

TOPIC 8: THE CENTRAL BANK BALANCE SHEET AND THE MONEY SUPPLY PROCESS*

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This lecture develops an understanding of how the central bank interacts with the financial system, and how its balance sheet is connected to the money and credit that flows through the economy.

1 THE CENTRAL BANK'S BALANCE SHEET

Central bank activities, e.g. supplying currency, providing deposit accounts to the government and commercial banks, making loans, and buying and selling securities and foreign currency, etc., cause changes in the **central bank's balance sheet**. We first look at the structure of the central bank's balance sheet. See Figure 17.1 below.

Figure 17.1 The Central Bank's Balance Sheet

	Assets	Liabilities
Government's Bank	Securities Foreign exchange reserves	Currency Government's account
Bankers' Bank	Loans	Accounts of the commercial banks (reserves)

Assets. There are three basic assets in the central bank's balance sheet. The first two are needed so that the central bank can perform its role as the government's bank; the third is a service to commercial banks.

- **Securities** are the primary assets of most central banks. The quantity of securities is controlled through purchases and sales known as **open market operations**.
- **Foreign exchange reserves** are the central bank's and government's balances of foreign currency. They are held in the form of bonds issued by foreign governments and used for foreign exchange interventions.

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Disclaimer: 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 Stephen Cecchetti and Kermit Schoenholtz (2014), *Money, Banking and Financial Markets*, 4th Edition, McGraw-Hill/Irwin. Please do NOT circulate.

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- **Loans** to commercial banks as well as nonbanks.

Liabilities. There are three major liabilities in the central bank's balance sheet. The first two allow the central bank to perform its role as the government's bank; the third allows it to fulfill its role as the bankers' bank.

- **Currency** circulating in the hands of the nonbank public is the principal liability of most central banks.
- **Government's account** into which the government deposits funds (primarily tax revenues) and from which the government writes checks and makes electronic payments.
- **Commercial bank accounts (reserves)** are the sum of two parts: deposits at the central bank plus the cash in the bank's own vault.¹ Note that reserves are assets of the commercial banking system and liabilities of the central bank.

Currency in the hands of the public and reserves in the banking system—the privately held liabilities of the central bank—make up the **monetary base**, also called **high-powered money**.

2 CHANGING THE SIZE AND COMPOSITION OF THE BALANCE SHEET

We will look at the impacts of four types of transactions on the central bank's balance sheet and the banking system's balance sheet. One simple rule: *When the value of an asset (liability) on the balance sheet increases, either the value of another asset (liability) decreases so that the net change is zero or the value of a liability (asset) rises by the same amount.*

Open market operations. When the Federal Reserve (at New York) buys or sells securities in financial markets, it engages in **open market operations**. For example, suppose the Fed purchases \$1 billion U.S. T-bills from a commercial bank. See Figure 17.2 below.

- The Fed's balance sheet: its assets and liabilities both go up \$1 billion, increasing the monetary base by the same amount.
- The banking system's balance sheet: no changes in liabilities and the changes in assets sum to zero.

¹There are two types of reserves: those that banks are required to hold, called **required reserves**, and those they hold voluntarily, called **excess reserves**.

Figure 17.2 Balance Sheet Changes after the Federal Reserve Purchases a U.S. Treasury Bond

A. Federal Reserve's Balance Sheet		B. Banking System's Balance Sheet	
Assets	Liabilities	Assets	Liabilities
Securities +\$1 billion (U.S. Treasury bond)	Reserves +\$1 billion	Reserves +\$1 billion Securities -\$1 billion (U.S. Treasury bond)	

Foreign exchange intervention. When the Federal Reserve (at New York) buys or sells foreign currency reserves in financial markets, it engages in **foreign exchange intervention**. For example, suppose the U.S. Treasury instructs the Fed to purchase \$1 billion worth of euros.² See Figure 17.3 below.

- The Fed's balance sheet: its assets and liabilities both go up \$1 billion, increasing the monetary base by the same amount.
- The banking system's balance sheet: no changes in liabilities and the changes in assets sum to zero.

Figure 17.3 Balance Sheet Changes after the Federal Reserve Purchases a German Government Bond

A. Federal Reserve's Balance Sheet		B. Banking System's Balance Sheet	
Assets	Liabilities	Assets	Liabilities
Foreign exchange reserves +\$1 billion (German government bonds in euros)	Reserves +\$1 billion	Reserves +\$1 billion Securities -\$1 billion (German government bonds)	

Discount loans. When the Fed makes loans backed by collaterals—assets pledged by a borrower that a lender can seize in the event of nonpayment—to the borrowing bank, it extends **discount loans**. For example, suppose the Fed makes a \$100 millions loan pledged by the U.S. T-bills to a commercial bank. See Figure 17.4 below.

- The Fed's balance sheet: its assets and liabilities both go up \$100 millions, increasing the monetary base by the same amount.
- The banking system's balance sheet: its assets and liabilities both go up \$100 millions, increasing the size of the balance sheet.

²To implement it, the Fed can buy German government bonds, denominated in euros, from the foreign exchange departments of large commercial banks and pays for them with dollars.

Figure 17.4 Balance Sheet Changes after the Federal Reserve Makes a Discount Loan

A. Federal Reserve's Balance Sheet				B. Banking System's Balance Sheet			
Assets		Liabilities		Assets		Liabilities	
Discount loans	+\$100 million	Reserves	+\$100 million	Reserves	+\$100 million	Discount loans	+\$100 million

Cash withdrawal. In contrast to the previous transactions, the **cash withdrawal** by nonbank public affects only the composition—not the size—of the monetary base. For example, suppose we withdraw \$100 from an ATM. See Figure 17.5 below.

- The Fed's balance sheet: by withdrawing cash we increase the amount of currency outstanding and decrease the reserves each by \$100, thereby altering the composition of the monetary base while leaving its size unchanged.
- The banking system's balance sheet: because the vault cash counts as reserves, by withdrawing cash we decrease the banking system's reserves as well as checkable deposits by \$100, thereby shrinking the size of the balance sheet by the same amount.

Figure 17.5 Balance Sheet Changes after a Private Person Withdraws Cash from His or Her Bank Account

A. Nonbank Public's Balance Sheet				B. Federal Reserve's Balance Sheet				C. Banking System's Balance Sheet			
Assets		Liabilities		Assets		Liabilities		Assets		Liabilities	
Currency	+\$100					Currency	+\$100	Reserves	-\$100	Checkable deposits	-\$100
Checkable deposits	-\$100					Reserves	-\$100				

3 THE DEPOSIT EXPANSION MULTIPLIER

Recall the two broader measures of money: M1 is currency plus demand deposits and M2 adds time deposits to M1. This section looks at the relationship between M1/M2 and the monetary base.

Deposit expansion in a system of banks. Consider a \$100,000 open market purchase of securities by the Fed from First Bank. For simplicity, we assume that banks hold no excess reserves and there is no change in currency held by the nonbank public. See Figures 17.6–17.8 below.

Figure 17.8 Multiple Deposit Creation

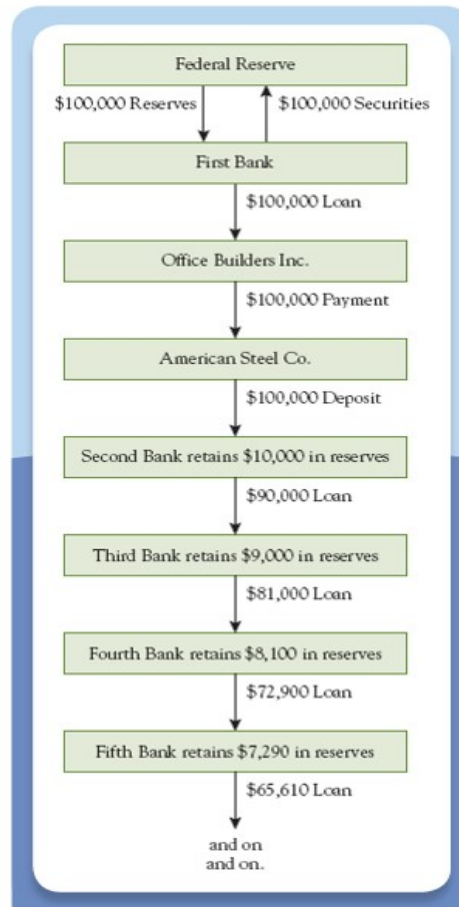


Figure 17.6

Changes in First Bank's Balance Sheet after the Fed's Purchase of a U.S. Treasury Bond

A. Immediate Impact			
Assets		Liabilities	
Reserves	+\$100,000		
Securities	-\$100,000		

B. After the Extension of a Loan		C. After Withdrawal by the Borrower	
Assets		Assets	
Reserves	+\$100,000	Reserves	\$0
Securities	-\$100,000	Securities	-\$100,000
Loans	+\$100,000	Loans	+\$100,000

		Liabilities	
Checkable deposits	+\$100,000	Checkable deposits	\$0

Figure 17.7 Changes in Balance Sheets

A. Second Bank after American Steel's Deposit				B. Second Bank after Extension of a Loan			
Assets		Liabilities		Assets		Liabilities	
Reserves	+\$100,000	American Steel's checking account	+\$100,000	Reserves	+\$10,000	American Steel's checking account	+\$100,000
				Loan	+\$90,000		

C. Third Bank after Deposit and Extension of a Loan			
Assets		Liabilities	
Reserves	+\$ 9,000	Checking account	+\$90,000
Loan	+\$81,000		

Let r_D be the **required reserve ratio**. Then a one-dollar increase in reserves creates an increase in deposits equal to

$$1 + (1 - r_D) + (1 - r_D)^2 + (1 - r_D)^3 + \cdots = \sum_{k=0}^{\infty} (1 - r_D)^k = \frac{1}{r_D} > 1 \quad (3.1)$$

See Table 17.3 below. Similarly, a decrease in reserves will generate an amplified deposit contraction. For example, a \$100,000 open market sale of securities by the Fed will reduce the level of deposits by \$1,000,000 if $r_D = 10\%$.

Table 17.3

Multiple Deposit Expansion following a \$100,000 Open Market Purchase
Assuming a 10% Reserve Requirement

Bank	Increase in Deposits	Increase in Loans	Increase in Reserves
First Bank	\$ 0	\$ 100,000	\$ 0
Second Bank	\$ 100,000	\$ 90,000	\$ 10,000
Third Bank	\$ 90,000	\$ 81,000	\$ 9,000
Fourth Bank	\$ 81,000	\$ 72,900	\$ 8,100
Fifth Bank	\$ 72,900	\$ 65,610	\$ 7,290
Sixth Bank	\$ 65,610	\$ 59,049	\$ 6,561
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.	.	.	.
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The Banking System	\$1,000,000	\$1,000,000	\$100,000

4 THE MONETARY BASE AND THE MONEY SUPPLY

This section relaxes the assumptions that banks hold no excess reserves and there is no change in currency held by the nonbank public.

The arithmetic of the money multiplier. We derive the **money multiplier**—the relation between the quantity of money (checkable deposits plus currency) and the monetary base (reserves in the banking system plus currency). Note that the monetary base is under the direct control of the central bank.

- Some notations. Let M denote the quantity of money, MB the monetary base, and m the money multiplier. Then

$$M = m \times MB \quad (4.1)$$

where

$$M = C + D, \quad \text{money} = \text{currency} + \text{checkable deposits} \quad (4.2)$$

$$MB = C + R, \quad \text{monetary base} = \text{currency} + \text{reserves} \quad (4.3)$$

$$R = RR + ER, \quad \text{reserves} = \text{required reserves} + \text{excess reserves} \quad (4.4)$$

- Let ER/D be the **excess reserve-to-deposit ratio**. Then (4.4) can be written as

$$R = r_D D + \frac{ER}{D} D = \left(r_D + \frac{ER}{D} \right) D \quad (4.5)$$

where ER depend on the costs and benefits of holding them:

- cost: interest on the loans forgone;
- benefit: safety should deposits be withdrawn suddenly.

Also, let C/D be the **currency-to-deposit ratio**. C depend on the costs and benefits of holding them:

- cost: interest on the deposits forgone;
- benefit: lower risk and greater liquidity.

Taken together, (4.3) can be written as

$$MB = \left(\frac{C}{D} + r_D + \frac{ER}{D} \right) D \quad (4.6)$$

and solving for D gives

$$D = \frac{1}{C/D + r_D + ER/D} MB \quad (4.7)$$

Note that if we ignore excess reserves and cash withdraws, (4.7) boils down to (3.1). More generally, (4.7) says that a one-dollar increase in the monetary base will increase deposits by less than $1/r_D$.

- Substituting (4.7) into (4.2) and solving for M give

$$M = \underbrace{\frac{C/D + 1}{C/D + r_D + ER/D}}_{m: \text{ money multiplier}} \times MB \quad (4.8)$$

See Table 17.4 below for the four factors that affect the quantity of money.

Table 17.4 Factors Affecting the Quantity of Money

Factor	Who Controls It	Change	Impact on M
Monetary base	Central bank	Increase	Increase
Required reserve-to-deposit ratio	Central bank	Increase	Decrease
Excess reserve-to-deposit ratio	Commercial banks	Increase	Decrease
Currency-to-deposit ratio	Nonbank public	Increase	Decrease