Chapter 15

The Money Supply Process

Money and Banking

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1 Introduction

- In monetary theory, movements in the money supply affect interest rates and inflation, and thus affect all.
  - Because of its far-reaching effects on economic activity, it is important to understand **how the money supply is determined**:
    1. Who controls the money supply?
    2. What causes it to change?
    3. How might control of it can be improved?
- In this chapter and subsequent chapters, we answer these questions by describing the "**money supply process**," the mechanism that determines the level of the money supply.
  1. Because *deposits at banks are by far the largest component of the money supply*, studying how these deposits are created is the first step in understanding the money supply process.
     - Hence, this chapter provides an overview of **how the banking system creates deposits**.
  2. The chapter also describes the basic principles of the money supply, needed as a foundation for later chapters.

- Before proceeding, we notice that there are the **"three" players in the money supply process**:

  1. **The central bank**—the government agency that oversees the banking system and is responsible for the conduct of monetary policy.

     - It (the Federal Reserve System in the U.S.) is the most important.
     - *The Fed's conduct of monetary policy involves actions that affect its balance sheet (holdings of assets and liabilities), to which we will turn shortly.*

  2. **Banks (depository institutions)**—the financial intermediaries that accept deposits from individuals/institutions and make loans.

     - Commercial banks, savings and loan associations, mutual savings banks, and credit unions.

  3. **Depositors**—individuals/institutions that hold deposits in banks.

2 The Central Bank's (Fed's) Balance Sheet

- The operation of the central bank (the Fed in the U.S.) and its monetary policy involve actions that affect its balance sheet, its holdings of assets and liabilities.
- Here is a simplified balance sheet:

Federal Reserve System

Assets	Liabilities
Securities	Currency in circulation
Loans to financial institutions	Reserves

  - **Four items in the Fed's balance sheet are essential to our understanding of the money supply process.**

2.1 Fed's Liabilities

- Two liability items, "currency in circulation" and "reserves," are often referred to as the **monetary liabilities of the Fed**.
  - They are an important part of the money supply story, because **increases in either or both will lead to an increase in the money supply** (everything else being constant).
- Details on two liability items are:
  1. **Currency in circulation**
     - The Fed issues currency. Currency in circulation is **the amount of currency in the hands of "the public."**
  2. **Reserves**
     - All banks have an account at the Fed in which they hold deposits. Reserves consist of **banks' deposits at the Fed plus vault cash** (i.e., currency physically held by banks).
       * As we will see, an increase in reserves leads to an increase in the level of deposits and thus in the money supply.
     - Total reserves can be divided into two categories: **required reserves** (reserves that the Fed requires banks to hold) and **excess reserves** (any additional reserves the banks choose to hold)
       * For example, the Fed might require that for every dollar of deposits at a depository institution, a certain fraction (called the **required reserve ratio** of, say, 10%, 10 cents) must be held as reserves.
- The sum of the Fed's monetary liabilities (currency in circulation and reserves) and the U.S. Treasury monetary liabilities (Treasury currency in circulation, primarily coins) is called the **monetary base**.
  - In our analysis, however, because the monetary liabilities of the Treasury account for less than 10% of the base, we just define:

$$\boxed{\text{the monetary base} = \text{the Fed's monetary liabilities (currency in circulation} + \text{reserves)}} \tag{2.1}$$

2.2 Fed's Assets

- Two assets items, "securities" and "loans to financial institutions," on the Fed's balance sheet are important for two reasons:
  - First, **changes in the asset items lead to changes in reserves and the monetary base, and consequently to changes in the money supply**.
  - Second, because these assets earn higher interest rates than the liabilities, the Fed makes billions of dollars ever year, some of which is spent on worthy causes, such as supporting economic research.
- Details on two asset items are:
  1. **Securities**
     - This category of assets covers the **Fed's holdings of government securities**, securities issued by the U.S. Treasury (and other securities in unusual circumstances as discussed in Chapter 16).
     - The **"primary" way the Fed provides reserves to the banking system** is by purchasing securities, thereby increasing its holdings of these assets. In this way, the money supply is increased.
  2. **Loans to financial institutions**
     - Another way the Fed can provide reserves to the banking system is by making loans to banks and other financial institutions, thereby increasing the money supply.
       * The loans these financial institutions have taken out are referred to as *borrowings from the Fed* or as **borrowed reserves**.
       * During normal times, the Fed makes loans "only" to banking institutions (called **discount loans**)—the interest rate charged banks for these loans is called the **discount rate**.

3 Control of the Monetary Base

- The **monetary base** MB (also called **high-powered money**) equals currency in circulation C plus the total reserves in banking system R:

$$MB = C + R \tag{3.1}$$

- The Federal Reserve exercises control over the monetary base through:

  1. **its purchases/sales of securities in the open market (called "open market operations")**
     - We will see that the effect of open market operations on the monetary base (MB) is much more certain than the effect on reserves (R), and therefore the Fed can control the monetary base with open market operations more effectively than it can control reserves.
  2. **its extension of discount loans to "banks"**
     - We will see that the monetary base changes one-for-one with the change in the loans made to banks and other financial institutions.

3.1 Federal Reserve Open Market Operations

- The open market operations are the **primary** way in which the Fed causes changes in the monetary base.
  - A purchase (sale) of bonds by the Fed is called an **open market purchase (sale)**.

3.1.1 Open Market Purchase

- **Open Market Purchase from a "Bank":** Suppose the Fed purchases \$100 million of bonds from banks and pays for them with a check for this amount.
  - **The bank will either deposit the check in its account with the Fed or cash it in for currency, which will be counted as vault cash**.
    - This transaction leads to changes of balance sheets in terms of reserves (= deposits at the Fed + vault cash).

Then, the resulting T-accounts for the banking system and the Fed, respectively, are (note that *T-accounts* list only the changes that occur in balance sheet items, starting from the initial balance sheet position):

Banking System				**Federal Reserve System**			
Assets		**Liabilities**		**Assets**		**Liabilities**	
Securities	−\$100 m			Securities	+\$100 m	Reserves	+\$100 m
Reserves	+\$100 m						

  - The net result of this open market purchase is that **reserves have increased by** \$100 **million, the amount of the open market purchase, and thus the monetary base has also risen by** \$100 **million since there has been no change of currency in circulation**.

- **Open Market Purchase from the "Nonbank Public":** Suppose the Fed purchases $100 million of bonds from the public and pays for them with a check for this amount.
  - To understand what happens when there is an open market purchase from the nonbank public, we must look at two cases: The people or corporations selling $100 million of bonds to the Fed do:
    1. deposit the Fed's checks in their local banks, or
    2. cash the Fed's checks either at a local bank or at the Federal Reserve Bank for currency.

1. **First, let's assume that the people or corporations selling $100 million of bonds to the Fed deposit the Fed's checks in their local banks.**
   - When banks receive the checks, they credit depositors' accounts and then deposit the checks in their account with the Fed, thereby adding to reserves.

   Then, the nonbank public's, banking system's, and Fed's T-accounts, respectively, are:

Nonbank Public

Assets		Liabilities	
Securities	−$100 m		
Checkable deposits	+$100 m		

Banking System

Assets		Liabilities	
Reserves	+$100 m	Checkable deposits	+$100 m

Federal Reserve System

Assets		Liabilities	
Securities	+$100 m	Reserves	+$100 m

   - **The net result of the Fed's open market purchase in this case is identical to the effect of its open market purchase from a bank**: Reserves have increased by the amount of the open market purchase of $100 million, and the monetary base increases by the same amount.

2. **Second, we assume that the people or corporations selling the bonds to the Fed cash the Fed's checks either at a local bank or at the Federal Reserve Bank for currency.**

   – If bond sellers cash the Fed's checks at their local banks, banks' reserves will remain the same and thus their T-accounts will not be affected.

     * This is because the vault cash of the $100 million that they pay out will be exactly matched by the deposits of the $100 million in checks at the Fed, that is, the increase in the vault cash is exactly offset by the increase in the deposits at the Fed.

   Then, in this case the nonbank public's and Fed's T-accounts are, respectively, as follows:

Nonbank Public				**Federal Reserve System**			
Assets		**Liabilities**		**Assets**		**Liabilities**	
Securities	−$100 m			Securities	+$100 m	Currency in circulation	+$100 m
Currency	+$100 m						

   – The effect of the open market purchase in this case is that **reserves are unchanged, whereas currency in circulation increases by the amount of the open market purchase of $100 million, and thus the monetary base increases by the same amount**.

Our analysis on the open market purchase from the nonbank public reveals that:

1. The effect of an open market purchase from the nonbank public on "**reserves**" depends on whether the public seller of bonds keeps the proceeds from the sale "in deposits" or "in currency."

2. However, the effect of an open market purchase from the nonbank public on the "**monetary base**" is always the same (the monetary base increases by the amount of the purchase) whether the public seller of bonds keeps the proceeds from the sale in deposits or in currency.

   – Thus, **the impact of an open market purchase on the monetary base is much more certain than its impact on reserves.**

3.1.2 Open Market Sale

- If the Fed sells \$100 million of bonds to banks or the nonbank public, the monetary base will decrease by \$100 million.
  - For example, the Fed sells bonds to the nonbank public who pay for them with currency:

Nonbank Public				**Federal Reserve System**			
Assets		**Liabilities**		**Assets**		**Liabilities**	
Securities	+\$100 m			Securities	−\$100 m	Currency in circulation	−\$100 m
Currency	−\$100 m						

    - In this example, **the effect of the open market sale is to reducing the monetary base by** \$100 **million**, although reserves remain unchanged.
  - For the cases in which buyers of the bonds are banks or buyers pay for the bonds with checks written on a checkable deposit account at a local bank, **there is the same reduction in the monetary base**, although such reduction is caused by the decline in reserves of \$100 million.

3.1.3 Conclusion from the Analysis of Open Market Operations

- Our analysis of open market purchases and sales has the following conclusion:
  - **The effect of open market operations on the monetary base (MB) is much more certain than the effect on reserves (R):**
    - Open market purchases (sales) increase (decrease) the monetary base by the amount of the purchase (sale) of the bonds.

    Therefore, the Fed can control the monetary base with open market operations more effectively than it can control reserves.

    - Open market operations can be done in other assets besides government bonds and have the same effects on the monetary base we have described here.

- **Shifts from Deposits into Currency**
  - Even if the Fed doesn't conduct open market operations, a shift from deposits to currency will affect the reserves in the banking system. However, such a shift will have no effect on the monetary base.
    - **This is another reason why the Fed has more control over the monetary base than over reserves.**
  - For example, suppose that during the Christmas season, the public wants to hold more currency to buy gifts and so withdraw $100 million in cash from their deposit accounts at banks.
    - Banks give them cash either from the vault cash or from their deposit accounts at the Fed, which leads to a reduction in reserves.

    Then, the resulting T-accounts are:

Nonbank Public

Assets		Liabilities	
Checkable deposits	−$100 m		
Currency	+$100 m		

Banking System

Assets		Liabilities	
Reserves	−$100 m	Checkable deposits	−$100 m

Federal Reserve System

Assets		Liabilities	
		Currency in circulation	+$100 m
		Reserves	−$100 m

* **The net effect is that the monetary base is unaffected by the public's increased desire for cash, but reserved are affected.**
  - This is true of shifts from currency into deposits.

3.2 Federal Reserve Loans to Financial Institutions

- We have seen so far how changes in the monetary base occur as a result of open market operations. However, **the monetary base is also affected when the Fed makes loans to financial institutions.**
  - For example, when the Fed makes a \$100 million loan to the First National Bank, the bank is credited with \$100 million of reserves from the the proceeds of the loan either in its deposit account at the Fed or as its vault cash:

Banking System				**Federal Reserve System**			
Assets		**Liabilities**		**Assets**		**Liabilities**	
Reserves	+\$100 m	Loans (borrowings from the Fed)	+\$100 m	Loans (borrowings from the Fed)	+\$100 m	Reserves	+\$100 m

    - The monetary base have increased by \$100 million.

    However, if the bank pays off its loan from the Fed, the T-accounts are:

Banking System				**Federal Reserve System**			
Assets		**Liabilities**		**Assets**		**Liabilities**	
Reserves	−\$100 m	Loans (borrowings from the Fed)	−\$100 m	Loans (borrowings from the Fed)	−\$100 m	Reserves	−\$100 m

    - The monetary base have decreased by \$100 million.
  - We see that **the monetary base changes one-for-one with the change in the borrowings from the Fed**.

3.3 Other Factors that Affect the Monetary Base

- So far, it "seems" as if the Fed has complete control of the monetary base throughout its open market operations and loans to financial institutions.
- However, there are **two important items that affect the monetary base, but are NOT controlled by the Fed**: (1) *float and (2) Treasury deposits at the Fed*.

  1. **Float**

     – When the Fed clears checks for banks, it often credits the amount of the check to a bank that has deposited it (increases the bank's reserves) **before** it debits (decreases the reserves of) the bank on which the check is drawn—*this can happen because of random events such as the weather.*

     – The resulting temporary net increase in the total amount of reserves in the banking system (and hence in the monetary base) occurring from the Fed's check-clearing process is called **float**.

  2. **Treasury Deposits at the Fed**

     – When the U.S. Treasury moves deposits from commercial banks to its account at the Fed, leading to an increase in *Treasury deposits at the Fed*, it causes a deposit outflow at these banks (like that shown in Chapter 11) and thus causes reserves in the banking system and the monetary base to decrease.

  Thus, float (affected by random events such as the weather, which influences how quickly checks are presented for payment) and Treasury deposits at the Fed (determined by the U.S. Treasury's actions) *both affect the monetary base, but are not controlled by the Fed at all*.

  – However, **these fluctuations are usually "predictable" and so can be offset through open market operations**, which means that *the Fed controls the monetary base "accurately."*

3.4 Overview of the Fed's Ability to Control the Monetary Base

- Two primary features determine the "monetary base": **open market operations** and **lending to financial institutions.**

  1. The amount of open market purchases/sales is **completely controlled** by the Fed's placing orders with dealers in bond markets.

  2. However, the Fed *cannot unilaterally determine* (banks' decisions play a role, too), and therefore *cannot perfectly* predict the amount of borrowings from the Fed (i.e., borrowed reserves).

     – In other words, the amount of lending to financial institutions is **not completely controlled** by the Fed, although it is influenced by the Fed's setting of the discount rate (interest rate on loans to banks).

  Hence, we might want to split the **monetary base**, MB, into two components:

  1. **Borrowed reserves**, BR: The less tightly controlled component, the amount of the base created by loans from the Fed.

  2. **Nonborrowed monetary base**, MB_n: $MB_n = MB - BR$, the completely controlled component, the amount of the base that results primarily from open market operations.

- Factors not controlled at all by the Fed (float and Treasury deposits at the Fed) undergo substantial short-run variations and can be important sources of fluctuations in the monetary base over time periods as short as week. However, these fluctuations are **usually predictable and so can be offset through open market operations**.

  – Therefore, although float and Treasury's deposits with the Fed undergo substantial short-run fluctuations, which complicate Fed's control of the monetary base, **they do not prevent the Fed from "accurately" controlling it.**

4 Multiple Deposit Creation: A Simple Model

- With our understanding of (1) how the Fed controls the monetary base and (2) how banks operate (from Chapter 11), we now have the tools necessary to explain **how deposits (D) are created**:
  - When the Fed supplies the banking system with \$1 of additional reserves, deposits increase by a multiple of this amount—a process called **multiple deposit creation**.

4.1 Deposit Creation: The "Single" Bank

- Let's consider the \$100 million open market purchase described earlier with the First National Bank, which results in an increase in the bank's reserves of \$100 million.
  - To analyze what the bank will do with these additional reserves, **we assume that:** *(a) the bank does not want to hold excess reserves because it earns little interest on them, and (b) the public does not want to hold any additional currency*.

1. The open market purchase with the First National Bank yields the following T-account for the bank:

First National Bank

Assets		Liabilities
Securities	−\$100 m	
Reserves	+\$100 m	

2. Because the bank has no increase in its checkable deposits, these additional reserves (simply as the vault cash) mean a rise in its excess reserves of \$100 million.
   - Under our assumption of no excess reserves, let's say that the bank decides to make a loan equal in amount to the \$100 million rise in excess reserves.
   - When it makes the loan, it sets up a checking account for the borrower and puts the proceeds of the loan into this account.

That is, the resulting T-account is:

First National Bank

Assets		Liabilities	
Securities	−$100 m	Checkable deposits	+$100 m
Reserves	+$100 m		
Loans	+$100 m		

- **The bank has created checkable deposits by its acting of lending. Because checkable deposits are part of the money supply ($M1$), the bank's act of lending created money.**

3. In its current balance sheet position, the Fist National Bank still has excess reserves and so might want to make additional loans. **However, these reserves will not stay at the bank for very long.**
   - The borrowers take out the $100 million in a checking account at the bank to purchase goods and services from other individuals/corporations.
   - When the borrowers make these purchases by writing checks, the checks will be deposited at *"other"* banks, and the $100 million of reserves will leave the First National Bank.
   - *As a result, a bank cannot safely make a loan for an amount greater than the excess reserves it has before it makes the loan.*

Then, the final T-account is:

First National Bank

Assets		Liabilities	
Securities	−$100 m		
Loans	+$100 m		

- In sum, the increase in reserves of $100 million (caused by an open market purchase) has been converted into additional loans of $100 at the First National Bank, plus an additional **$100 million of deposits that have made their way to "other" banks**
  - All the checks written on accounts at the First National Bank are deposited in other banks rather than converted into cash, *because we assumed that the public do not want to hold any additional currency*.
- **In what follows, let's see what happens to these deposits at the other banks.**

4.2 Deposit Creation: The "Banking System"

- For simplicity, let's assume that the $100 million of deposits created by the First National Bank's loan is deposited at Bank A and that this bank and all other banks hold no excess reserves.

1. **Let's consider Bank A's T-accounts.**

   (a) When the $100 million of deposits created by the First National Bank's loan is deposited at Bank A, Bank A's T-account becomes:

Bank A

Assets		Liabilities	
Reserves	+$100 m	Checkable deposits	+$100 m

   (b) If the required reserve ratio is 10%, Bank A will find itself with a $10 million increase in required reserves, leaving it $100 million of excess reserves. Thus, this bank will make loans for the entire amount of these excess reserves.
   - Its loans and checkable deposits will then increase by $90 million.
   - But when the borrowers spend the $90 million of checkable deposits, the checkable deposits and the reserves at Bank A will fall back down by the same amount.

The net result is that we have the following T-account of Bank A:

Bank A

Assets		Liabilities	
Reserves (required reserves)	+$10 m	Checkable deposits	+$100 m
Loans	+$90 m		

2. **Let's look at T-accounts of another bank (Bank B) in which the money spent by the borrowers from Bank A is deposited.**

   (a) If the money spent by the borrowers to whom Bank A lent the $90 million is deposited in Bank B, the T-account for Bank will be:

Bank B

Assets		Liabilities	
Reserves	+$90 m	Checkable deposits	+$90 m

   (b) When Bank B will make loans of its entire excess reserves of $81 million and the borrowers from Bank B will spend the proceeds from the loans (by depositing them at another bank, say, Bank C), the same reasoning as in Bank A yields the following T-account of Bank B:

Bank B

Assets		Liabilities	
Reserves (required reserves)	+$9 m	Checkable deposits	+$90 m
Loans	+$81 m		

3. **Consequently,** from the initial \$100 million increase of reserves in the banking system, the total increase of checkable deposits in the system so far (including Bank C) is \$271 million (= \$100 m + \$90 m + \$81 m).

   – **Following the same reasoning, the total increase in deposits from the initial** \$100 **million in reserves will be** \$1,000 **million for an infinite number of banks in the banking system (given the required reserve ratio of** 10%**):**

   * Table 1 show creation of deposits (assuming 10% reserve requirement and a \$100 million increase in reserves):

Creation of Deposits (assuming 10% reserve requirement and a \$100 million increase in reserves)

Bank	Increase in Deposits (\$)	Increase in Loans (\$)	Increase in Reserves (\$)
First National	0.00	100.00 m	0.00
A	100.00 m	90.00 m	10.00 m
B	90.00 m	81.00 m	9.00 m
C	81.00 m	72.90 m	8.10 m
D	72.90 m	65.61 m	7.29 m
E	65.61 m	59.05 m	6.56 m
F	59.05 m	53.14 m	5.91 m
.	.	.	.
.	.	.	.
.	.	.	.
Total for all banks	1,000.00 m	1,000.00 m	100.00 m

   * **The increase is tenfold, the reciprocal of the** 10% **reserve requirement.**

   – The multiple increase in deposits generated from an increase in the banking system's reserves is called the **simple deposit multiplier**, which equals the **reciprocal of the required reserve ratio** $\frac{1}{rr}$ (in our example, it is 10). So the **formula for the multiple expansion of deposits** is written as follows:

$$\Delta D = \frac{1}{rr} \times \Delta R \tag{4.1}$$

   * $\Delta D =$ change in total checkable deposits in the banking system; $rr =$ required reserve ratio; $\Delta R =$ change in reserves for the banking system.

- The multiple deposit creation results in the following T-account of the banking system as a whole (including the First National Bank):

Banking System

Assets		Liabilities	
Securities	−$100 m	Checkable deposits	+$1,000 m
Reserves	+$100 m		
Loans	+$1,000 m		

- **Deriving the Formula for Multiple Deposit Creation**
  - Our assumption that banks do not hold on to any excess reserves ($ER = 0$) means that the total amount of required reserves for the banking system RR will equal the total reserves in the banking system R:

$$R = RR + ER \Rightarrow \underbrace{R = RR}$$

  - The total amount of required reserves RR equal the required reserve ratio rr times the total amount of checkable deposits D:

$$RR = rr \times D$$

Substituting this for RR yields:

$$D = \frac{1}{rr} \times R \tag{4.2}$$

Taking the change in both sides of the above equation gives Equation (4.1) above:

$$\Delta D = \frac{1}{rr} \times \Delta R$$

- **Critique of the Simple Model**
  - Our model of multiple deposit creation **seems to indicate that** the Fed is able to exercise complete control over the level of checkable deposits by setting the required reserve ratio and the level of reserves.

    However, the assumptions we made simplify the actual creation of deposits:

    1. **We assumed that the public does not want to hold any additional currency.**
       - **If proceeds from Bank A's** \$90 **million loan are not deposited but are kept in currency,** nothing is deposited in Bank B and the deposit creation stops.
       - As a result, the total increase in the money supply is now \$190 million = the \$90 million increase in currency + the initial \$100 million of deposits created by First National Bank's loans – this increase is considerably less than the \$1,000 million calculated from our simple model.
       - Therefore, if some proceeds from loans are not deposited in banks but instead are used to raise the holdings of currency, less multiple expansion occurs overall, and the money supply will not increase by as much as our simple model predicts.
    2. **We assumed that the bank does not want to hold excess reserves.**
       - **If Bank A decides to hold on to all** \$90 **million of its excess reserves,** no deposits would be made in Bank B, and this would also stop the deposit creation process. As a result, the total increase in deposits would be only \$100 million.
       - Hence, if banks choose to hold on to all or some of their excess reserves, the full expansion of deposits predicted by our simple model does not occur.
  - *These examples indicate that the* **Fed** *is not the only player whose behavior influences the level of deposits and hence the money supply.* **Depositors' decisions** *regarding how much currency to hold and* **banks' decisions** *regarding the amount of excess reserves to hold also can cause the money supply to change.*

5 The Money Supply Process

5.1 Factors that Determine the Money Supply

- We now discuss all the factors that affect the money supply.
- Let's look at changes in each factor, *holding all other factors constant*:
  1. **Changes in the nonborrowed monetary base,** MB_n
     - Open market purchases (sales) $\Rightarrow MB_n \uparrow (\downarrow) \Rightarrow MB$ and $R \uparrow (\downarrow)$, thereby causing a multiple expansion (contraction) of deposits and thus increasing (decreasing) the money supply (M).
     - *The money supply is positively related to the nonborrowed monetary base* MB_n*.*
  2. **Changes in borrowed reserves from the Fed,** BR
     - An increase (decrease) in loans from the Fed $\Rightarrow BR \uparrow (\downarrow) \Rightarrow MB$ and $R \uparrow (\downarrow)$, thereby causing a multiple expansion (contraction) of deposits and thus increasing (decreasing) M.
     - *The money supply is positively related to borrowed reserves from the Fed* BR*.*
  3. **Changes in the required reserves ratio,** rr
     - $rr \uparrow (\downarrow) \Rightarrow$ multiple deposit creation shrinks (expands), thereby decreasing (increasing) M.
     - *The money supply is negatively related to the required reserve ratio* rr*.*
  4. **Changes in currency holdings**
     - As shown before, checkable deposits undergo multiple deposit expansion, while currency does not. Therefore, when checkable deposits are converted into currency, the overall level of multiple expansion declines and the money supply falls.
     - *The money supply is negatively related to currency holdings.*

5. **Changes in excess reserves**

   - As shown before, when banks increase their holdings of excess reserves, those reserves are no longer being used to make loans, causing multiple deposit creation to stop dead in its tracks and thus resulting in less expansion of the money supply.

   - *The money supply is negatively related to the amount of excess reserves.*

Therefore, we have the following summary table:

Money Supply Response

Player	Variable	Change in Variable	Money Supply Response	Reason
Federal Reserve System	Nonborrowed monetary base, MB_n	↑	↑	More *MB* for deposit creation
	Required reserve ratio, *rr*	↑	↓	Less multiple deposit expansion
Banks	Borrowed reserves, *BR*	↑	↑	More *MB* for deposit creation
	Excess reserves	↑	↓	Less loans and deposit creation
Depositors	Currency holdings	↑	↓	Less multiple deposit expansion

Note: Only increases (↑) in the variables are shown. The effects of decreases on the money supply would be the opposite of those indicated in the "Money Supply Response" column.

5.2 The Money Multiplier

- In this section we derive all of the results in the previous section using a concept called the **money multiplier**, m.
  - The money multiplier m tells us how much the money supply, M, changes for a given change in the monetary base, MB.
  - The relationship between M, m, and MB is written as follows:

$$\boxed{M = m \times MB} \tag{5.1}$$

    * m tells us what multiple of the monetary base is transformed into the money supply.
    * Because $m > 1$, the alternative name for the monetary base, *high-powered money*, is logical.

- To derive the money multiplier, **let's first assume that the desired holdings of currency C and excess reserves ER grows proportionally with checkable deposits**.
  - In other words the ratios of these items to checkable deposits are constant in equilibrium:

$$c = \frac{C}{D}: \text{ currency ratio}; \; e = \frac{ER}{D}: \text{ excess reserves ratio} \tag{5.2}$$

  - In the below, we will now derive Equation (5.1) with a formula for the money multiplier (m) as a function of the currency ratio desired by depositors (c), the excess reserves ratio desired by banks (e), and the required reserve ratio set by the Fed (rr).

- We begin with the **definition of the total reserves in the banking system** (R):

$$R = RR + ER = \underbrace{rr \times D}_{} + \underbrace{e \times D}_{} \tag{5.3}$$

  - A key point of this equation ($R = rr \times D + ER$) is that holding ER constant, \$1 of reserves (R) can support more than \$1 of deposits (D) because $rr < 1$, meaning that the multiple expansion of deposits can occur.

- We assumed earlier that there is no holdings of excess reserves ($ER = 0$ or $e = 0$), which leads to $R = RR$ in equilibrium.
  - Thus, we have $D = \frac{1}{rr} \times R$, which is the same as Equation (4.2) in the previous section.

By the **definition of the monetary base (MB)**, we have a relationship between MB and D:

$$MB = C + R = \underbrace{c \times D} + \underbrace{rr \times D + e \times D} = (rr + c + e) \times D \Rightarrow \underbrace{D = \frac{1}{(rr + c + e)} \times MB} \tag{5.4}$$

- Another interpretation of this equation ($MB = C + rr \times D + ER$) is that it reveals the amount of the monetary base (MB) needed to support the existing amounts of checkable deposits (D), currency (C), and excess reserves (ER).

The **M1 definition of the money supply** (M) as currency (C) plus checkable deposits (D) leads to a relationship between M and D:

$$M = C + D = \underbrace{c \times D} + D = (1 + c) \times D \Rightarrow \underbrace{D = \frac{1}{(1 + c)} \times M} \tag{5.5}$$

Finally, equating Equation (5.4) with Equation (5.5) gives the relationship between M, m (as a function of c, e, and rr), and MB:

$$M = m \times MB, \text{ where } m = \frac{1 + c}{rr + c + e} > 1 \text{ for } (rr + e) < 1 \tag{5.6}$$

- The sufficient condition for $m > 1$ is $(rr + e) < 1$, which is true under plausible values of rr and e.
- **The monetary multiplier is less than the simple deposit multiplier (i.e., $m = \frac{1+c}{rr+c+e} < \frac{1}{rr}$ for $c > 0$).**
  - **Although there is multiple expansion of deposits, there is no such expansion for currency: that is,** $0 < c < 1$.
  - For this result, we can ignore the role of e because its realistic value is usually very small.

- By looking at Equation (5.6), we can algebraically understand the responses of the money supply to changes in the factors, which were shown in the summary table of the previous section.
  - We first recognize that the monetary base equals nonborrowed the monetary base plus borrowed reserves:

    $$MB = MB_n + BR$$

    Substituting for MB in Equation (5.6) gives:

    $$M = m \times (MB_n + BR) = \left(\frac{1+c}{rr+c+e}\right) \times (MB_n + BR) \tag{5.7}$$

  - From the above expressions, we see the relationship between the money supply and each factor:
    1. $MB_n \uparrow$ (throughout open market purchases) $\Rightarrow M \uparrow$ by a multiple amount because $m > 1$.
    2. $BR \uparrow$ (banks borrow more from the Fed) $\Rightarrow M \uparrow$ by a multiple amount because $m > 1$.
    3. $rr \downarrow$ (the Fed lowers the required reserve ratio) $\Rightarrow M \uparrow$ because m rises.
    4. $e \downarrow$ (banks holds less excess reserves) $\Rightarrow M \uparrow$ because m rises.
    5. $c \downarrow$ (depositors holds less currency) $\Rightarrow M \uparrow$ because m rises ($\frac{\partial m}{\partial c} = \frac{(rr+e)-1}{(rr+c+e)^2} < 0$).

5.3 Application: The 2007–2009 Financial Crisis and the Money Supply

- As shown in Figure 4, during the 2007–2009 financial crisis, the monetary base (MB) increased by more than 200% as a result of the Fed's purchase of assets and creation of new lending facilities to stem the financial crisis (will be discussed in Chapter 16), while the M1 money supply (M) rose by less than 25%.

- **How does our money supply model explain this?**

  - Figure 5 shows the currency ratio (c) and the excess reserves ration (e) for the 2007–2009 period.

    1. c fell somewhat during this period.

       * Our model suggests that this fall in c would raise the money multiplier (m) and the money supply (M)

    2. e increased extraordinarily by more than a factor of over 500 during this period.

       * Our model suggests that this rise in e would lower the money multiplier (m) and the money supply (M)

       * The explanation for this increase in e was that banks were willing to hold the huge increase in excess reserves because they had become costless to hold once the Fed began paying interest on these reserves and this interest rate often exceeded the federal funds rate.

  - Therefore, the effects of the decline in c were entirely offset by the extraordinary rise e.