Money supply process

Lecture 4

Readings

- Mishkin, chapter 15, 10th edition (or chapter 14, 9th edition)

Plan

How is money supply determined? Who controls it? What causes it to change?

- Fed's balance sheet

- Control of the monetary base (or high-powered money)

- Multiple deposit creation

- Money multiplier and money supply process

Deposits and money supply

	Value as of November 2008 ($ billions)
M1 = Currency	804.9
+ Traveler's checks	5.6
+ Demand deposits	405.9
+ Other checkable deposits	306.1
Total M1	1,522.5
M2 = M1	
+ Small-denomination time deposits	1,351.0
+ Savings deposits and money market deposit accounts	4,007.1
+ Money market mutual fund shares (retail)	1,053.9
Total M2	6,412.0

Source: www.federalreserve.gov/releases/h6/hist.

- Recall in the US there are two official measures of money supply: M1 and M2
- Focus on M1, the narrowest measure of money, basically equal to currency + checkable deposits
- Bank deposits accounts for almost 50 percent of total M1
- To understand the money supply process, need to understand how bank deposits are created

Three players in the money supply process

1. **Central Bank**: Government agency that oversees the banking system and is responsible for the conduct of monetary policy (Fed in US and ECB in Euro area)

2. **Banks (depository institutions)**: Financial institutions that accepts deposits from individuals and institutions and make loans (in the US commercial banks, credit unions, mutual savings banks, savings and loan associations)

3. **Depositors**: Individuals and institutions that hold deposits in banks

   The conduct of monetary policy by the central bank - the most important player - involves actions that affects its balance sheet. Let's see. In examples studying the money supply process, focus on the Fed.

Fed simplified balance sheet

Federal Reserve System	
Assets	**Liabilities**
Government securities	Currency in circulation
Discount loans	Reserves

Simplified balance sheet including only four items that are essential to understanding the money supply process in normal times

Liabilities

1. Currency in circulation:

    –   Since currency held at banks (vault cash) is included in reserves, currency in circulation is defined as the amount of currency circulating outside banks

2. Reserves:

    –   Include currency held at banks (vault cash) and deposits held by banks at the Fed

    –   Reserves are assets for the banks, but liabilities for the Fed

    –   Broken into required reserves, which the law requires to hold, and excess reserves

The two liabilities together define the monetary base:

Monetary base = Currency in circulation + Reserves

Assets

1. US government securities:

   – Fed buys and sell US Treasury securities

   – These pay interest

2. Discount loans:

   – The Fed makes discount loans to banks

   – The interest rate charged on these loans is called the discount rate

   – Banks refer to these as borrowings from the Fed or borrowed reserves or borrowings from the Fed

Control of the monetary base

- Monetary base, MB, equals currency in circulation, C, plus reserves, R

$$MB = C + R$$

- How does the Fed control the monetary base?

  1. Through purchase and sale of government securities in the regular (open) market, open market operations

  2. Through extension of discount loans to banks

a. Open market purchase from a bank

- Fed purchases $100 of bonds from a bank and pays for them with a check

- Bank will either deposit the check in its account with the Fed or cash the check

Banking System	
Assets	Liabilities
Securities -$100	
Reserves +$100	

Federal Reserve System	
Assets	Liabilities
Securities +$100	Reserves +$100

- Reserves have increased by $100

- No change in currency

- Monetary base has risen by $100

b. Open market purchase from nonbank public I

- Fed purchases $100 of bonds from the nonbank public and pays for them with a check

- Nonbank public deposits the Fed's check in a bank

- Bank credits the depositor account and deposits the check at its account with the Fed

Nonbank public		
Assets		Liabilities
Securities -$100		
Checkable +$100 deposits		

Banking System		
Assets		Liabilities
Reserves +$100		Checkable +$100 deposits

- Reserves have increased by $100

- No change in currency

- Monetary base has risen by $100

Federal Reserve System	
Assets	Liabilities
Securities +$100	Reserves +$100

c. Open market purchase from nonbank public II

- Fed purchases $100 of bonds from the nonbank public and pays for them with a check

- Nonbank public cashes the Fed's check at a bank

- Bank pays out vault cash and deposits the Fed's check in its account at the Fed

Nonbank public		
Assets		**Liabilities**
Securities -$100		
Currency +$100		

Banking System		
Assets		**Liabilities**
Reserves (vault cash) -$100		
Reserves (deposits at Fed) +$100		

- Currency in circulation increases by $100

- No change in reserves

- Monetary base has risen by $100

Federal Reserve System	
Assets	**Liabilities**
Securities +$100	Currency in +$100 circulation

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

- The effect of an open market purchase from the nonbank public on the monetary base, however, is always the same

- The effect of an open market sale is symmetric

d. Open market sale

1. If the Fed sells $100 of bonds to the nonbank public and the buyer pays for them with cash

   - Currency in circulation falls by $100

   - Reserves do not change

   - Monetary base falls by $100

2. If the Fed sells $100 of bonds to either a bank or to a nonbank buyer that pays with a check

   - Reserves fall by $100

   - Currency in circulation does not change

   - Monetary base falls by $100

d. Shifts from deposits to currency

- A depositor withdraws $100 from his/her checking account at the local bank

Nonbank public		Banking system	
Assets	Liabilities	Assets	Liabilities
Checkable deposits -$100		Reserves -$100	Checkable deposits -$100
Currency +$100			

- Reserves have fallen by $100

- Currency in circulation has increased by $100

- Monetary base remains unchanged

Federal Reserve System	
Assets	Liabilities
	Currency in circulation +$100
	Reserves -$100

e. Discount loans

- A bank borrows $100 as a discount loan from the Fed

- Fed credits the bank's account with the Fed with an additional $100

Banking system				Federal Reserve System			
Assets		Liabilities		Assets		Liabilities	
Reserves	+$100	Discount loans (Borrowings from the FED)	+$100	Discount loans (Borrowings from the FED)	+$100	Reserves	+$100

- Reserves have increased by $100

- No change in currency in circulation

- Monetary base has risen by $100

Control of the monetary base: summing up

- Open market operations

  - A $100 open market purchase increases the monetary base by $100, but may or may not increase reserves

  - A $100 open market sale decreases the monetary base by $100, but may or may not decrease reserves

- Discount loans

  - A $100 discount loan increases the monetary base by $100, and also increases reserves

- Random shifts from deposits to currency, and from currency to deposits, do not affect the monetary base, but do change reserves

- Fed controls monetary base much more precisely than it controls reserves

Multiple deposit creation

- Central bank controls the monetary base, C+R

- Monetary base → base on which money supply and credit are built

- Money supply, C+D → money available for transactions

- What is the relation between the monetary base and money supply? How are deposits created from reserves?

Multiple deposit creation, cont.

- How are deposits created?

- Fed supplies the banking system with an additional \$1 in reserves $\rightarrow$ deposits increase by more than \$1

- This process is called multiple deposit creation

- Start with a simple model of multiple deposit creation

  Assume:

  - banks never hold excess reserves

  - nonbank public never holds currency

- Look first at a single bank, then at the entire banking system

Deposit creation: the single bank

- Fed purchases $100 of Treasury bonds from First Bank, and pays for them with a check

First Bank		
Assets		**Liabilities**
Securities	-$100	
Reserves	+$100	

- First Bank has not increased checkable deposits → its required reserves have not changed → the $100 in new reserves are excess reserves → it does not want to hold excess reserves → it makes a new $100 loan and credits the borrower's account with $100

First Bank		
Assets		**Liabilities**
Securities	-$100	Checkable deposits +$100
Reserves	+$100	
Loans	+$100	

- Borrower uses the $100 loan to make a purchase, writing a check to another individual

First Bank		
Assets		**Liabilities**
Securities	-$100	
Loans	+$100	

Deposit creation: the banking system

- The other individual does not want to hold cash and thus deposits the check in his account at Bank A

  Bank A deposits the check at its account with the Fed. The Fed transfers $100 out of First national Bank account into Bank A account

- Bank A by law must hold $100x10%, or $10, as required reserves → it has $90 of excess reserves → it makes a new $90 loan

- Borrower uses the $90 loan to make a purchase, writing a check to another individual

Bank A			
Assets		Liabilities	
Reserves	+$100	Checkable deposits	+$100

Bank A			
Assets		Liabilities	
Reserves	+$100	Checkable deposits	+$190
Loans	+$90		

Bank A			
Assets		Liabilities	
Reserves	+$10	Checkable deposits	+$100
Loans	+$90		

Deposit creation: the banking system, cont.

- The other individual does not want to hold cash and thus deposits the check in his account at Bank B

  Bank B deposits the check at its account with the Fed. The Fed transfers $90 out of Bank A account into Bank B account

- Bank B by law must hold $90x10%, or $9, as required reserves → it has $81 of excess reserves → it makes a new $81 loan

- Borrower uses the $81 loan to make a purchase, writing a check to another individual

- and so on….

Bank B		
Assets		Liabilities
Reserves	+$90	Checkable deposits +$90

Bank B		
Assets		Liabilities
Reserves	+$90	Checkable deposits +$171
Loans	+$81	

Bank B		
Assets		Liabilities
Reserves	+$9	Checkable deposits +$90
Loans	+$81	

Deposit creation: the banking system, cont.

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

Deposit creation: the banking system, cont.

- The $100 increase in reserves leads to a $1000 increase in deposits

- Note that

$$\frac{\$100 \text{ increase in reserves}}{\$1000 \text{ increase in deposits}} = \frac{\Delta R}{\Delta D} = 0.10 = 10\%$$

- This result holds true more generally

$$\frac{\Delta R}{\Delta D} = r \quad \text{and} \quad \Delta D = \frac{1}{r} \Delta R$$

where r is the required reserve ratio and where 1/r is a number greater than 1, called the simple deposit multiplier

Deriving the simple deposit multiplier, I

- Derive simple deposit multiplier by adding up banks increases in deposits

$$\Delta D = \Delta R + (1-r)\, \Delta R + (1-r)\,(1-r)\, \Delta R + \ldots$$
$$= \Delta R\,(1 + (1-r) + (1-r)^2 + \ldots)$$
$$= \Delta R\,[\,1 / (1 - (1-r)\,]$$
$$= (1/r)\, \Delta R$$

- In the example

$$\Delta D = 100 + 0.9 \times 100 + 0.81 \times 100 + \ldots$$
$$= 100\,(1 + 0.9 + 0.9^2 + \ldots)$$
$$= (1/0.1)\,100$$
$$= 10 \times 100$$
$$= 1000$$

Deriving the simple deposit multiplier, II

- Reserves (R) = Required Reserves (RR) + Excess Reserves (ER)

  Assume ER = 0 $\rightarrow$ R = RR

  We also know RR = r D

  $\rightarrow$ R = r D $\rightarrow$ D = (1/r) R

  Taking the change on both sides ΔD = (1/r) ΔR

- Looking at the banking system as a whole

Banking system			
Assets		Liabilities	
Securities	-$100	Checkable deposits	+$1000
Reserves	+$100		
Loans	+$1000		

Additional $100 reserves supports additional $1000 deposits (with ER=0)

Critique of simple model

- Simple model $\rightarrow$ Fed can control D by setting r and R

- But simple model assumes

  - banks never hold excess reserves (ER=0)
  - nonbank public never hold currency (C=0)

- If ER > 0 and/or C > 0 $\rightarrow$ deposits will not increase as much as in simple model

- Fed not the only player, need to account for

  - banks decisions on how much excess reserves to hold

  - depositors decisions on how much currency to hold

Example

- Banks hold excess reserves equal to 5% of checking account deposits
  Individuals hold cash equal to 5% of their deposits

- Go back to previous example: Fed purchases $100 securities from First Bank which proceeds to make a $100 loan to a borrower who uses the loan to make a payment to some other individual

- Show that the next loan cannot be $90

- Individual receiving payment: keeps about $100x(0.05/1.05)=$4.76 in cash and deposits $95.24 in his account at Bank A

Bank A	
Assets	Liabilities
Reserves +$95.24	Checkable deposits +$95.24

- Bank A holds $95.24x10%=$9.524 as required reserves and $95.24x5%=$4.762 as excess reserves
  New loan amounts to $95-$9.524-$4.762 = $80.75

Bank A	
Assets	Liabilities
Excess Reserves +$4.762	Checkable deposits +$95.24
Required reserves +$9.524	
Loans +$80.954	

Money supply and money multiplier

- Link between money supply and monetary base is

$$M = m \times MB$$

  where m is the money multiplier

- Money multiplier indicates how much the money supply changes for a given change in the monetary base and (the subsequent analysis will reveal) it is larger than 1

Deriving the money multiplier

- Define the currency ratio as

    c = C/D = how much currency relative to deposits the nonbank public holds

- Define the excess reserve ratio as

    e = ER/D = how much excess reserves relative to deposits banks hold

- As before, let the required reserve ratio be

    r = RR/D = how much reserves relative to deposits banks are required to hold

Deriving the money multiplier, cont.

- Write the expression for the monetary base

    MB = R + C
           = ER + RR + C
           = e x D + r x D + c x D
           = (e + r + c) x D

- Rearrange to obtain

    D = [1 / (e + r + c)] x MB

    Note if e=c=0 as in the simple model, then D = (1/r) x MB

- Then write the expression for money supply and rearrange

    M = C + D
          = c x D + D
          = (1+ c) x D
          = [(1+c) / (e + r + c)] x MB

Deriving the money multiplier, cont.

- Example

  r = 10%

  C = $400 billion

  D = $800 billion

  ER = $0.8 billion

- We can calculate

  c = C/D = $400/$800 = 0.5 $\rightarrow$ behavior of depositors

  e = ER/D = $0.8/$800 = 0.001 $\rightarrow$ behavior of banks

- Finally we can calculate

$$m = \frac{1+c}{r+e+c} = \frac{1.5}{0.1+0.001+0.5} = 2.5$$
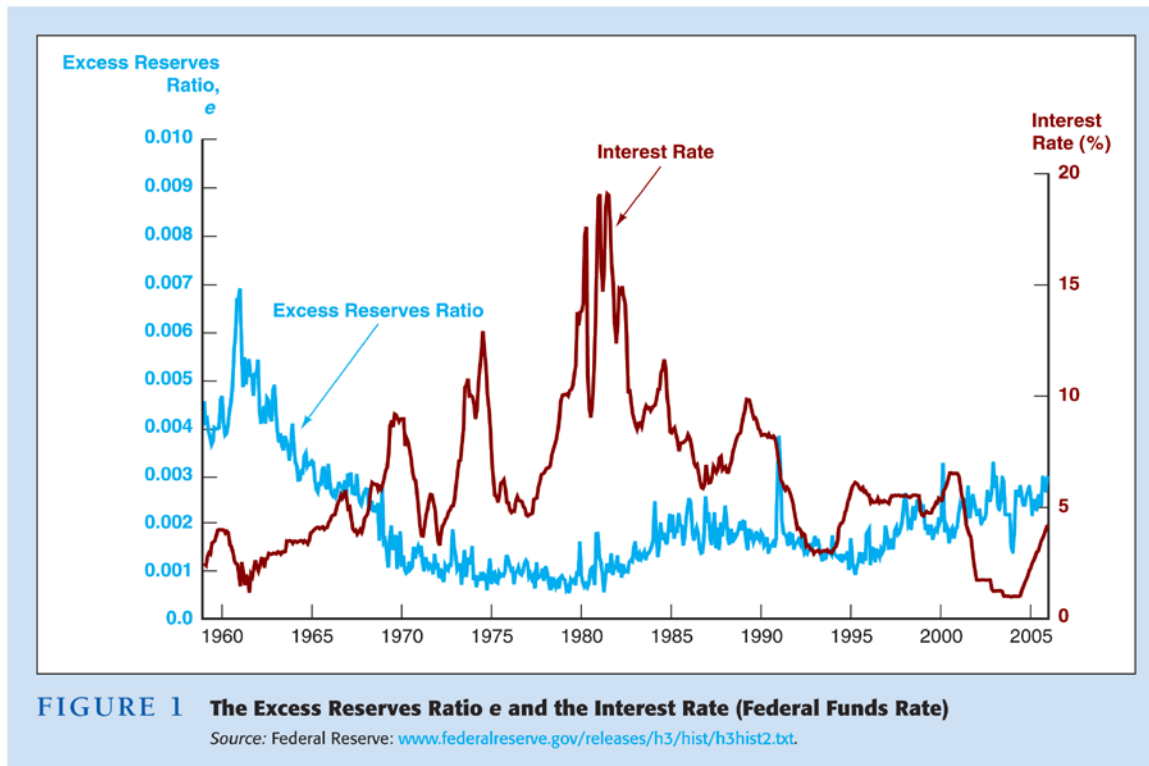
Factors that determine the money multiplier

- The money multiplier is

$$m = \frac{1+c}{r+e+c}$$

- The money multiplier is

  1. negatively related to the required reserve ratio, r
  2. negatively related to the excess reserve ratio, e
  3. negatively related to the currency ratio, c

- We can show that

  money multiplier = (1+c) / (r + e + c) < 1 / r = simple deposit multiplier

- In addition, the excess reserve ratio *e* is negatively related to market interest rates

- Also, the excess reserve ratio *e* is positively related to expected deposits outflows

FIGURE 1 **The Excess Reserves Ratio e and the Interest Rate (Federal Funds Rate)**
Source: Federal Reserve: www.federalreserve.gov/releases/h3/hist/h3hist2.txt.

Additional factors that determine money supply

- Can the Fed tightly control the monetary base MB?

    - Open market operations are controlled by the Fed, but
    - Fed cannot determine the amount of discount loans (borrowing by banks from the Fed), can only influence it by setting the discount rate

- Split the monetary base into two components

    Monetary Base (MB) = Nonborrowed Monetary Base (MB_n) + Borrowed Reserves (BR)

- The money supply is

$$M = m \times MB = m \times (MB_n + BR)$$
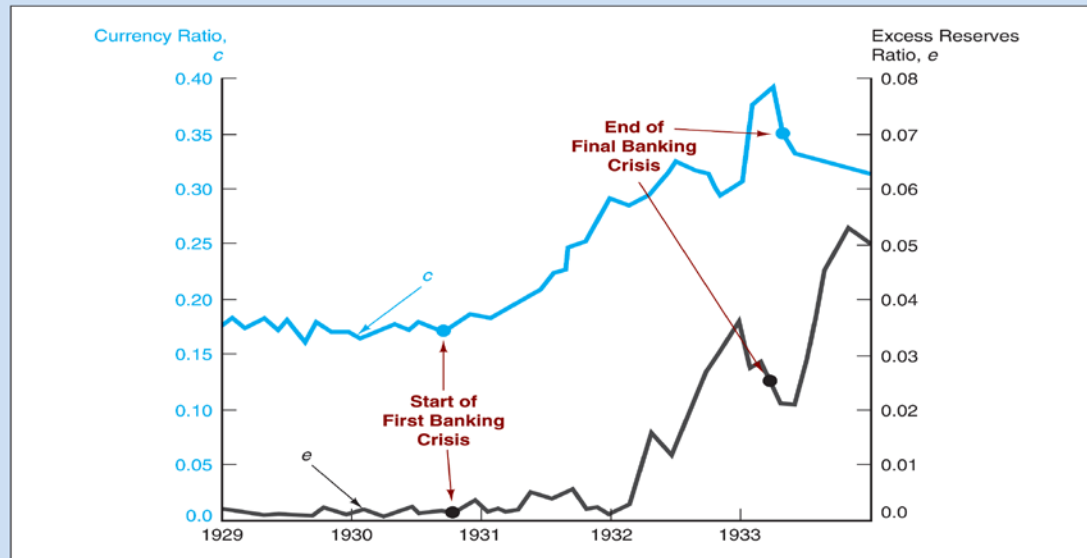
The Great Depression bank panics

Currency Ratio, c

Excess Reserves Ratio, e

End of
Final Banking
Crisis

Start of
First Banking
Crisis

FIGURE 5 **Excess Reserves Ratio and Currency Ratio, 1929–1933**

Sources: Federal Reserve *Bulletin*; Milton Friedman and Anna Jacobson Schwartz, *A Monetary History of the United States, 1867–1960* (Princeton, N.J.: Princeton University Press, 1963), p. 333.
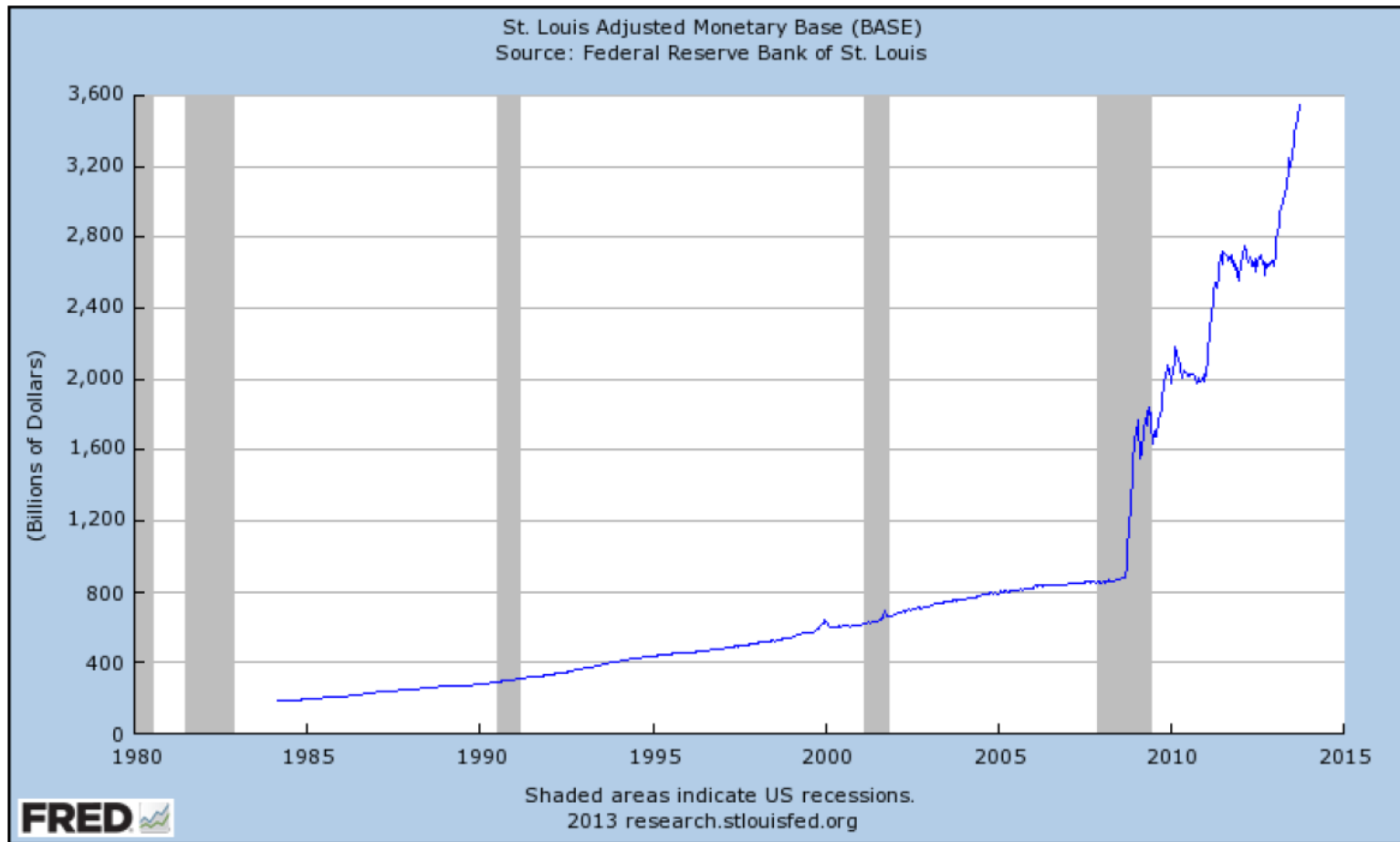
- At that time, no deposit insurance
- With onset of first banking crises, deposit outflows: C↑ and D↓ → c ↑
- Banks protect against deposit outflows: R ↑ relative to D → e ↑

The Great Depression bank panics, cont.

FIGURE 6   **M1 and the Monetary Base, 1929–1933**

Source: Milton Friedman and Anna Jacobson Schwartz, *A Monetary History of the United States, 1867–1960* (Princeton, N.J.: Princeton University Press, 1963), p. 333.
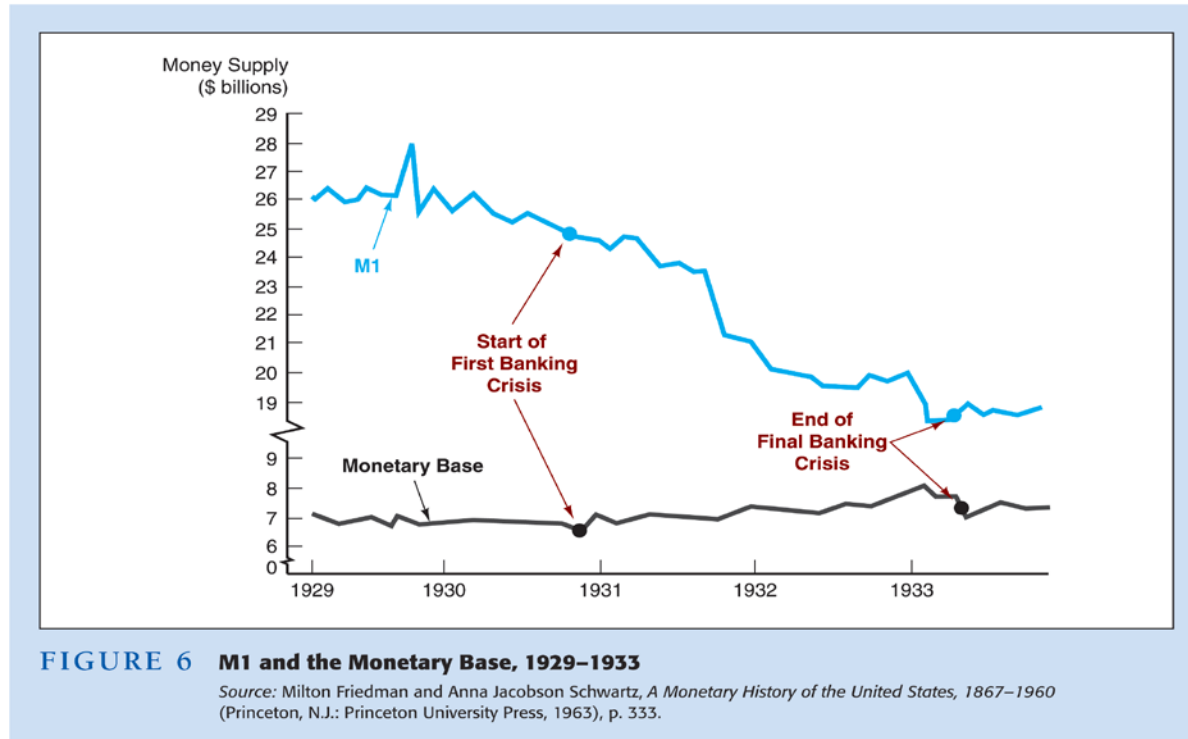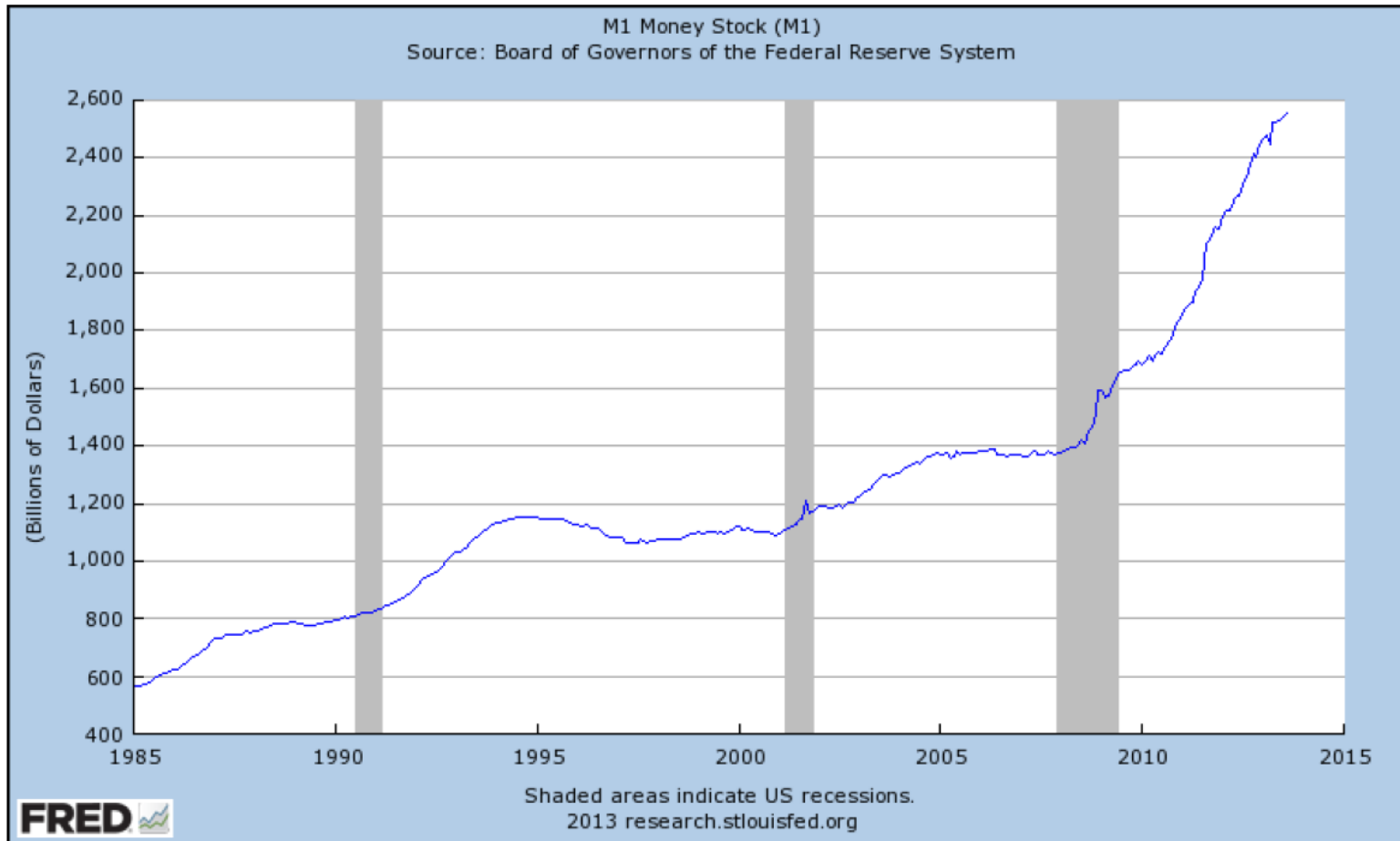
- Between 1930 and 1931 money supply declined by over 25% despite a 20% rise in the monetary base
- Importance of accounting for changes in money multiplier in conducting monetary policy

US monetary base, 1984-2013

US M1 money stock, 1959-2013

M1 Money Stock (M1)
Source: Board of Governors of the Federal Reserve System

Shaded areas indicate US recessions.
2013 research.stlouisfed.org

US M1, MB and components, 2006-2013