket $0.07 million from this transaction. (A lot of money!)

Commercial Banks

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- Alex would have to build a few ATM's for Allen, depending on where Allen wants to go in Southeast Asia.

Commercial Banks

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Why can't Alex borrow money directly from Allen? - The bank gets to pocket $1000 from this transaction.

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- Alex would have to build a few ATM's for Allen, depending on where Allen wants to go in Southeast Asia.
- Allen needs to do a background check on Alex if he can pay back the money.

Commercial Banks

Why Banks?

Why can't Alex borrow money directly from Allen? - The bank gets to pocket $1000 from this transaction.

- It takes time for them to find each other.
- Alex would have to build a few ATM's for Allen, depending on where Allen wants to go in Southeast Asia.
- Allen needs to do a background check on Alex if he can pay back the money.
- Allen needs to pay a lawyer lots of money (more than $1000) to write a very detailed contract.

Commercial Banks

Why Banks?

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- It takes time for them to find each other.
- Mary has to make sure Maria won't escape with the $1 million!

Commercial Banks

Why Banks?

Why can't Maria borrow money directly from Mary? - The bank gets to pocket $0.07 million from this transaction. (A lot of money!)

- It takes time for them to find each other.
- Mary has to make sure Maria won't escape with the $1 million!
- Maria probably needs to borrow against her house, which requires some expensive legal service.

Commercial Banks

Why Banks?

If there were no commercial banks, Alex wouldn't be able to buy the road bike (at least sooner), and Maria wouldn't be able to realize her business idea. GDP suffers! We will get back to this in a few weeks.

Which banks got bailed out in 2008?

"Lehman Brothers went bankrupt. *Merrill Lynch, AIG, Freddie Mac, Fannie Mae, HBOS, Royal Bank of Scotland, Bradford & Bingley, Fortis, Hypo and Alliance & Leicester* all came within a whisker of doing so and **had to be rescued**"

Commercial Banks

Reserves

- Each commercial bank wants to lend out as much money (buy future money) as possible
- But each bank also wants to (and also is required to) keep some **cash in their vault** (**reserves**) to avoid bank run (a Self-fulfilling Prophecy). This is for both precautionary and for regulatory reasons.

Commercial Banks

Reserves

How much **reserves** does a bank need to keep in their vault?

- Reserves are used for people to **withdraw cash**.
- People withdraw cash from their **checkable deposits**.
- If a bank has larger checkable deposits, it needs to prepare more reserves.

$$R^d = \theta D^d$$

R^d **is the reserves demand from banks**.

θ **is the reserve ratio**.

D^d **is the dollar amount of checkable deposits demand from households**.

Checkable Deposits

Here is the question, how much checkable deposits are demanded by households D^d?

Recall that **checkable deposits** is just a form of money, and the other form is **currency**.

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Recall that **checkable deposits** is just a form of money, and the other form is **currency**.

Also, recall the money demand is M^D - let's assume people hold:

c proportion of their money in currency

$1-c$ proportion of their money in checkable deposits.

- The demand for checkable deposits is $D^d = (1-c)M^d$
- The demand for currency is $CU^d = cM^d$

(Central Bank) Money Market

(Central Bank) Money Market

Demand for Central Bank Money

Central Bank Money can be used as

- currency held by **households**
- reserves held by **commercial banks** in their vaults

Demand for Central Bank Money:

$$H^d = CU^d + R^d$$

(Central Bank) Money Market

Demand for Central Bank Money

$$
\begin{aligned}
H^d &= CU^d + R^d \\
&= cM^d + \theta D^d \\
&= cM^d + \theta(1-c)M^d \\
&= [c + \theta(1-c)]M^d \\
&= [c + \theta(1-c)]\$YL(i)
\end{aligned}
$$

(Central Bank) Money Market

Supply for Central Bank Money

Supply for **Central Bank Money** is achieved by **Open Market Operations (OMO)** by **the Federal Open Market Committee (FOMC)**.

- FOMC decides how much **government securities** they want to sell to or buy in the open market. These government securities are very safe assets.

(Central Bank) Money Market

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- When FOMC buys government securities, they inject central bank money into the economy (**Expansionary OMO**).

(Central Bank) Money Market

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- FOMC decides how much **government securities** they want to sell to or buy in the open market. These government securities are very safe assets.
- When FOMC buys government securities, they inject central bank money into the economy (**Expansionary OMO**).
- When FOMC sells government securities, they take central bank money out of the economy (**Contractionary OMO**).

(Central Bank) Money Market

Supply for Central Bank Money

Through **OMO**, the Fed can control the **supply of Central Bank Money** H^S in the economy.

- Again, since the model doesn't explain the level of H^S, we say it is exogeneous.

$$H^S = H$$

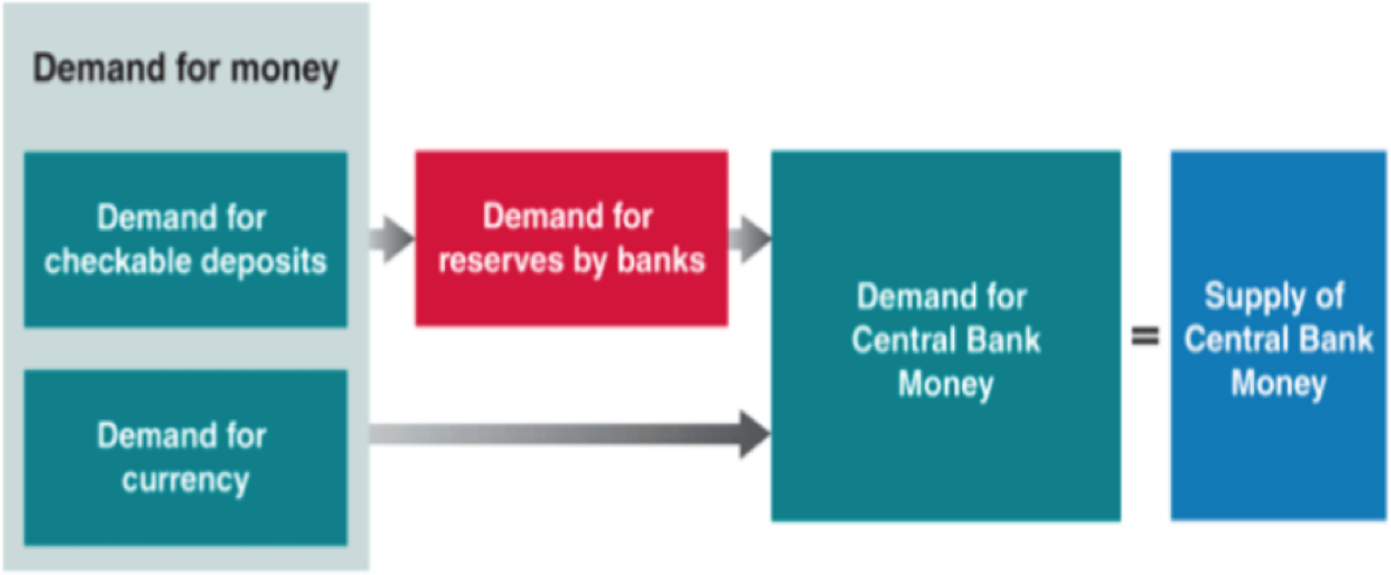
- **OMO** is one of the most important tools for the Federal Reserve Bank.

(Central Bank) Money Market

Equilibrium

Demand for Central Bank Money = Supply for Central Bank Money

$$H^D = H^S$$



(Central Bank) Money Market

Equilibrium

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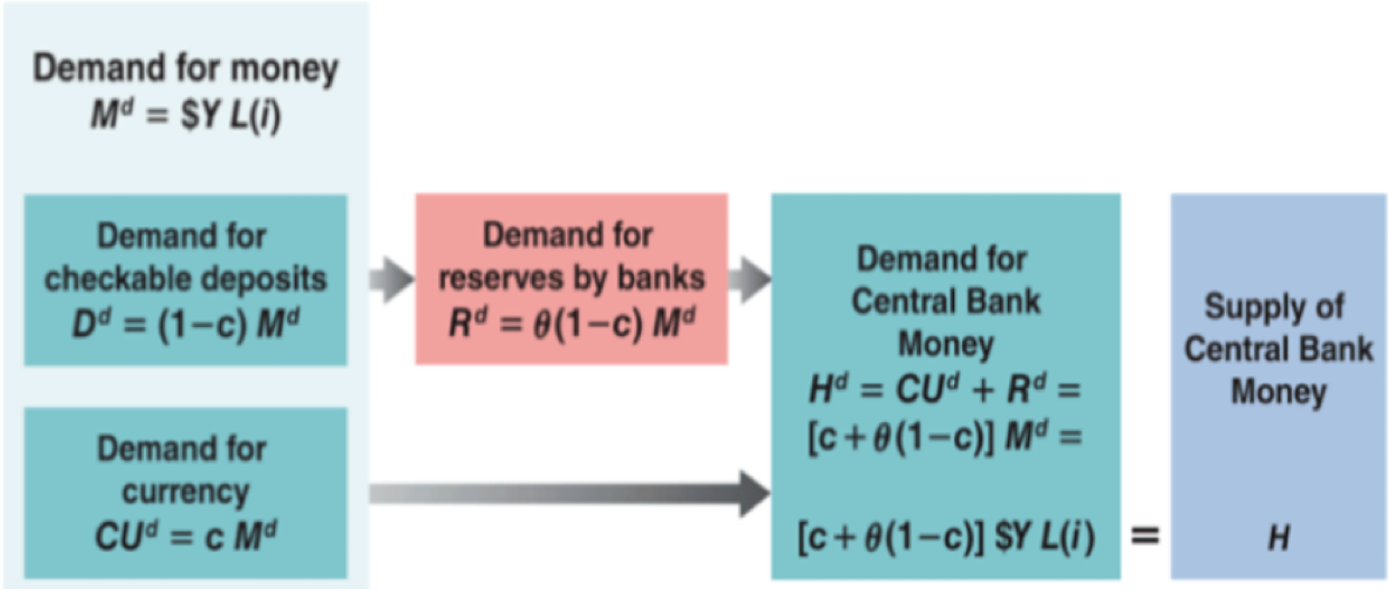


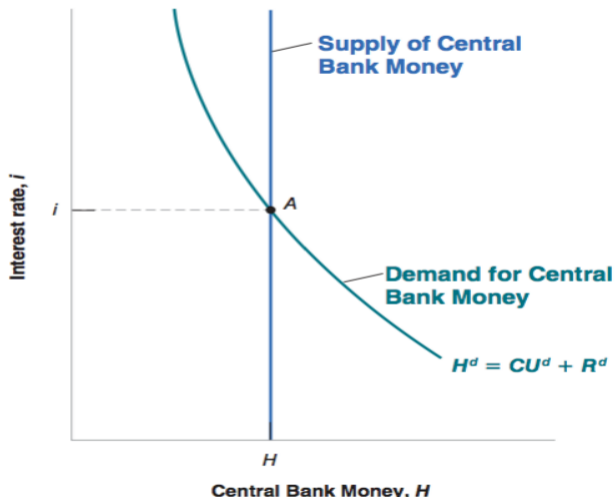
(Central Bank) Money Market

Equilibrium

Demand for Central Bank Money = Supply for Central Bank Money

$$H^D = H^S$$
$$[c + \theta(1-c)]\$YL(i) = H$$

Note that H^D is still a decreasing function in i, we have the following Equilibrium Graph. H^S is independent from the interest rate i.



(Central Bank) Money Market

Connection to the Money Market

Now the Equilibrium for the Central Bank Money Market is as follows.

$$[c + \theta(1 - c)]\$YL(i) = H$$

(Central Bank) Money Market

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(Central Bank) Money Market

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(Central Bank) Money Market

Connection to the Money Market

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$$[c + \theta(1 - c)]\$YL(i) = H$$

Recall the Money Demand is

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We have

$$[c + \theta(1 - c)]M^D = H$$

Or

$$M^D = \frac{1}{[c + \theta(1 - c)]}H$$

(Central Bank) Money Market

Connection to the Money Market

$$\overbrace{M^D}^{\text{Money Demand}} = \overbrace{\frac{1}{[c+\theta(1-c)]}H}^{\text{Money Supply}}$$

In the equilibrium, the money supply is

$$M^S = \underbrace{\frac{1}{[c+\theta(1-c)]}}_{\text{Money Multiplier}} H$$

According to this equation, when the central bank increases central bank money (H) by 1 dollar, the actual money supply goes up by $\frac{1}{[c+\theta(1-c)]}$ dollars.

Note that the **money mulitipler** is larger than 1.

(Central Bank) Money Market

Monetary Multiplier

To understand monetary multiplier, let's make a simplifying assumption:

- **households only want to hold checkable deposits and no cash**.
- That is to say c = 0, and multiplier is $\frac{1}{\theta}$.

(Central Bank) Money Market

Monetary Multiplier

- The FOMC buys **1 dollar** worth of bond in the open market from **Seller 1**.

(Central Bank) Money Market

Monetary Multiplier

- The FOMC buys **1 dollar** worth of bond in the open market from **Seller 1**.
- **Seller 1** doesn't hold cash, so they deposit this 1 dollar at **Bank A**.
- **Bank A** now has 1 dollar checkable deposits, so it is required to hold $\theta * 1$ dollars as reserves in the vault and uses the rest of $(1 - \theta) * 1$ dollars to buy bonds from **Seller 2**

(Central Bank) Money Market

Monetary Multiplier

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- **Bank A** now has 1 dollar checkable deposits, so it is required to hold $\theta * 1$ dollars as reserves in the vault and uses the rest of $(1-\theta) * 1$ dollars to buy bonds from **Seller 2**
- **Seller 2** doesn't hold cash, so they deposit this $(1-\theta)$ dollar at **Bank B**.
- **Bank B** now has $(1-\theta)$ dollar checkable deposits, so it is required to hold $\theta * (1-\theta)$ dollars as reserves in the vault and uses the rest of $(1-\theta) * (1-\theta)$ dollars to buy bonds from **Seller 3**

(Central Bank) Money Market

Monetary Multiplier

(Central Bank) Money Market

Monetary Multiplier

- **Seller 3** doesn't hold cash, so they deposit this $(1-\theta)^2$ dollar at **Bank C**.

- **Bank C** now has $(1-\theta)^2$ dollar checkable deposits, so it is required to hold $\theta * (1-\theta)^2$ dollars as reserves in the vault and uses the rest of $(1-\theta) * (1-\theta)^2$ dollars to buy bonds from **Seller 4**.

(Central Bank) Money Market

Monetary Multiplier

- **Seller 3** doesn't hold cash, so they deposit this $(1-\theta)^2$ dollar at **Bank C**.
- **Bank C** now has $(1-\theta)^2$ dollar checkable deposits, so it is required to hold $\theta * (1-\theta)^2$ dollars as reserves in the vault and uses the rest of $(1-\theta) * (1-\theta)^2$ dollars to buy bonds from **Seller 4**.
- **Seller 4** doesn't hold cash, so they deposit this $(1-\theta)^3$ dollar at **Bank D**.
- ...

(Central Bank) Money Market

Monetary Multiplier

- **Seller 1** holds 1 dollar checkable deposits

(Central Bank) Money Market

Monetary Multiplier

- **Seller 1** holds 1 dollar checkable deposits
- **Seller 2** holds $(1-\theta)$ checkable deposits

(Central Bank) Money Market

Monetary Multiplier

- **Seller 1** holds 1 dollar checkable deposits
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- **Seller 3** holds $(1-\theta)^2$ checkable deposits

(Central Bank) Money Market

Monetary Multiplier

- **Seller 1** holds 1 dollar checkable deposits
- **Seller 2** holds $(1-\theta)$ checkable deposits
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- **Seller 4** holds $(1-\theta)^3$ checkable deposits

(Central Bank) Money Market

Monetary Multiplier

- **Seller 1** holds 1 dollar checkable deposits
- **Seller 2** holds $(1-\theta)$ checkable deposits
- **Seller 3** holds $(1-\theta)^2$ checkable deposits
- **Seller 4** holds $(1-\theta)^3$ checkable deposits
- $\ldots$

The total money supply (which only contains checkable deposits in this world because $c = 0$) is as follows:

$$1 + (1-\theta) + (1-\theta)^2 + (1-\theta)^3 + \ldots = \frac{1}{1-(1-\theta)} = \frac{1}{\theta}$$

(Central Bank) Money Market

Monetary Multiplier

- **Central Bank** bought 1 dollar worth of bonds

(Central Bank) Money Market

Monetary Multiplier

- **Central Bank** bought 1 dollar worth of bonds
- **Bank A** bought $(1-\theta)$ dollar worth of bonds

(Central Bank) Money Market

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- **Central Bank** bought 1 dollar worth of bonds
- **Bank A** bought $(1-\theta)$ dollar worth of bonds
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(Central Bank) Money Market

Monetary Multiplier

- **Central Bank** bought 1 dollar worth of bonds
- **Bank A** bought $(1-\theta)$ dollar worth of bonds
- **Bank B** bought $(1-\theta)^2$ dollar worth of bonds
- **Bank C** bought $(1-\theta)^3$ dollar worth of bonds

(Central Bank) Money Market

Monetary Multiplier

- **Central Bank** bought 1 dollar worth of bonds
- **Bank A** bought $(1-\theta)$ dollar worth of bonds
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- $\dots$

(Central Bank) Money Market

Monetary Multiplier

- **Central Bank** bought 1 dollar worth of bonds
- **Bank A** bought $(1-\theta)$ dollar worth of bonds
- **Bank B** bought $(1-\theta)^2$ dollar worth of bonds
- **Bank C** bought $(1-\theta)^3$ dollar worth of bonds
- $\ldots$

Ultimate increase in the money supply is a result of **successive rounds of purchases of bonds**:

- First, the Fed, in its open market operation.
- and then, the following rounds by commercial banks. (Money Creation)

Federal Funds Market

Federal Funds Market

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Although our former analysis still holds, we still should consider the market that actually exists, which is the **Federal Funds Market**.

Federal Funds Market

Each commercial bank is required to hold a minimum **reserves**, $\theta * D^d$, in their vault.

Federal Funds Market

Each commercial bank is required to hold a minimum **reserves**, $\theta * D^d$, in their vault.

In the morning, all commercial banks get prepare in their vault:

- **Required reserves**
- **Some extra reserves** for households to withdraw.

Federal Funds Market

However, each bank **can't predict** exactly how much extra reserves they need for that day.

Some banks have **extra reserves**, and some banks have **insufficient reserves**.

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All the commercial banks "get together" in a place called **Federal Funds Market**.

Banks with extra reserves **sell the excess reserves** to the market.

Banks with insufficient reserves **buy reserves** from the market.

The equilibrium interest rate is called **Federal Funds Rate (FFR)**

Federal Funds Market

Equilibrium

The **Federal Funds Market Equilibrium** can be derived from the **Central Bank Money Market Equilibrium**. First recall

$$\underbrace{H}_{\text{Central Bank Money Supply}} = \underbrace{CU^d + R^d}_{\text{Central Bank Money Demand}}$$

$$\underbrace{H - CU^d}_{\text{Reserves Supply}} = \underbrace{R^d}_{\text{Reserves Demand}}$$

$$\underbrace{H - c\$YL(i)}_{\text{Reserves Supply}} = \underbrace{\theta(1-c)\$YL(i)}_{\text{Reserves Demand}}$$

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- Recall $L(i)$ is decreasing in i

Federal Funds Market

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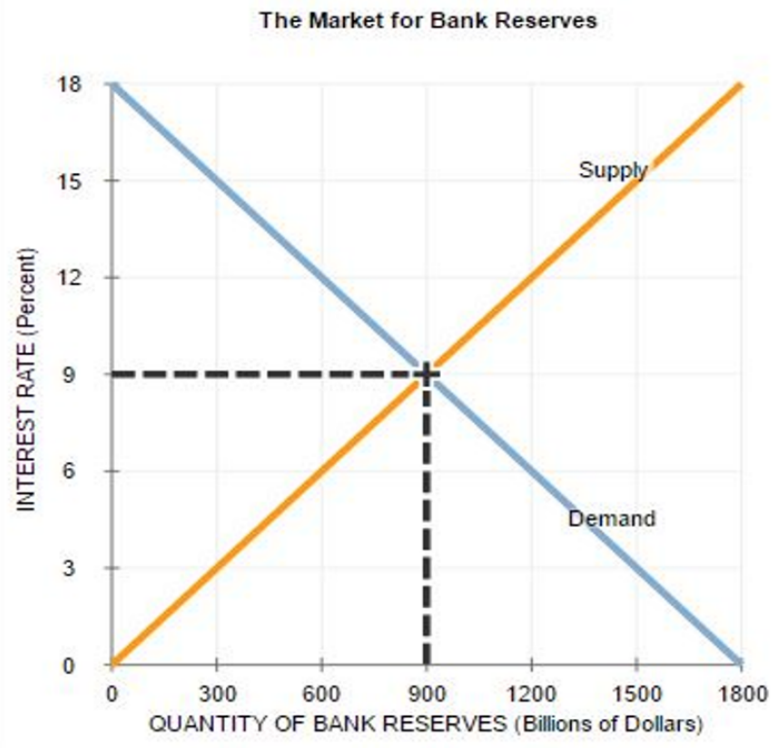
- Recall $L(i)$ is decreasing in i
- Left-hand Side: Reserve Supply is increasing in i
- Right-hand Side: Reserve Demand is decreasing in i

Federal Funds Market

Equilibrium - Example



Federal Funds Market

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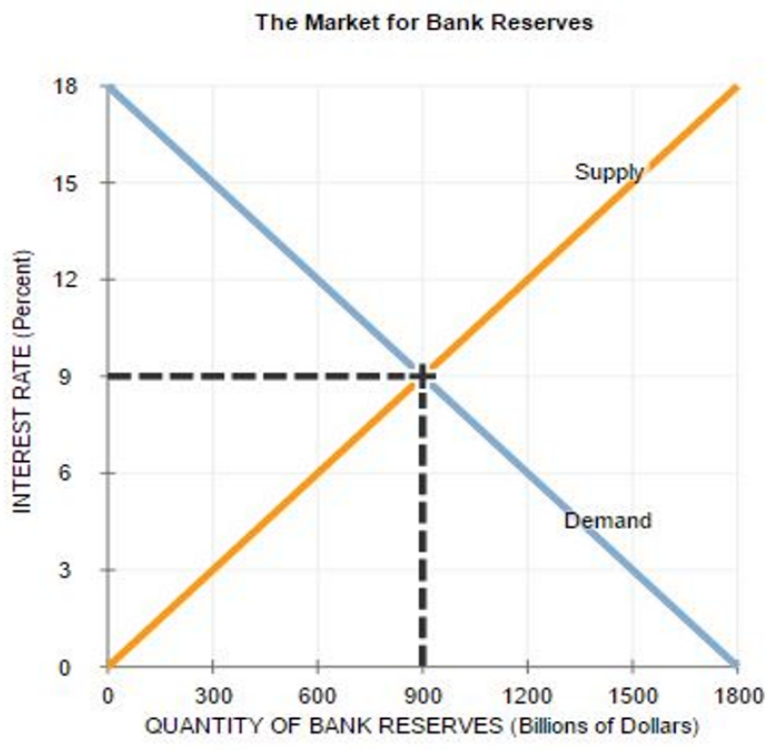


What happens to **Federal Funds Rate (FFR)** if the **FOMC** conducts an **expansionary open market operation**?

Federal Funds Market

Discount Rate

The Fed also supplies reserves in the federal funds market.

Commercial Banks can always buy reserves from the Fed through the "**discount window**"

The **discount rate** refers to the interest rate charged to the commercial banks.

Federal Funds Market

Discount Rate

Question: when the market rate is **higher than the discount rate**, who will be the only supply for reserves in the federal funds market?

Answer: **The Fed**

The Discount Rate is the **upper bound for the FFR** in the federal funds market, and the Fed has control over the upper bound.

Federal Funds Market

Interest Rate on Reserves (IOR)

The Fed pays interests to the reserves commercial banks hold in their vault. This rate is called **Interest Rate on Reserves (IOR)**.

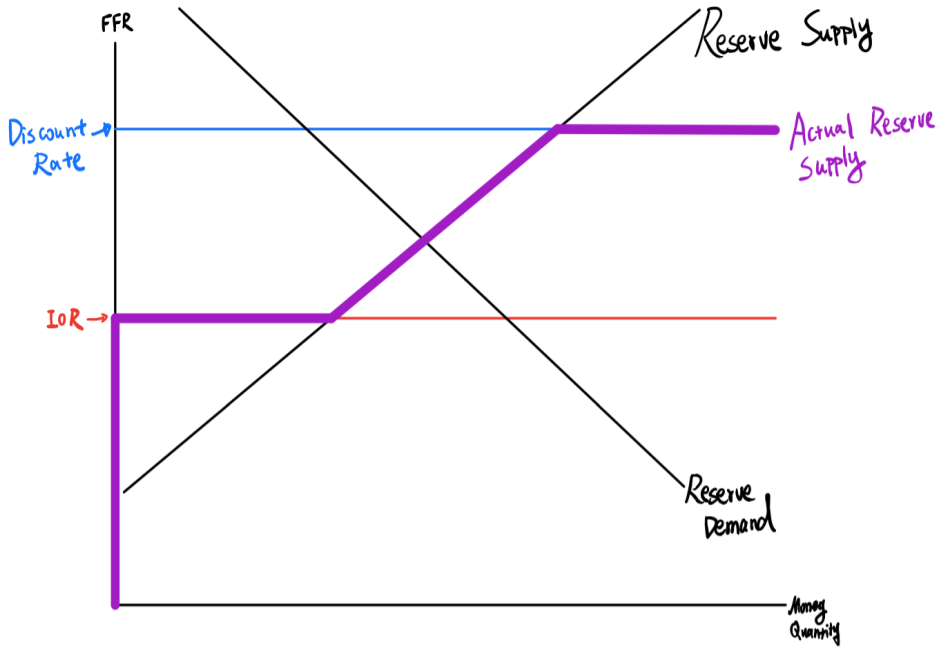
This sounds a little odd, but doing this gives the Fed the power to set **the lower bound for FFR**.

Question: when the market rate is **lower than IOR**, will there be any supplies for reserves?

Answer: No

Federal Funds Market

Upper and Lower Bound



Federal Funds Market

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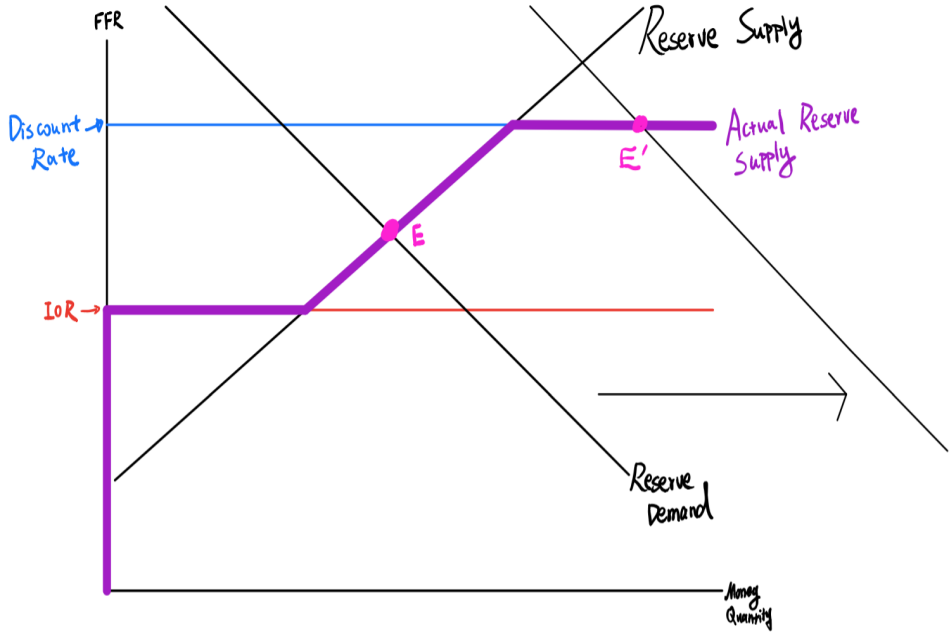

Federal Funds Market

Upper and Lower Bound