The model of economic activity we developed in Chapter 3 did not include an interest rate, so there was no role for the central bank and its chair. This was a strong simplification, and it is time to relax it. In this chapter, we shall introduce the simplest model needed to think about the determination of the interest rate and the role of the central bank, a model in which people face a simple portfolio choice, whether to hold money or to hold bonds.

In that model, we can think of the interest rate as determined by the demand of money and the supply for money. Then, in the next chapter, we shall look at how the interest rate in turn affects demand and output. This simple model does not, however, do justice to the complexity of the financial system.

## The Demand for Money

### Money and wealth

Suppose, as a result of having steadily saved part of your income in the past, your financial wealth today is $50,000. You may intend to keep saving in the future and increase your wealth further, but its value today is given. Suppose also that you only have the choice between two assets, money and bonds:

لنفترض أنه نتيجة لتوفير جزء من دخلك في الماضي ، فإن ثروتك المالية اليوم تبلغ 50000 دولار. قد تنوي الاستمرار في الادخار في المستقبل وزيادة ثروتك بشكل أكبر. افترض أيضًا أن لديك فقط خيارين ، اما الاحتفاظ في المال او شراء سندات:

- **Money**, which you can use for transactions, pays no interest. In the real world.

  *There are two types of money: currency, coins and bills, and checkable deposits, the bank deposits on which you can write checks. The sum of currency and checkable deposits is called M1.*

- **Bonds** pay a positive interest rate $(i)$ but they cannot be used for transactions.

  There are many types of bonds and other financial assets, each associated with a specific interest rate. For the time being, we will also ignore this aspect of reality and assume that there is just one type of bond and that it pays, (i) the rate of interest.
  هناك أنواع عديدة من السندات والأصول المالية الأخرى ، يرتبط كل منها بمعدل فائدة محدد. في الوقت الحالي ، سنتجاهل أيضًا هذا الجانب من الواقع ونفترض أن هناك نوعًا واحدًا فقط من السندات وأنه يدفع معدل فائدة قيمة i.

Assume that buying or selling bonds implies some cost; ***for example***, a phone calls to your broker and the payment of a transaction fee. How much of your $50,000 should you hold in money, and how much in bonds? On the one hand, holding all your wealth in the form of money is clearly very convenient. You won't ever need to call a broker or pay transaction fees. But it also means you will receive no interest income. On the other hand, if you hold all your wealth in the form of bonds, you will earn interest on the full amount, but you will have to call your broker frequently—whenever you need money to take the subway, pay for a cup of coffee, and so on. This is a rather inconvenient way of going through life.

افترض أن شراء أو بيع السندات ينطوي عليه بعض التكلفة ؛ على سبيل المثال ، مكالمات هاتفية إلى وسيطك المالي ودفع رسوم المعاملة. ما هو المبلغ الذي يجب أن تحتفظ به من نقودك البالغة 50000 دولار ، وكم ستستثمر في شراء السندات؟ من ناحية أخرى ، من الواضح أن الاحتفاظ بكل ثروتك على شكل نقود أمر مريح للغاية. لن تحتاج أبدًا إلى الاتصال بالوسيط أو دفع رسوم المعاملات. ولكن هذا يعني أيضًا أنك لن تحصل على فوائد على نقودك. من ناحية أخرى ، إذا قررت ان تستثمر بكل ثروتك في شراء السندات، فستكسب فائدة على المبلغ بالكامل ، ولكن سيتعين عليك الاتصال بالوسيط الخاص بك بشكل متكرر - كلما احتجت إلى المال لركوب مترو الأنفاق ، ادفع مقابل كوب من القهوة ، وما إلى ذلك. هذه طريقة غير مريحة إلى حد ما لخوض الحياة.

Therefore, it is clear that you should hold both money and bonds. But in what proportions? This will depend mainly on two variables:

- Your level of transactions. You will want to have enough money on hand to avoid having to sell bonds whenever you need money.
  مستوى المعاملات الخاصة بك . سترغب في امتلاك ما يكفي من المال لتجنب الاضطرار إلى بيع السندات متى احتجت إلى المال.

- The interest rate on bonds. The only reason to hold any of your wealth in bonds is that they pay interest. If bonds paid zero interest, you would want to hold all of your wealth in the form of money because it is more convenient. The higher the interest rate, the more you will be willing to deal with the hassle and costs associated with buying and selling bonds.

  معدل الفائدة على السندات. السبب الوحيد للاحتفاظ بأي جزء من الثروة في السندات هو السندات تحقق قوائد. إذا لم تحقق فائدة على السندات ، فقد ترغب في الاحتفاظ بكل ثروتك في شكل نقود لأنها أكثر ملاءمة. كلما ارتفع سعر الفائدة ، زادت استعدادك للتعامل مع المتاعب والتكاليف المرتبطة بشراء وبيع السندات.

## Deriving the Demand for Money

Denote the amount of money people want to hold–their demand for money–by $M^d$. The demand for money in the economy as a whole is just the sum of all the individual demands for money by the people in the economy. Therefore, *it depends on the overall level of transactions in the economy and on the interest rate.*

يشير مفهوم الطلب على النقود إلى مقدار المال الذي يريد الناس الاحتفاظ به. إن الطلب على النقود في الاقتصاد ككل هو مجموع الطلب الفردي للمال من قبل الناس في الاقتصاد. يعتمد الطلب على النقود في الاقتصاد على المستوى العام للمعاملات في الاقتصاد وعلى معدل الفائدة.

The overall level of transactions in the economy is hard to measure, but it is likely to be roughly proportional to nominal income (income measured in dollars). If nominal income were to increase by 10%, it is reasonable to think that the dollar value of transactions in the economy would also increase by roughly 10%. So we can write the relation between the demand for money, nominal income, and the interest rate as:

من الصعب قياس المستوى الإجمالي للمعاملات في الاقتصاد ، ولكن من المرجح أن يتناسب طردياً مع الدخل الاسمي (الدخل المقاس بالدولار). إذا زاد الدخل الاسمي بنسبة 10٪ ، فمن المعقول الاعتقاد بأن قيمة المعاملات بالدولار في الاقتصاد ستزيد أيضًا بنسبة 10٪ تقريبًا. لذلك يمكننا كتابة العلاقة بين الطلب على النقود والدخل الاسمي وسعر الفائدة على النحو التالي:

$$M^d = \underset{(+)}{\$Y} \; \underset{(-)}{L(i)}$$

Where $\$Y$ denotes nominal income. Read this equation in the following way: The demand for money $M^d$ is equal to nominal income $\$Y$ times a function of the interest rate $(i)$, with the function denoted by $L(i)$.

- The minus sign under $i$ in $L(i)$ captures the fact that the interest rate has a negative effect on money demand: An increase in the interest rate decreases the demand for money, as people put more of their wealth into bonds.
  توضح علامة الطرح تحت i في L (i) حقيقة أن معدل الفائدة له تأثير سلبي على الطلب على النقود: تؤدي الزيادة في سعر الفائدة إلى تقليل الطلب على النقود ، حيث يضع الناس المزيد من ثرواتهم في السندات.

  The demand for money depends negatively on the interest rate: An increase in the interest rate decreases the demand for money.

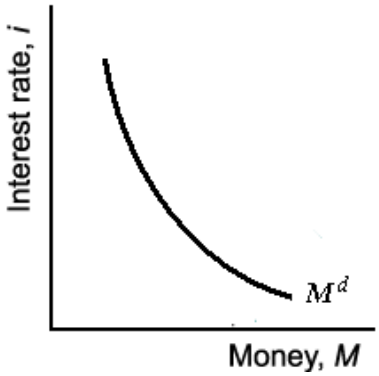
  $i \uparrow \Rightarrow M^d \downarrow$

- The demand for money increases in proportion to nominal income. If nominal income doubles, increasing from $\$Y$ to $\$2Y$, then the demand for money also doubles, increasing from $\$Y\ L(i)$ to $\$2YL(i)$.

  $\$Y \uparrow \Rightarrow M^d \uparrow$

  يزداد الطلب على النقود مع زيادة الدخل بشكل متناسب. إذا تضاعف الدخل الاسمي فإن الطلب على النقود يتضاعف أيضًا .

The relation between the demand for money, and the interest rate implied by equation $Md = \$Y\, L(i)$ is shown in Figure. The interest rate $(i)$ is measured on the vertical axis. Money $(M)$ is measured on the horizontal axis.




The relation between the demand for money and the interest rate for a given level of nominal income \$Y is represented by the $M^d$ curve. The curve is downward sloping: The lower the interest rate (the lower i), the higher the amounts of money people want to hold (the higher M).

**Example**

Suppose that a person's yearly income is \$60,000. Also suppose that this person's money demand function is given by: $M^d = \$Y\ (0.35 - i)$

1. What is this person's demand for money when the interest rate is 5%? 10%?

   $M^d = \$Y\ (0.35 - i) = 60{,}000 * (0.35 - 0.05) = \$18{,}000$

   $M^d = \$Y\ (0.35 - i) = 60{,}000 * (0.35 - 0.10) = \$15{,}000$

2. Explain how the interest rate affects money demand

   An increase in the interest rate from 5% to 10% decreases the demand for money from \$18,000 to \$15,000

3. Suppose that the interest rate is 10%. In percentage terms, what happens to this person's demand for money if her yearly income is reduced by 50%?

   $M^d = \$Y\ (0.35 - i) = 30{,}000 * (0.35 - 0.10) = \$7{,}500$

   Percentage change in money demand = $\frac{7{,}500 - 15{,}000}{15{,}000} * 100\% = \frac{-7{,}500}{15{,}000} * 100\% = -50\%$ (reduced by 50%)

**Example**

Suppose that a person's wealth is \$50,000 and that her yearly income is \$60,000. Also suppose that her money demand function is given by $M^d = \$Y\ (0.35 - i)$

A. Derive the demand for bonds.

   Demand for bonds $(B^d)$ = wealth – demand for money

   $B^d = W - M^d$ = $50{,}000 - [60{,}000\ (0.35 - i)]$

   $B^d = 50{,}000 - (21{,}000 - 60{,}000\ i)$

   $B^d = 29{,}000 + 60{,}000\ i$

B. Suppose the interest rate increases by 10 percentage points. What is the effect on the demand for bonds?

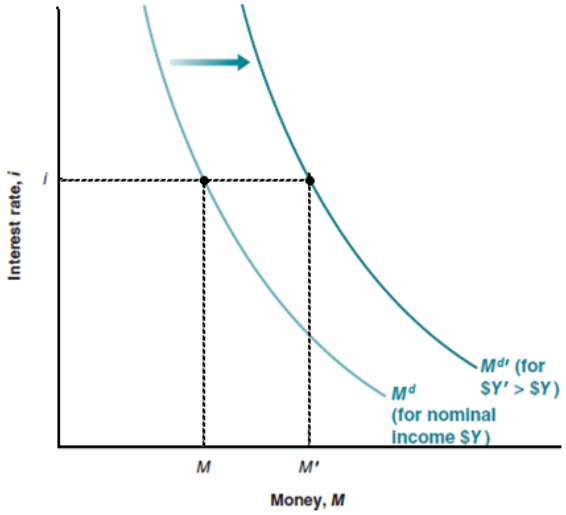
   $B^d = 29{,}000 + 60{,}000\ i$ : as interest rate increase , demand for bond increase

   $\Delta B^d = 60{,}000 \Delta i \ \rightarrow\ \Delta B^d = 60{,}000 * (10\%) = 6{,}000$

   Demand for bond increase by 6,000

## The effect of an increase in nominal income on the demand for money

For a given interest rate, an increase in nominal income increases the demand for money. In other words, an increase in nominal income shifts the demand for money to the right, from $M^d$ to $M^{d\prime}$. For example, at interest rate *i*, an increase in nominal income from $\$Y$ to $\$Y'$ increases the demand for money from $M$ to $M'$.




## Determining the Interest Rate

Having looked at the demand for money, we now look at the supply of money and then at the equilibrium.

*In the real world, there are two types of money: checkable deposits, which are supplied by banks, and currency, which is supplied by the central bank.* In this section, we will assume that checkable deposits do not exist–that the only money in the economy is currency. In the next section, we will reintroduce checkable deposits, and look at the role banks play.

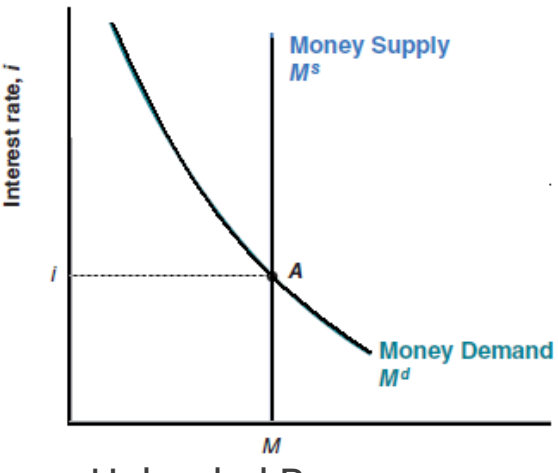
### Money Demand, Money Supply, and the Equilibrium Interest Rate

Suppose the central bank decides to supply an amount of money equal to $M$, so $M^S = M$

Equilibrium in financial markets requires that money supply be equal to money demand, that $M^S = M^d$, Then, using $M^S = M$ and $M^d = \$Y\ L(i)$

The equilibrium condition is Money supply = Money demand: $M = \$Y\ L(i)$

This equilibrium condition is represented graphically in Figure below. As in the Figure, money is measured on the horizontal axis, and the interest rate is measured on the vertical axis. The demand for money, $M^d$, drawn for a given level of nominal income, $\$Y$, is downward sloping: A higher interest rate implies a lower demand for money. The supply of money is drawn as the vertical line denoted $M^S$: The money supply equals $M$ and is independent of the interest rate. Equilibrium occurs at point *A*, and the equilibrium interest rate is given by $i$.



**Example**

Suppose that money demand is given by: $M^d = \$Y\ (0.25 - i)$
Where \$Y is \$100. Also, suppose that the supply of money is \$20.

A. What is the equilibrium interest rate?

At equilibrium: $M^S = \$Y\ L(i) \rightarrow 20 = 100\ (0.25 - i)$

$20 = 25 - 100\ i \rightarrow 100\ i = 5$

$i = \frac{5}{100} = 5\%$

B. If the central Bank wants to increase $i$ by 10 percentage points, at what level should it set the supply of money?

$i$ by 10 percentage points $\rightarrow$ new interest rate = 5% + 10% = 15%

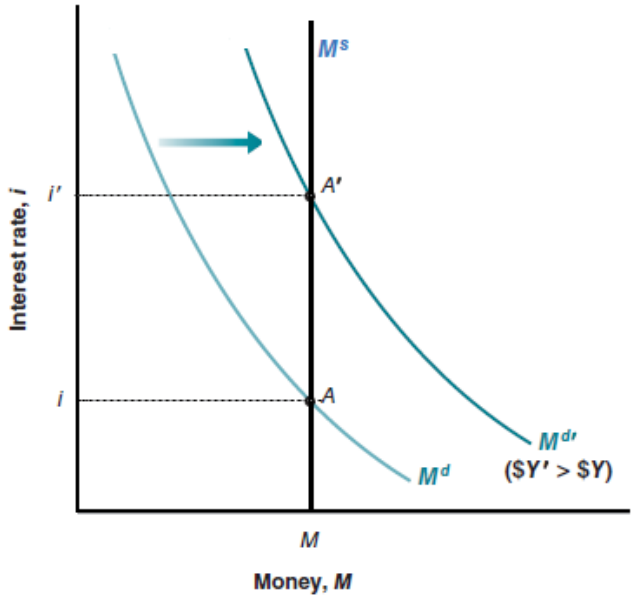
$M^S = \$Y\ (0.25 - i) \rightarrow M^S = 100\ (0.25 - 0.15) \rightarrow M^S = 10$

Money supply decrease from \$20 to \$10

**The effects of an increase in nominal income on the interest rate**

The initial equilibrium is at point $A$. An increase in nominal income from $\$Y$ to $\$Y'$increase the level of transaction which increase the demand for money at any interest rate. The money demand curve shifts to the right, from $M^d$ to $M^{d\prime}$. The equilibrium moves from $A$ up to $A'$ the equilibrium interest rate increases from $i$ to $i'$

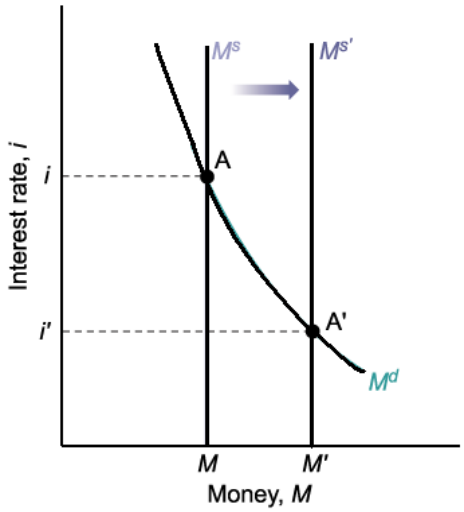
In words: An increase in nominal income leads to an increase in the interest rate. The reason: At the initial interest rate, the demand for money exceeds the supply. An increase in the interest rate is needed to decrease the amount of money people want to hold and to reestablish equilibrium.



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

The initial equilibrium is at point $A$, with interest rate $i$. An increase in the money supply, from $M^S$ to $M^{S'}$, leads to a shift of the money supply curve to the right, from $M^S$ to $M^{S'}$. The equilibrium moves from $A$ down to $A'$; the interest rate decreases from $i$ to $i'$.

In words: an increase in the supply of money by the central bank leads to a decrease in the interest rate. The decrease in the interest rate increases the demand for money so it equals the now larger money supply.




## Monetary Policy and Open Market Operations

*Open market operations*, the way central banks change the supply of money is by buying or selling bonds in the bond market.

*If a central bank wants to increase the amount of money in the economy, it buys bonds and pays for them by creating money. If it wants to decrease the amount of money in the economy, it sells bonds and removes from circulation the money it receives in exchange for the bonds. These actions are called open market operations because they take place in the "open market" for bonds.*

- If the central bank buys, say, $1 million worth of bonds, the amount of bonds it holds is higher by $1 million, and so is the amount of money in the economy. Such an operation is called an *expansionary open market operation*, because the central bank increases (*expands*) the supply of money.

  *If the central bank buy bonds in open market operation → money supply increase*

- If the central bank sells $1 million worth of bonds, both the amount of bonds held by the central bank and the amount of money in the economy are lower by $1 million. Such an operation is called a *contractionary open market operation*, because the central bank decreases (*contracts*) the supply of money.

  *If the central bank sells bonds in open market operation ⇨ money supply decreases*

## The Supply and the Demand for Central Bank Money

- ✓ The demand for central bank money is equal to the demand for currency by people plus the demand for reserves by banks.
- ✓ The supply of central bank money is under the direct control of the central bank.
- ✓ The equilibrium interest rate is such that the demand and the supply for central bank money are equal.

The demand for money by people is for both checkable deposits and currency. Because banks have to hold reserves against checkable deposits, the demand for checkable deposits leads to a demand for reserves by banks. Consequently, the demand for central bank money is equal to the demand for reserves by banks plus the demand for currency. The supply of central bank money is determined by the central bank. The interest rate must be such that the demand and the supply of central bank money are equal.

## The Demand for Money

When people can hold both currency and checkable deposits, the demand for money involves two decisions. First, people must decide how much money to hold. Second, they must decide how much of this money to hold in currency and how much to hold in checkable deposits.

It is reasonable to assume that the overall demand for money (currency plus checkable deposits) is given by the same factors as before. People will hold more money the higher the level of transactions and the lower the interest rate on bonds.

So we can assume that overall money demand is given by: $M^d = \underset{(+)}{\$Y}\ \underset{(-)}{L(i)}$

*How do people decide how much to hold in currency, and how much in checkable deposits?*

Currency is more convenient for small transactions (it is also more convenient for illegal transactions.) Checks are more convenient for large transactions. Holding money in your checking account is safer than holding cash.

Assume that people hold a fixed proportion of their money in currency (call this proportion $c$) and, by implication, a fixed proportion $(1 - c)$ in checkable deposits. Call the demand for currency $CU^d$ Call the demand for checkable deposits $D^d$. The two demands are given by:

$$CU^d = c\, M^d$$

$$D^d = (1 - c)M^d$$

## The Demand for Reserves

The larger the amount of checkable deposits, the larger the amount of reserves the banks must hold. Let $\theta$ (theta) the reserve ratio, the amount of reserves banks hold per dollar of checkable deposits. Let $R$ denote the reserves of banks. Let $D$ denote the dollar amount of checkable deposits. Then, by the definition of $\theta$, the following relation holds between $R$and $D$.

$$R = \theta\, D$$

If people want to hold $D^d$ in deposits, then from equation above, banks must hold $\theta\, D^d$ in reserves. The demand for reserves by banks is given by:

$$R^d = \theta\,(1 - c)\,M^d$$

## The Demand for Central Bank Money

Call $H^d$ the demand for central bank money. This demand is equal to the sum of the demand for currency and the demand for reserves.

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

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

Replace the overall demand for money, $M^d$, by its expression from equation to get:

$$H^d = [c + \theta\,(1 - c)]\,\$Y\,L\,(i)$$

*Suppose banks doubled the number of locations of ATMs, making them more convenient to use for their customers. What would happen to the demand for central bank money?*

## The Determination of the Interest Rate

Let $H$ be the supply of central bank money; $H$ is directly controlled by the central bank (the central bank can change the amount of H through open market operations).

The equilibrium condition is that the supply of central bank money be equal to the demand for central bank money:

$$H = H^d$$

Or, using equations:

$$H = [c + \theta\,(1 - c)]\,\$Y\,L\,(i)$$

*The supply of central bank money (the left side of equation) is equal to the demand for central bank money (the right side of equation), which is equal to the term in brackets times the overall demand for money.*

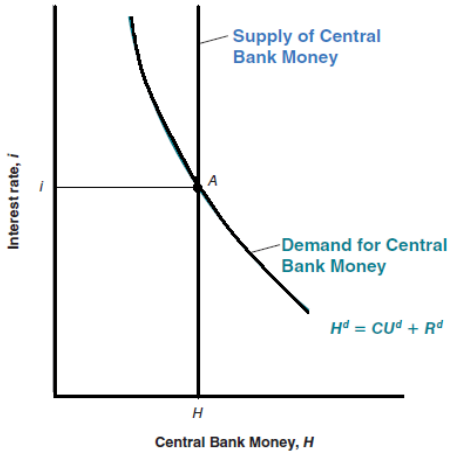
Look at the term in brackets. *Assume that people held only currency, so* $c = 1$. Then, the term in brackets would be equal to 1, and the equation would be $H = \$Y\,L(i)$. In this case, people would hold only currency, and banks would play no role in the supply of money.

*Assume that people hold only checkable deposits. In this case,* $c = 0$, and the term in brackets is equal to $\theta$. Suppose, for example, that $\theta = 0.1$, then, the demand for central bank money is equal 10% of the overall demand for money.

*Assume that people hold some checkable deposits (so that c <1)*, the term in bracket is less than 1: the demand for central bank money is less than the overall demand for money. This comes from the fact that the demand for reserves by banks is only a fraction of the demand for checkable deposits.

## Equilibrium in the Market for Central Bank Money

The demand for central bank money is drawn for a given level of nominal income. A higher interest rate implies a lower demand for central bank money for two reasons: The demand for currency goes down; the demand for checkable deposits also goes down, leading to a decrease in the demand for reserves by banks. The supply of money is fixed, and is represented by a vertical line at $H$. equilibrium is at point A, with interest rate $i$.




An increase in the supply of central bank money leads to a shift in the vertical supply line to the right. This leads to a lower interest rate. As before, an increase in central bank money leads to a decrease in the interest rate. A decrease in central bank money leads to an increase in the interest rate.

## The Supply of Money, the Demand for Money, and the Money Multiplier

We can look at the equilibrium in terms of the overall supply and the overall demand for money (currency and checkable deposits).

To derive an equilibrium condition in term of the overall supply of money and the overall demand for money, take the equilibrium condition: $H = [c + \theta\,(1 - c)]\,\$Y\,L(i)$ and divide both sides by $c + \theta\,(1 - c)$.

$$\frac{1}{[c+\theta(1-c)]}\ H = \$Y\,L(i)$$

*The right side of the equation gives the overall demand for money (currency plus checkable deposits). The left side gives the overall supply of money (currency plus checkable deposits).* Condition says that, in equilibrium, the overall supply and the overall demand of money must be equal.

Because $[c + \theta\,(1 - c)]$ is less than one, the constant term $\frac{1}{[c+\theta(1-c)]}$ is grater than one. For this reason, this constant term is called the *money multiplier*. The overall supply of money is equal to central bank money times the money multiplier.

Money multiplier = $\frac{1}{[c+\theta(1-c)]}$

If the money multiplier is 4, for example, then the overall supply of money is equal to 4 times the supply of central bank money.

The overall supply of money depends in the on the amount of central bank money, central bank money is often called **high-powered money**, or the **monetary base**. The term high powered reflects the fact that increase in H leads to more than one for one increase in the overall money supply. In the same way, the term monetary base reflects the fact that the overall money supply depends ultimately on a "base" - the amount of central bank money in the economy.

The presence of a multiplier in equation implies that a given change in central bank money has a larger effect on the money supply–and in turn a larger effect on the interest rate.

To make the arithmetic easier, let's consider a special case where people hold only checkable deposits, so $c = 0$. In this case, the multiplier is $1/\theta$. In other words, an increase of a dollar of high powered money leads to an increase of $1/\theta$ dollars in the money supply. Assume further that $\theta = 0.1$, so that the multiplier equals $1/0.1 = 10$.

**Example**

Suppose the following assumptions hold:

- The public holds no currency
- The ratio of reserves to deposits is $0.1$
- The demand for money is given by: $M^d = \$Y\ (0.8 - 4\,i)$

Initially, the monetary base is $25 billion and nominal income is $500 billion.

A. What is the demand for central bank money?
The demand for central bank money equal to the sum of the demand for currency and the demand for reserves

The public holds no currency $\rightarrow\ c = 0$
The ratio of reserves to deposits is $0.1 \rightarrow\ \theta = 10\%$
Monetary base is $10 billion $\rightarrow H = 25$ billion
Nominal income is $500 billion $\rightarrow \$Y = 500$ billion

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

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

$$H^d = 0 + 0.1(1 - 0)\,500\,(0.8 - 4\,i)$$

$$H^d = 50\,(0.8 - 4\,i) = 40 - 200i$$

B. Find the equilibrium interest rate.

The equilibrium condition is that the supply of central bank money be equal to the demand for central bank money:

$$H = H^d \rightarrow\ 40 - 200i = 25 \rightarrow\ 200i = 15 \rightarrow\ i = 15 / 200 = 7.5\%$$

C. What is the overall supply of money? Is it equal to the overall demand for money at the interest rate you found in (b)?

Overall supply of money = $\dfrac{1}{[c+\theta(1-c)]}\ H = \dfrac{1}{[0+0.1(1-0)]}\,x\,25 = 250\ billion.$

Overall demand for money = $M^d = \$Y\ (0.8 - 4\ i) = 500(0.8 - 4x\ 0.075) = 500x\ 0.5 = 250\ billion.$

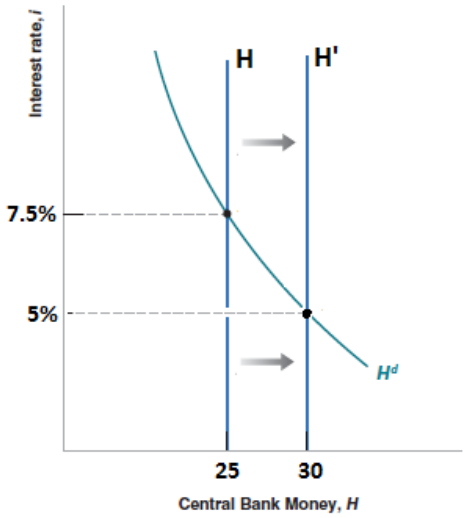
At $i = 7.5\%$ : Overall supply of money = Overall demand for money

D. What is the impact on the interest rate if central bank money increased to 30 billion?

The equilibrium condition is that the supply of central bank money be equal to the demand for central bank money:

$H = H^d \rightarrow 40 - 200i = 30 \rightarrow 200i = 10 \rightarrow i = 10 / 200 = 5\%$

Interest rate decrease to 5%




E. If the overall money supply increases to $320 billion, what will be the impact on ?

At equilibrium: Overall supply of money = Overall demand for money

$320 = M^d = \$Y\ (0.8 - 4\ i) \rightarrow 320 = 500\ (0.8 - 4i)$

$320 = 400 - 2{,}000\ i \Rightarrow 2000\ i = 80 \rightarrow i = 80/2000 = 4\%$