LECTURE 3: FINANCIAL MARKETS*

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Investment is a function of the interest rate, so output is also affected by the interest rate. In addition, the determination of interest rate is intimately related to monetary policy. This lecture introduces the simplest model to think about how the interest rate is determined in the short run. Interest rate is determined by equilibrium in the money market, i.e., the condition that money supply equals money demand. For simplicity, we take nominal GDP, which affects money demand, as given, so the financial markets can be considered in isolation from the goods market. We address the *joint* short-run determination of output and interest rate in the next lecture.

1 THE DEMAND FOR MONEY

Assumptions. First, we focus on the determinants of the **demand for money**. For the allocation of a given stock of financial wealth, assume that we only have the choice between two assets, money and bonds:

- **Money**, which can be readily used for transactions, pays no interest.[1] There are two types of money: **currency** supplied by central bank and **checkable deposits** supplied by private banks, the sum of which is called $M1$.
- **Bonds**, which cannot be used for transactions, pay a positive interest rate, i. Note that i is also the interest forgone and hence the opportunity cost (or the implicit price) of holding money.

For obvious reasons one should hold both money and bonds, the proportions of which to the overall wealth depend mainly on two variables: level of transactions and the interest rate on bonds. The higher (lower) level of transactions or the lower (higher) interest rate on bonds, the higher (lower) the proportion of money.

Deriving the demand for money. Denote the demand for money by M^d, which depends on the overall level of transactions in the economy and the interest rate. Assume that the overall level of transactions is proportional to nominal income (or GDP). Then the demand for

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These are notes that I used by myself to lecture from and for educational purposes only. The material presented here is largely based upon the undergraduate textbook by Blanchard and Johnson (2012), *Macroeconomics*, 6th Edition, Prentice Hall. Please do NOT circulate.

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[1] Be careful about the semantic difference among money, income, and wealth. Both money (part of wealth) and wealth are stock variables whereas income is a flow variable.

money can be written as

$$M^d = \$YL\,(i) \quad (-) \tag{1.1}$$

where $\$Y$ denotes nominal income and L is a function of the interest rate i. See Figure 1 below. Here are two remarks on the relation (1.1):

- At a given interest rate, the demand for money increases in proportion to nominal income.
- At a given nominal income, the demand for money depends negatively on the interest rate; an increase in the interest rate decreases the demand for money as people put more of their wealth into bonds.

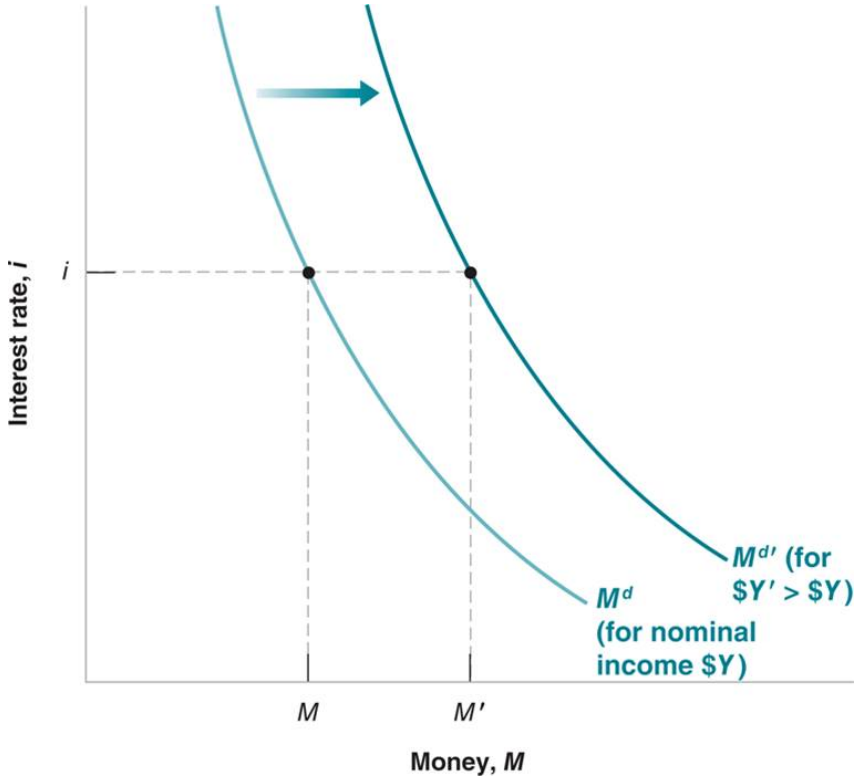

Figure 1. The demand for money

2 DETERMINING THE INTEREST RATE: I

Equilibrium interest rate. We assume that checkable deposits do not exist for simplicity. Suppose the central bank decides to supply an amount of money equal to M, which is independent of the interest rate, i.e.

$$M^s = M \tag{2.1}$$

Then equilibrium in financial markets requires that money supply be equal to money demand, i.e.

$$M = M^s = M^d = \$YL(i) \tag{2.2}$$

This equilibrium relation is called the **LM relation**.[2] See Figure 2 below.

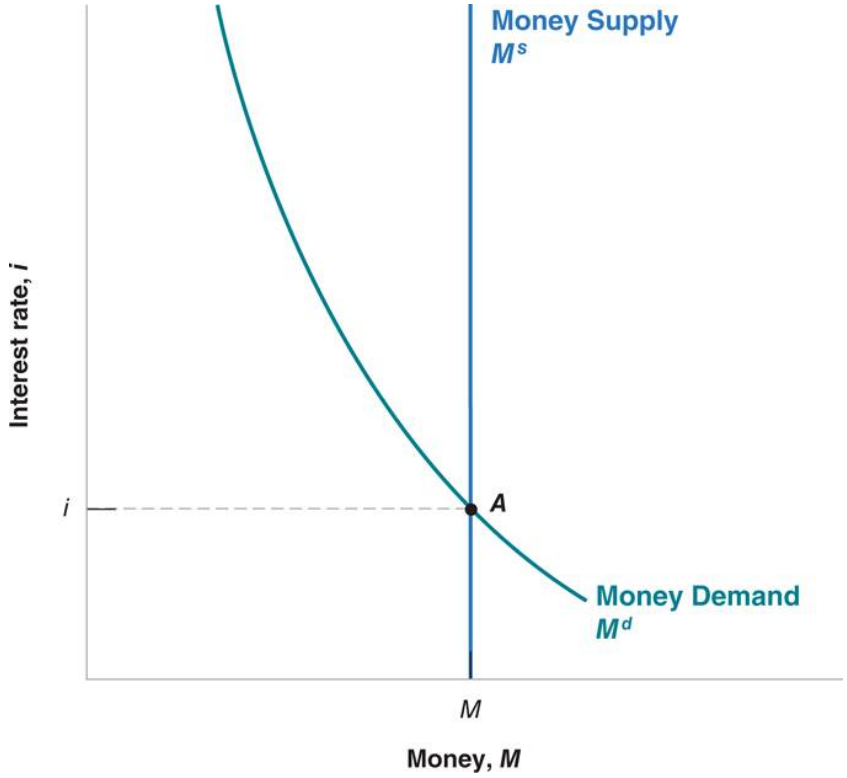

Figure 2. The determination of interest rate

We can also look at how changes in nominal income or changes in the money supply by the central bank affect the equilibrium interest rate:

- An increase in nominal income leads to an increase in the interest rate. This is because the demand for money exceeds the supply at the initial interest rate, an increase of which is needed to reestablish equilibrium. See Figure 3 below.
- An increase in the supply of money by the central bank leads to a decrease in the interest rate, which is needed to increase the demand for money so it equals the larger money supply. See Figure 4 below.

[2]Here L stands for **liquidity**, a measure of how easily an asset can be exchanged for money, and M stands for money, which is fully liquid.

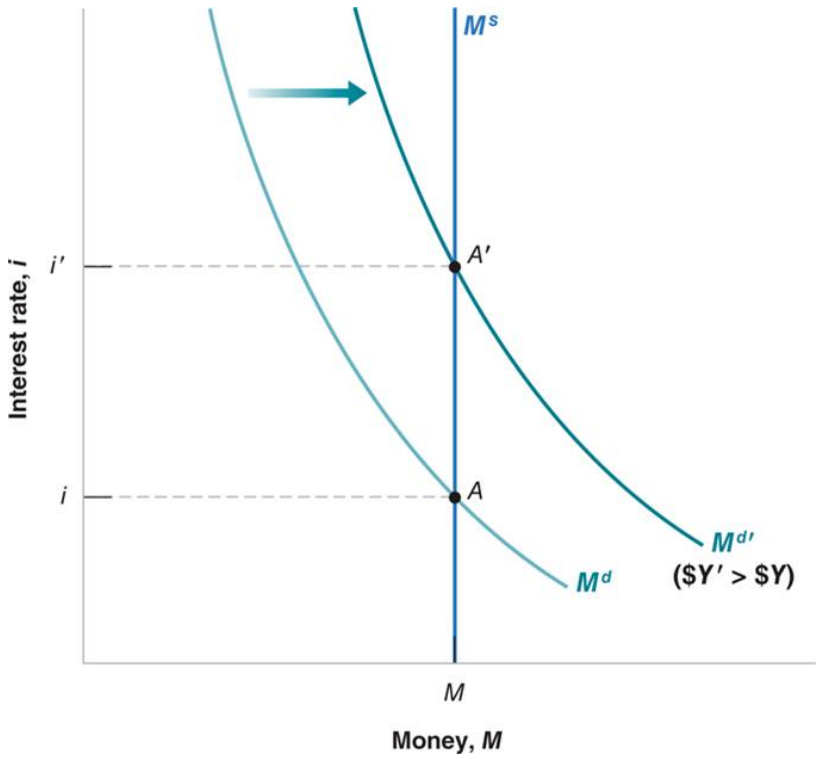

Figure 3. The effects of an increase in nominal income on the interest rate

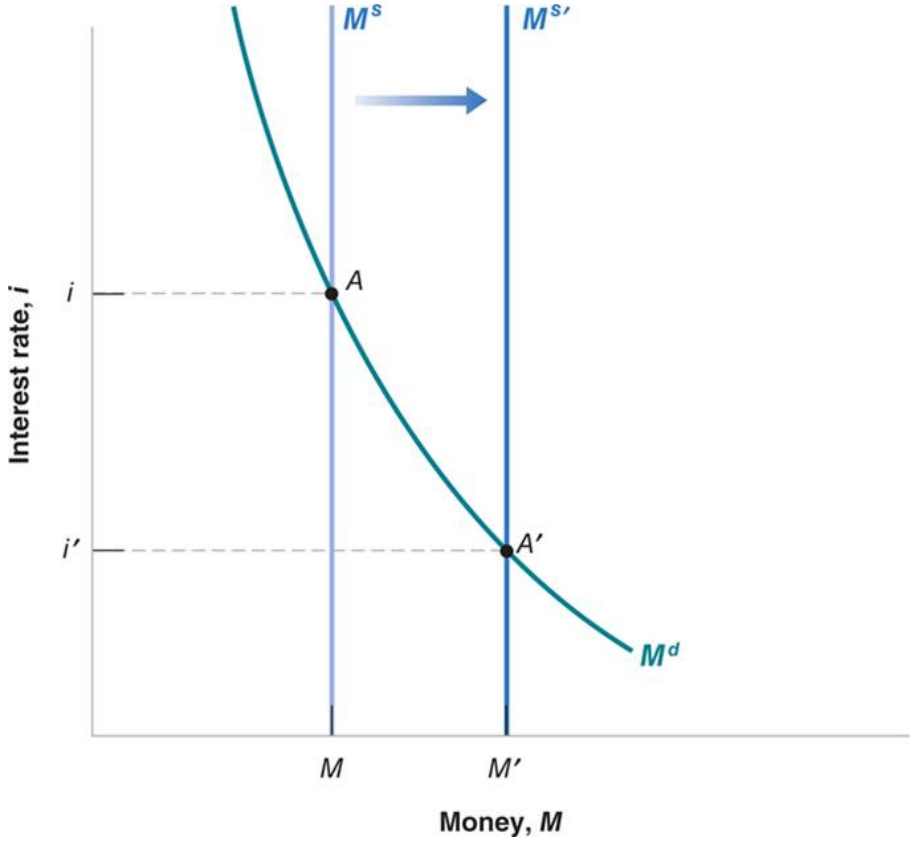

Figure 4. The effects of an increase in money supply on the interest rate

Bond prices and bond yields. What is determined in bond markets is bond prices, from which interest rates can be inferred. For simplicity, assume that all bonds are one-year and promise a payment of \$100 a year from now.[3] Let the bond price today be $\$P_B$.

- If we buy the bond today and hold it for a year, the rate of return on holding the bond for a year, or the interest rate on the bond, is given by

$$i = \frac{\$100 - \$P_B}{\$P_B} \times 100\% \tag{2.3}$$

  Thus, the higher the bond price, the lower the interest rate.

- Rearranging (2.3) gives the price of a one-year bond paying \$100 a year from today

$$\$P_B = \frac{\$100}{1+i} \tag{2.4}$$

  Thus, the higher the interest rate, the lower the bond price.

Monetary policy and open market operations. In modern economies, central banks can change the money supply by buying or selling bonds in the "open market" for bonds. These actions are called **open market operations**.

- **Expansionary open market operation**: central bank expands the money supply by buying bonds. This leads to an increase in the price of bonds and a decrease in the interest rate.

- **Contractionary open market operation**: central bank contracts the money supply by selling bonds. This leads to a decrease in the price of bonds and an increase in the interest rate.

Alternatively, we could have described the central bank as choosing the (short-term) interest rate and adjusting the money supply so as to achieve the chosen interest rate. This is indeed what modern central banks typically do.

3 DETERMINING THE INTEREST RATE: II

What banks do. We relax the assumption on interest rate determination by introducing both currency and checkable deposits as money. The latter are supplied by (private) banks, which are one type of **financial intermediaries**.[4] See Figure 5 below for the balance sheet of banks and central bank.

[3] In the U.S., bonds issued by the government are of four types: **Treasury bills** (short-term securities), **Treasury notes** (medium-term securities), and **U.S. savings bonds** (long-term, nonmarketable bonds).

[4] Financial intermediaries are institutions that receive funds from people and firms and use these funds to buy financial assets or to make loans to other people and firms.

- **Checkable deposits** are the funds banks receive from people and firms (e.g. via direct deposit). They are the liabilities of banks.
- **Reserves** are part of the funds banks receive and held partly in **vault cash** and partly in an account at the central bank. They are the assets of banks. Banks are subject to reserve requirements, which require them to hold reserves in some proportion of checkable deposits.[5] Banks can use the nonreserve assets to make loans or buy bonds.

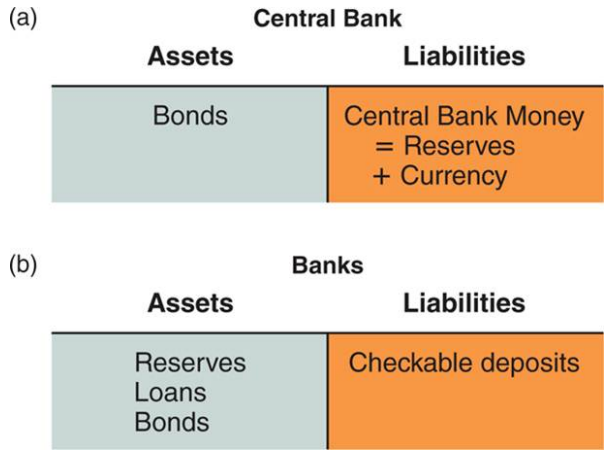

Figure 5. The balance sheets of banks and central bank

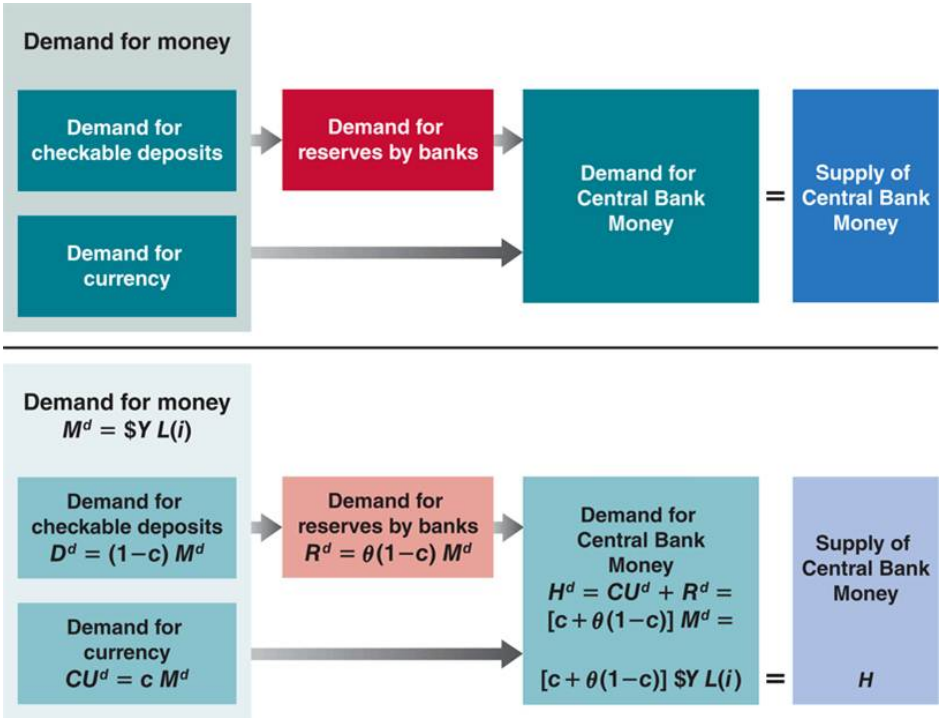

Figure 6. Determinants of the demand and supply of central bank money

[5] In the U.S., the **reserve ratio** is about 10% set by the Fed.

The supply and demand for central bank money. The liabilities of the central bank are the money it has created, **central bank money**. Its demand stems from the demand for currency by people and the demand for reserves by banks, while its supply is under the central bank's direct control. The equilibrium interest rate is such that the demand and supply for central bank money are equal. See Figure 6 above, which we formalize in a mathematical framework:

- **The demand for money.** Assume that the overall money demand (currency plus checkable deposits) is given by (1.1). Since currency is more convenient for small transactions whereas checks are more convenient for large transactions, we assume that people hold a fixed proportion, $c \in [0,1]$, of their money in currency, and the remaining proportion $(1-c) \in [0,1]$ in checkable deposits. Then we have

$$\text{demand for currency:} \quad CU^d = cM^d \tag{3.1}$$

$$\text{demand for checkable deposits:} \quad D^d = (1-c)M^d \tag{3.2}$$

- **The demand for reserves.** For precautionary and regulatory reasons, the larger the amount of checkable deposits, the larger the amount of reserves banks must hold. Let θ be the reserve ratio. Then we have

$$\text{demand for reserves:} \quad R^d = \theta D^d = \theta(1-c)M^d \tag{3.3}$$

- **The demand for central bank money.** The demand for central bank money is equal to the demand for currency plus the demand for reserves, i.e.

$$\begin{aligned} \text{demand for central bank money:} \quad H^d &= CU^d + R^d \\ &= [c + \theta(1-c)]M^d \\ &= [c + \theta(1-c)]\$YL(i) \end{aligned} \tag{3.4}$$

- **The determination of the interest rate.** Let H be the supply of central bank money, which can be controlled by the central bank through open market operations. The equilibrium in money market requires that the supply be equal to the demand for central bank money, i.e.

$$H = H^s = H^d = \underbrace{[c + \theta(1-c)]}_{\text{less than 1 if } c \in (0,1)} \ \$YL(i) \tag{3.5}$$

  If people held only currency, i.e. $c = 1$, the above equation reduces to (2.2) with M replaced by H. If people held only checkable deposits, i.e. $c = 0$, the above equation becomes $H = \theta\$YL(i)$ and the economy reaches a cashless limit. See Figure 7 below.

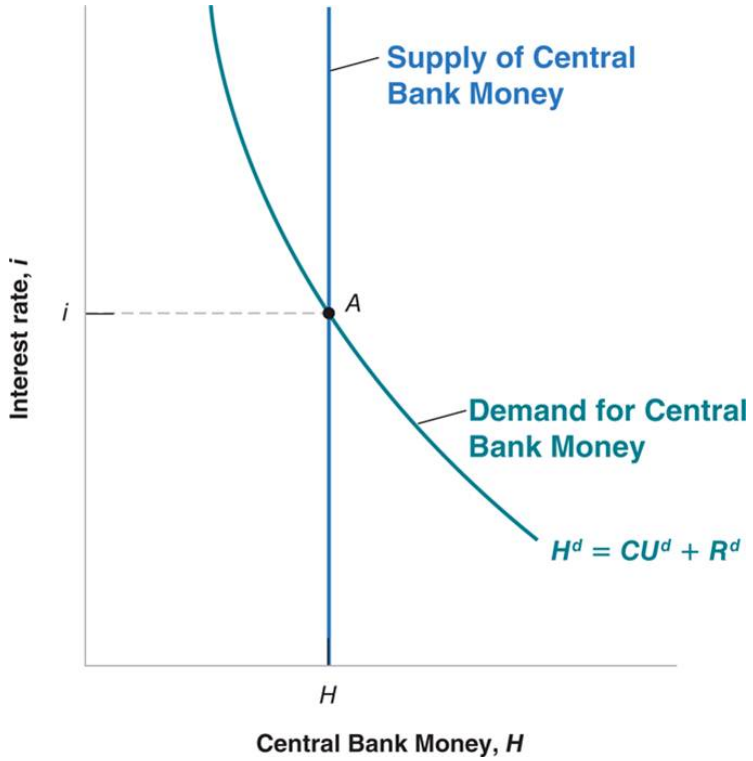

Figure 7. Equilibrium in the market for central bank money

4 TWO ALTERNATIVE WAYS OF LOOKING AT THE EQUILIBRIUM

Federal funds market and federal funds rate. An equivalent equilibrium condition requires that the supply of reserves, which equals the supply of central bank money H minus the demand for currency CU^d, be equal to its demand R^d, i.e.

$$H - CU^d = R^d \tag{4.1}$$

There is indeed an actual market for bank reserves in the U.S., where the interest rate adjusts to balance the supply and demand for reserves. This market is called the **federal funds market** and the interest rate determined therein is called the **(effective) federal funds rate**, which can be effectively chosen by the Fed through adjusting the supply of central bank money, and thus serves as the main instrument of U.S. monetary policy. You can download the effective federal funds rate (annualized and in percentage) from the Board of Governors of the Federal Reserve System, http://www.federalreserve.gov.

The supply and demand for money and the money multiplier. Another equivalent equilibrium condition requires that the overall supply and the overall demand for money (currency and

checkable deposits) be equal, i.e.

$$\underbrace{\frac{1}{[c+\theta(1-c)]}H}_{\text{supply of money}} = \underbrace{\$YL(i)}_{demand\,for\,money} \tag{4.2}$$

which can be obtained by dividing both sides of (3.5) by $c+\theta(1-c)$. Two remarks:

- Since $[c+\theta(1-c)] \in (0,1)$, the overall supply of money is equal to central bank money times the **money multiplier**, $1/[c+\theta(1-c)]$, which is greater than 1. In a special case where people hold no currency, i.e. $c=0$, this multiplier is $1/\theta$. For example, with $\theta = .1$, if the Fed buys \$100 worth of bonds in an open market operation, the overall money supply will increase by $\$1,000$.
- Central bank money is sometimes called the **high-powered money**, or the **monetary base**. The term high-powered emphasizes the fact that increases in H lead to more than one-for-one increases in the overall money supply. (4.2) also implies that changes in H have a larger effect on the money supply and hence the interest rate in an economy with banks than that without banks.