

Mishkin ch.14: The Money Supply Process

- Objective: Show *how* the Fed controls stocks of money; focus on M1.
 - Macro theory simply assumes that the Fed can set “M” via open market operations.
 - Point here: control is indirect – relies on assumptions about banks and depositors.
 - Assume “normal” conditions: $i > 0$, no IOR. Later examine crises, era of IOR.
- Focus on M1: **Money = Currency + Deposits** **M1 = C + D**
 1. Show that the Fed can control the monetary base
Monetary Base = Currency + Reserves **MB = C + R**
 2. Derive a **money multiplier** so that
M1 = Multiplier · Monetary Base **M1 = m · MB**
 - Message: Fed can control M1 by controlling MB, though not perfectly.
- Add extensions and prepare for Fed Funds market analysis:
 - Show how the Fed can control balance sheet items other than MB.
 - Introduce distinction between dynamic and defensive open market operations.
 - Derive a money multiplier for M2.
 - Case studies: the Great Depression and the 2007-09 crisis.

Balance Sheet Analysis: Monetary Aggregates at Banks and at the Fed

- Balance Sheet of the Banking System:

Assets	Liabilities
Loans	D Checkable Deposits
Securities	Time Deposits etc.
R Reserves	BR Borrowed Reserves

- Balance Sheet of the Federal Reserve: includes all of MB but only part of M1.

Assets	Liabilities
Securities	C Currency
BR Discount loans	R Bank reserves
Gold	Treasury Dep.
Check Float	Foreign CB Dep.

- **Money stock M1** = Sum of monetary aggregates C+D from both balance sheets.
[Similar for M2. Note that currency includes Treasury coins – small amount ignored to simplify.]
- Monetary base MB = C+R: exclusively on the Fed balance sheet.
- **Linkages:** R = Bank Reserves = Banks' deposits at Fed + Vault cash
BR = Borrowed Reserves = Discount loans from Fed

Open Market Operations (OMO) and the Monetary Base

Examine with numerical examples

Initial Fed Balance Sheet (normal: assets mostly securities; liabilities mostly currency)

Assets		Liabilities	
Securities	99	Currency	90
Discount Loans	1	Reserves	5
		Treasury/CB Dep.	5

⇒ MB = 95

Example 1: Purchase of securities with payment to a bank's reserve account:

Assets		Liabilities	
Securities	+1	Reserves	+1

New Fed Balance Sheet:

Assets		Liabilities	
Securities	100	Currency	90
Discount Loans	1	Reserves	6
		Treasury/CB Dep.	5

⇒ MB = 96

Find: Open market purchases increase the monetary base one-for-one.

Example 2: Sale of securities with payment from a bank's reserve account:

Assets		Liabilities	
Securities	-1	Reserves	-1

New Fed Balance Sheet:

Assets		Liabilities	
Securities	98	Currency	90
Discount Loans	1	Reserves	4
		Treasury/CB Dep.	5

⇒ MB = 94

Find: Open market sales reduce the monetary base one-for-one.

Example 3: Purchase of securities with currency issued to the public

Assets		Liabilities	
Securities	+1	Currency	+1

New Fed Balance Sheet:

Assets		Liabilities	
Securities	100	Currency	91
Discount Loans	1	Reserves	5
		Treasury/CB Dep.	5

⇒ MB = 96

• **Conclude: Open market operations change MB one-for-one**, regardless how the Fed pays for them. (Settlement is almost always with reserves.)

⇒ **Tool for the Fed to change the monetary base – at will and at short notice.**

Open Market Operations and Bank Reserves

Why focus on MB and not bank reserves?

- Open market operations with banks also change R one-for-one.
- Argument for using MB: R changes, when the public demands currency.

Example 4: Bank customers withdraw currency from checking accounts.

Assets	Liabilities	
	Currency	+1
	Reserves (vault cash)	- 1
New Fed Balance Sheet:		
Assets	Liabilities	
Securities	Currency	91 ⇒ MB = 95
Discount Loans	Reserves	4
	Treasury/CB Dep.	5

Find: changes in the composition of money demand (C vs. D within M1) have no effect on the monetary base.

- Counterargument: R is also controllable because the Fed can monitor currency withdrawals and execute offsetting open market operations immediately.
 - Analysis of the Fed funds market commonly assumes the Fed can control R

Discount Loans: An instructive complication

Example 5: Bank takes out a discount loan. (Note: Loans require Fed approval, but approval is routine, so bank effectively determine BR.)

Assets	Liabilities
Discount Loans +1	Reserves +1

New Fed Balance Sheet:

Assets	Liabilities
Securities 99	Currency 90
Discount Loans 2	Reserves 6 \Rightarrow MB = 96
	Treasury/CB Dep. 5

Find: Discount loans increase the monetary base one-for-one.

- How can the Fed avoid losing control over MB?
 - Answer: quickly do offsetting OMO; works because Fed knows BR.
 - Here: if MB target is 95 and BR increases, do open market sale \Rightarrow MB=95.
- Distinction: Defensive versus Dynamic open market operations
 - Dynamic = intended to change a variable targeted by monetary policy
 - Defensive = intended to prevent or offset a change in a targeted variable

Non-Borrowed MB and Non-Borrowed Reserves

- Standard way of handling discount loans:
 - Assume BR is controlled by banks, so changes in BR require defensive open market operation to control MB.
 - Define: $MB_n = MB - BR = \text{non-borrowed monetary base}$.
 - Note in the Example: $MB_n = 94$ remains unchanged. Suggests that MB_n is easier to control than MB => Approach in Mishkin:
 - Write $MB = MB_n + BR$. Treat MB_n as completely under Fed control
- Analogous approach will be used in the Fed funds market:
 - Define: $NBR = R - BR = \text{non-borrowed reserves}$.
 - In Example 5: as BR changes, $NBR = 4$ remains unchanged
 - In Example 4: currency outflow reduces R and NBR. Again, Fed can control NBR using defensive open market operations.
- General insight: **Defensive open market operations can be used to control any single variable that (a) responds to OMOs and (b) the Fed can observe.**
 - Caveat: controlling one variable means giving up control of others.

The Multiplier Idea

- Motivation: Fed cannot directly control M1. Bank deposit volume depends on bank customers' decisions how to allocate their wealth.
- Fed has authority to impose reserve requirements on checkable deposits:
 - Reserve ratio = rr . (Fed policy since 1990s: $rr = 10\%$.)
$$\text{Reserves} \geq rr \cdot \text{Deposits} \qquad R \geq rr \cdot D$$
$$\Rightarrow \text{Deposits} \leq (1/rr) \cdot \text{Reserves} \qquad D \leq (1/rr) \cdot R$$
 - Find: Reserve requirements impose an upper bound on deposit volume.
- Complications:
 - What if $R > rr \cdot D$? Define $RR = rr \cdot D$, $ER = R - RR$. Argue that excess reserves are costly under normal conditions ($i > i_{or}$), hence small.
 - Currency: if $C/M1$ is small, then $M1 \approx D$ and $MB \approx R$, so $M1/MB \approx D/R \approx 1/rr$;
if $D/M1$ is small, then $M1 \approx C$ and $MB \approx C$, so $M1/MB \approx 1$.
 - Find: For given MB, M1 depends on how money demand divides into C and D. Upper bound on D/R implies an upper bound on $M1/MB$.
- Systematic approach: find conditions for $M1/MB = m$ to be constant.
Start with simple case, then generalize.

The Deposit Multiplier

- Simple math combining definitions and assumptions:
 - Definition of required reserves: $RR = rr \cdot D$
 - Assumption of no excess reserves: $ER = 0$ (assuming $i > 0$)
 - Definition of total reserves: $R = RR + ER$
 - \Rightarrow $R = rr \cdot D$ (with equality, not \geq)
 - \Rightarrow Invert: $D = (1/rr) \cdot R$
- Define: Deposit multiplier = $1/rr$
 - If $rr = 10\%$: Deposit multiplier = 10
- Key assumption: No excess reserves \Rightarrow When Fed increases R , banks will create deposits whenever they can: $\Delta D = (1/rr) \cdot \Delta R$
- Caveats:
 - Banking system vs single bank: Textbook argument that a single bank is limited to own excess reserves, not a multiple. Outdated: Banks can borrow Fed Funds.
 - Don't confuse the deposit multiplier with the general money multiplier (next). Money includes currency: Different answers if customers withdraw currency.

The M1 Money Multiplier

- Include currency and non-zero excess reserves in a simple way. Define:

$$c = C/D = \text{Currency-deposit ratio}$$

$$e = ER/D = \text{Excess reserves-deposit ratio}$$

- Assume both ratios are constant.

- Step 1: Reserves are a fixed fraction of deposits:

- Definition of total reserves: $R = RR + ER$

- Definition of required reserves: $RR = rr \cdot D$

- Assumption about excess reserves: $ER = e \cdot D$

$$\Rightarrow R = rr \cdot D + e \cdot D = (rr+e) \cdot D$$

- Step 2: Monetary base is a fixed fraction of deposits:

- Definition of monetary base: $MB = R + C$

- Assumption about currency: $C = c \cdot D$

- Know reserve-deposit relation: $MB = (rr+e+c) \cdot D$

$$\Rightarrow \text{Invert: } D = MB/(rr+e+c)$$

- Step 3: M1 is currency plus checkable deposits:

$$M1 = C + D = (1+c) \cdot D = (1+c)/(rr+e+c) \cdot MB$$

- Result: The M1 money multiplier

$$m = (1+c)/(rr+e+c)$$

- Economic reasoning:

1. If the Fed increases reserves, banks seek to expand deposits until
 - Bank customers withdraw currency (c)
 - Reserves are tied down as required reserves (rr)
 - Reserves are held as targeted excess reserves (e)
2. Extension of deposit multiplied: $m = \text{Ratio of } M = D + C \text{ to } MB = R + C$.
 - Ratio of D to R is $1/(rr+e) \sim 10$, provided e is small. Ratio of C to C is 1.
 - => Ratio of M to MB is normally between 1 and 10.
3. All quantities are proportional to D, hence proportional to each other.

The M2 Money Multiplier

- Same idea with more components – practically relevant.
- Use same approach as for M1. See Mishkin’s online appendix 14#2
 - Simplified definition:

$$M2 = D + C + T + MMF$$

where $T = \text{time and savings deposits} = t \cdot D$

$MMF = \text{money market funds etc.} = mm \cdot D$

$$\Rightarrow m_2 = (1+c+t+mm)/(r+e+c)$$

- Find: If m_2 is constant, $\Delta M2 = m_2 \cdot \Delta MB$, is controllable by the Fed.
- Conclude: Multiplier idea works for any concept of money, if bank and customer behavior is stable – if “everything is proportional to D” applies.

- Applications will focus on M1 to avoid duplication
- Summary: TABLE 1 of Ch.14 ...

Summary: Determinants of the M1 Money Supply

Money Supply Response				
Player	Variable	Change in Variable	Money Supply Response	Reason
Federal Reserve System	Nonborrowed monetary base, MB_n	↑	↑	More <i>MB</i> for deposit creation
	Required reserve ratio, rr	↑	↓	Less multiple deposit expansion
Banks	Borrowed reserves, BR	↑	↑	More <i>MB</i> 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.

Applications of Multiplier Analysis

- Clarify the *objective*: Control M1. If m is constant, open market operations should translate into predictable, proportional changes in M1:

$$\Delta M1 = m \cdot \Delta MB$$

where $m = (1+c)/(rr+e+c)$ and $\Delta MB = \Delta MB_n + \Delta BR$

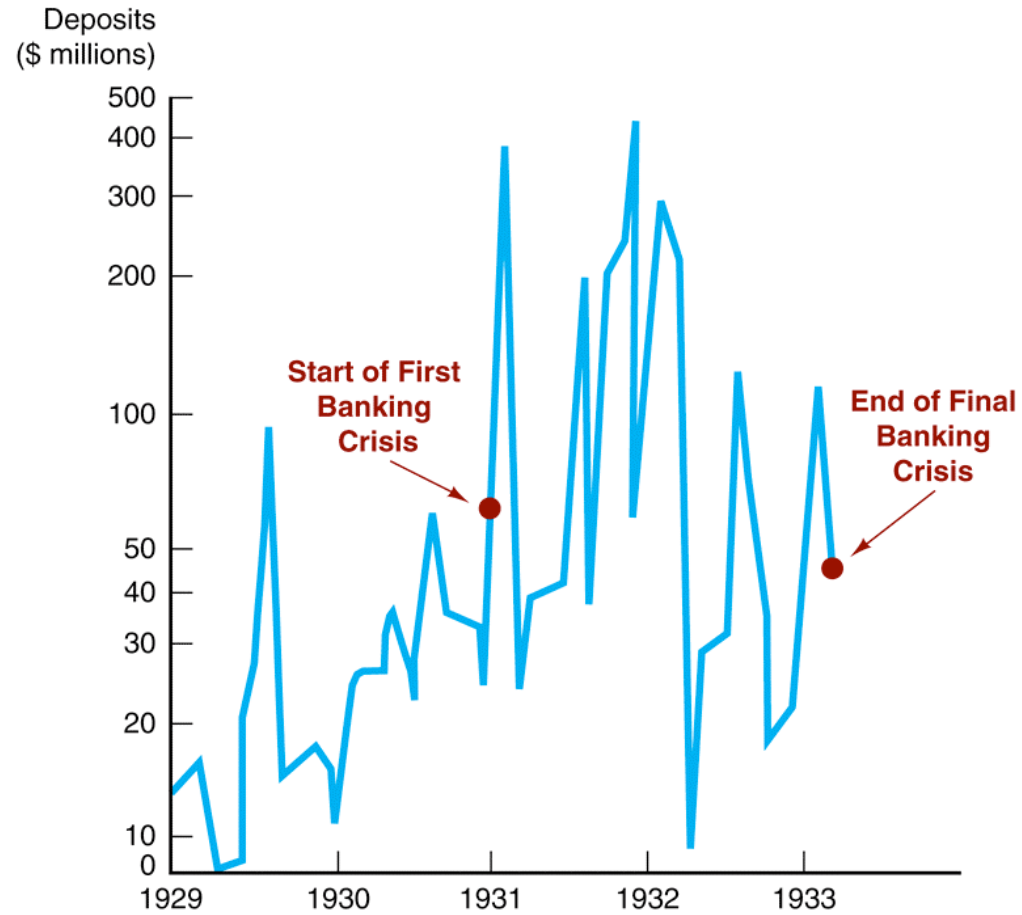
- Fact: M1 also changes when m or BR change. These are *complications*.

Money Multiplier Example #1: Normal Conditions (2007)

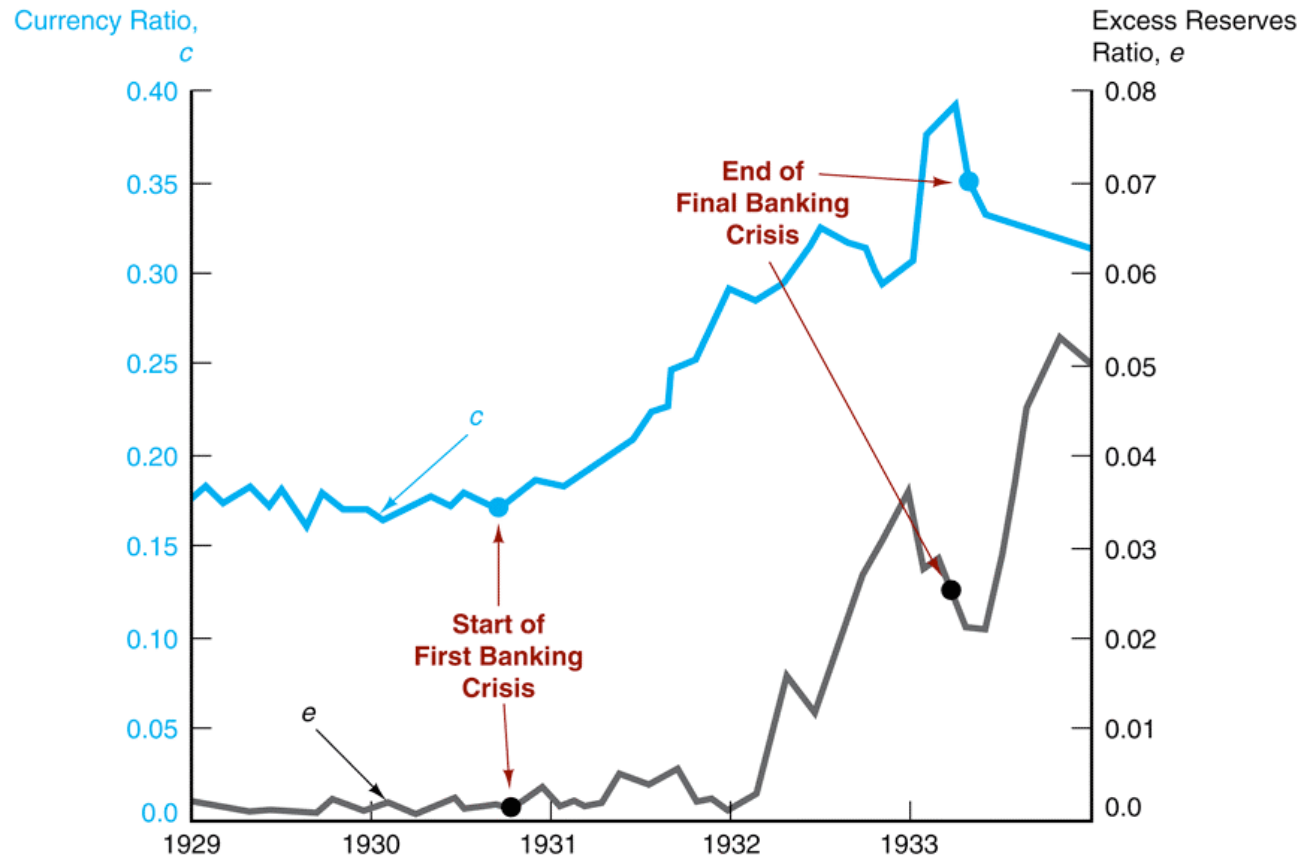
- Data (\$bill): $C=760$, $D = 620$, $R = 64.5$, $BR=0.1$ all in
 - Implies: $M1 = 1380$, $MB = 824.5$, $MB_n = 824.4$, $NBR = 64.4$, $RR=62$, $ER=2.5$
 - Ratios: $c = 760/620 = 1.2258$, $e = 0.0040$, $rr = 0.10$.
- Multiplier: $m = \frac{1+c}{rr+e+c} = \frac{1+1.2258}{0.1+0.004+1.2258} = \frac{2.2258}{1.3298} = 1.6738$
 - Verify: $M1 = 1.6738 \cdot 824.5 = 1380$
 - Lesson: \$1 open market purchase/sale should raise/reduce M1 by \$1.67.

Case Study #1: The Great Depression

Series of Bank Runs

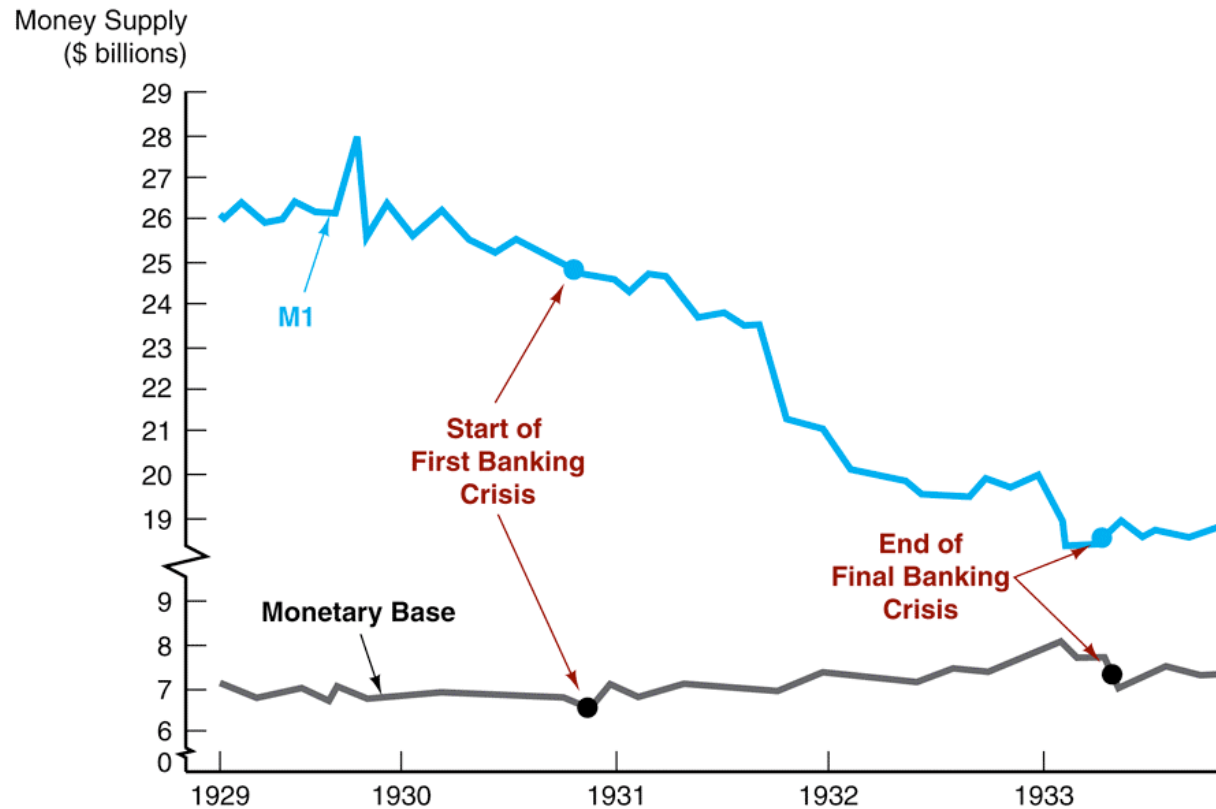


Currency and Excess Reserve Ratios



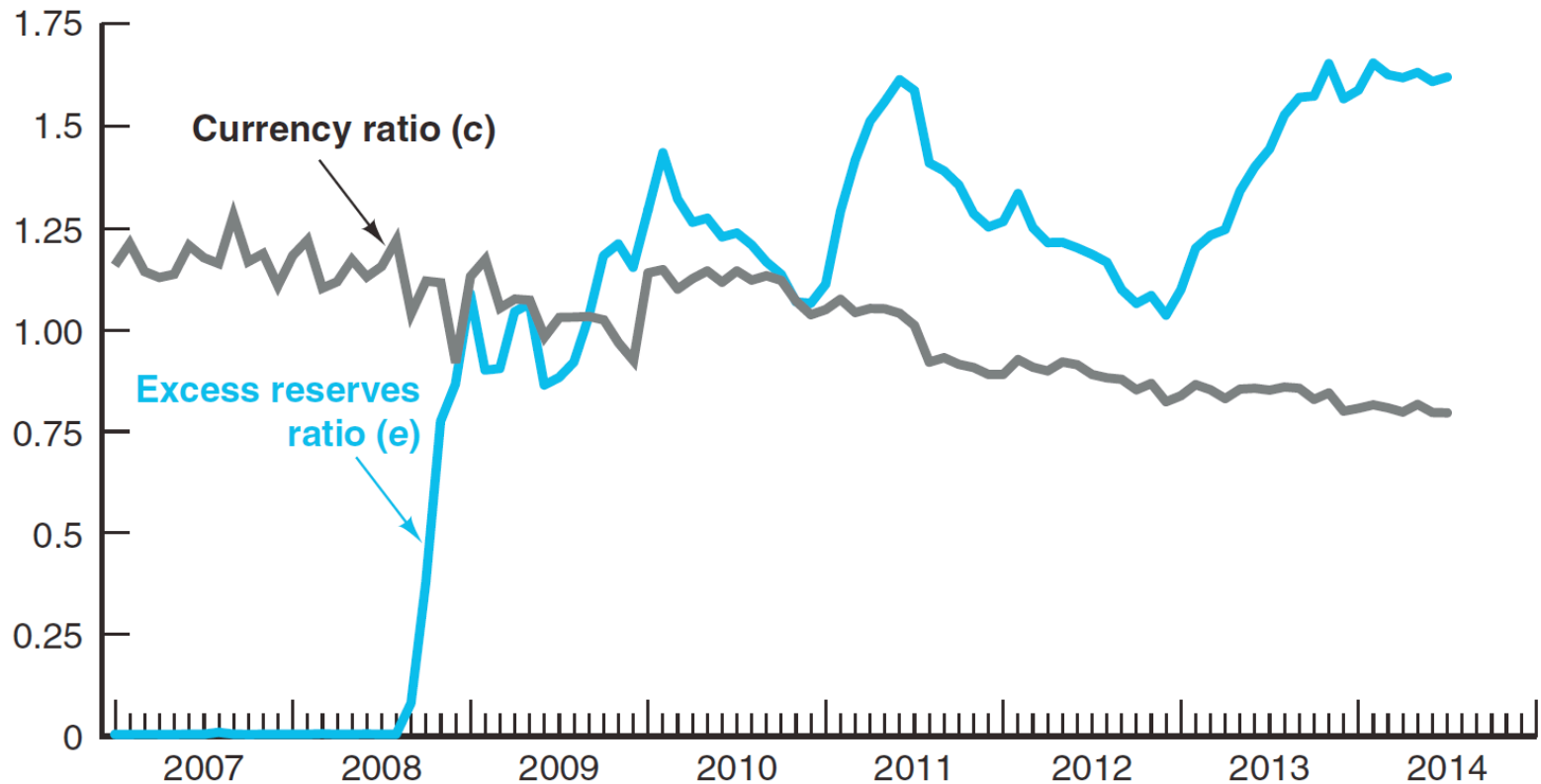
[Note on 2008: Rise in e but stable c . FDIC has prevented bank runs!]

Money and the Monetary Base



- Conclusion by Milton Friedman and Anna Schwartz: The Fed should have stabilized M1. Policy mistake made the Great Depression worse.
- General lesson: The money stock must be monitored in problem situations, e.g., during financial crises; also, in financially unstable countries.

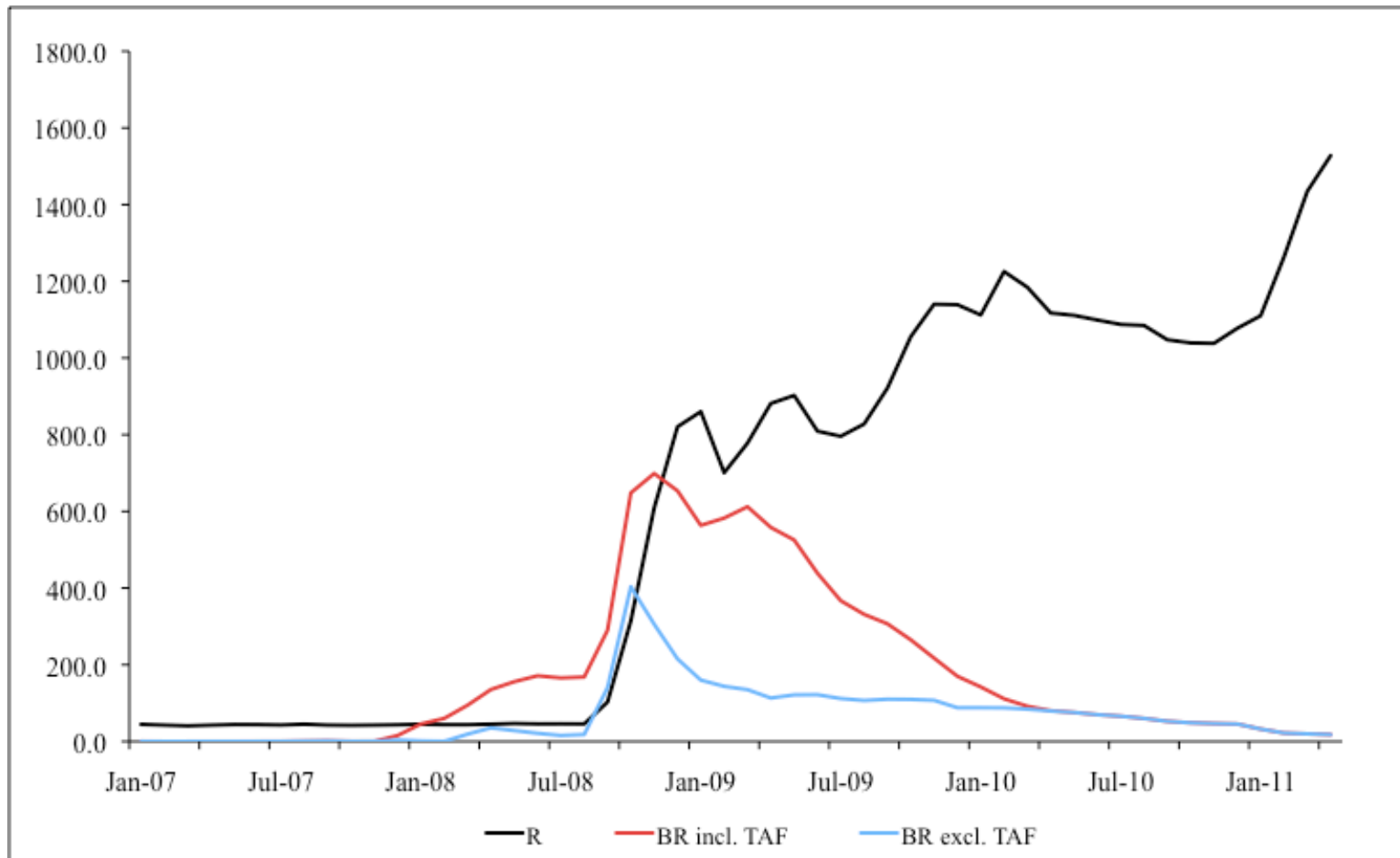
Case Study #2: The Financial Crisis of 2007-2009



- No shift to currency (Difference to Great Depression: FDIC insurance.)
- Huge increase in excess reserves => Money multiplier declines.

Emergency Lending and Quantitative Easing

- Fed Response: Discount loans (BR \uparrow), special term auction facility (TAF), emergency loans to non-banks; then open market purchases (Quantitative Easing, NBR \uparrow)



Policy Responses to the Financial Crisis

- Federal Reserve liquidity programs (2007-early 2009)

Term Auction Facility (TAF) – December 2007. 28-day discount loans.

Emergency lending to non-banks – to Primary Dealers – March 2008, to Commercial Paper and Money Markets Mutual funds – Sept. 2008.

- Support for specific institutions (Treasury, Federal Reserve, & FDIC)

Bear Stearns (Mar.08); AIG (Sept.08); Citigroup (Nov. 08); Bank of America (Jan.09)

- Expansionary Open Market Operations; a.k.a. Quantitative Easing (QE)

- Buying MBS and Treasury securities (2009-11).

- Focus on troubled market segments a.k.a “Credit Easing”

- Extending maturities from short to long – “Operation Twist” (2011-12)

Supplemented by “forward guidance” – stated intent to keep Fed funds rate low for an extended time => reducing long-term rates through term structure logic

- Additional rounds of QE until Nov. 2014. Result: Massive expansion of Fed assets, massive expansion of MB, banks holding enormous excess reserves.

The Federal Reserve Balance Sheet: Credit

Federal Reserve Assets (\$bill.)	Jul-2007	Dec-2007	Jun-2008	Dec-2008	Dec-2009
Treasury Bills	277.0	227.8	21.7	18.4	18.4
Treasury Bonds&Notes	513.5	512.8	457.1	457.5	* 758.2
MBS & Agency Debt *				20.3	* 1069.5
Repurchase Agreements	27.2	39.8	110.3	80.0	0.0
TAF credit		40.0	150.0	450.2	75.9
Discount loans	0.2	5.8	15.0	86.6	19.7
Other loans (PD, AIG, TSLF)			1.7	101.2	68.4
Commercial Paper Funding				332.4	14.1
Maiden Lane I-III			29.8	75.0	90.1
Central Bank Swaps		24.0	62.0	553.2	10.3
Other assets (incl. Float)	39.4	41.6	42.3	71.7	95.4
Total Reserve Bank Credit	857.3	891.7	890.0	2246.5	2219.9
Summary:					
<u>Securities: Treasury</u>	817.7	780.4	589.1	556.0	776.6
New: MBS etc.				20.3	1069.5
<u>Discount Lending: regular...</u>	0.2	5.8	15.0	86.6	19.7
New: TAF & CB swaps		64.0	212.0	1003.4	86.2
New: Loans to Non-banks			31.5	508.6	172.6
Memo: Fed Funds Rate	5.25%	4.25%	2.00%	0.16%	0-0.25%
* Exceptional Lending	Pre-crisis	Discount	Loans up,	Loans UP,	Start of QE
* Quantitative Easing (QE)		loans up	T-bills down	Total UP	

Money Multiplier Example #2 (Spring 2009, Peak of Crisis)

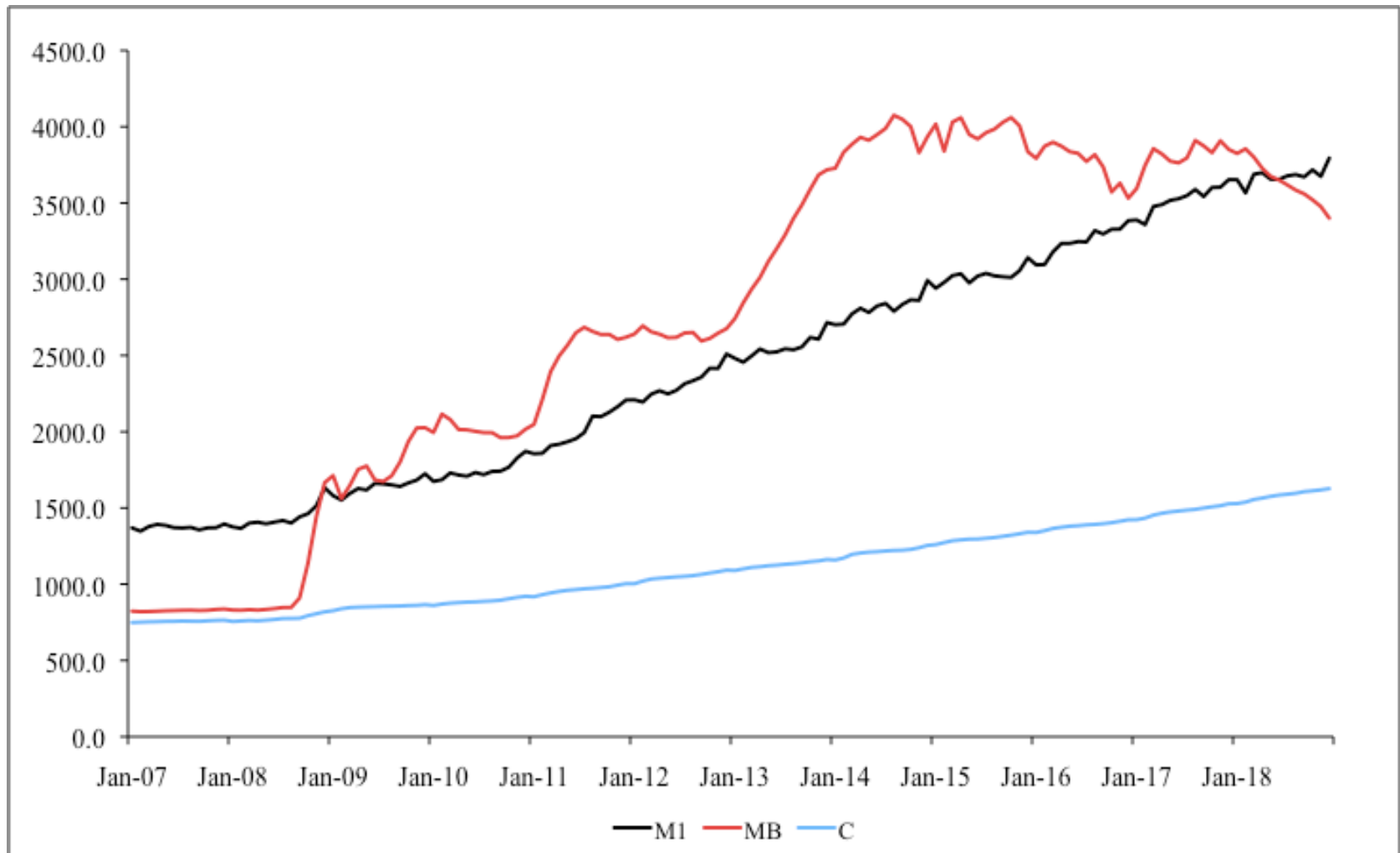
- Data: $C=860$, $D = 740$, $R = 765$, $BR = 404$ (Sign of crisis: $BR \gg 0$)
 - Implies: $M1 = 1600$, $MB = 1625$, $MB_n = 1221$, $NBR = 361$, $RR=74$, $ER=691$
 - Ratios: $c = 860/740 = 1.1622$, $e = 0.9338$, $rr = 0.10$.
- Multiplier: $m = \frac{1+c}{rr+e+c} = \frac{1+1.1622}{0.1+0.9338+1.1622} = \frac{2.1622}{2.196} = 0.9846$
 - Verify: $M1 = 0.9846 \cdot 1625 = 1600$.
- Compare to $M1=1380$ in 2007: **In contrast to the Great Depression, Fed did not allow M1 to decline, and instead increased R to offset the decline in m.**
- Question 1: **What if the Fed had refused to ease?** Example: keep $MB=880$ as in 2007
 $\Rightarrow M1 = 0.9846 \cdot 880 = 866$. Suggests reduction in $M1 \Rightarrow$ deflation.
- Question 2: **Should one worry about the growth in MB causing inflation?**
 - Concerns: If banks resume lending, e returns to normal, $M1$ would rise sharply.
Math: if $e \downarrow 0$, $m = \frac{1+c}{rr+e+c} = \frac{1+1.1622}{0.1+0+1.1622} = 1.713$, so $M1 = 1.713 \cdot 1625 = 2874$.
 - Counterargument: if $e \downarrow 0$, Fed could stop lending, so $BR \downarrow 0$, which would quickly reduce MB to $MB \downarrow MB_n = 1221$, so $M1 = 1.713 \cdot 1221 = 2165$.
 - Lesson: MB -expansion through discount loans can be reversed quickly, mitigates concerns about inflation.

Money Multiplier Example #3 (Fall 2010, Recovery)

- Data: $C=910, D = 850, R = 1060, BR = 70$ (Era of QE; reduced BR)
 - Implies: $M1 = 1760, MB = 1970, MB_n= 1900, NBR= 990, RR=85, ER=975$
 - Ratios: $c = 910/850 = 1.0706, e = 1.1471, rr = 0.10.$
- Multiplier: $m = \frac{1+c}{rr+e+c} = \frac{1+1.0706}{0.1+1.1471+1.0706} = \frac{2.0706}{2.3177} = 0.8934.$
- Questions:
 1. **Should one worry about growth in MB causing inflation?**
Math: If $e \downarrow 0, m = \frac{1+c}{r+e+c} = \frac{1+1.1471}{0.1+1.1471} = 1.66,$ and then $M1 = 1.66 \cdot 1970 = 3270.$
=> Potential for money growth. Consistent with QE goal to increase expected inflation.
 2. **Could an increase in M1 be reversed by reduced discount loans?** No, BR is small.
If $BR \downarrow 0$ and $e = 0, MB = MB_n= 1900$ and $M1 = 1.66 \cdot 1900 = 3154.$
Getting to $M1 \sim 1760$ would require huge contractionary open market operations.
 3. **Can the Fed still control M1?** Questionable!
 - If \$1 open market sale would reduce M1 by \$0.89. Banks could reduce ER instead, so $m \uparrow.$ Need to reconsider how M1 is determined.

Legacy of Quantitative Easing: Excess Reserves

(2009-2018: Reserves > Deposits. Multiplier < 1)



Money Multiplier Example #4 (Spring 2019, Era of Ample Reserves)

- Data: $C=1650, D = 2170, R = 1640, BR = 30.$
 - Implies: $M1 = 3820, MB = 3290, MB_n=3260, NBR=1610, RR=217, ER=1423$
 - Ratios: $c = 1650/2170 = 0.7604, e = 0.6558, rr = 0.10.$
- Multiplier: $m = \frac{1+c}{rr+e+c} = \frac{1+0.7604}{0.1+0.6558+0.7604} = \frac{1.7604}{1.5162} = 1.1612.$

- Observe: return to $m > 1$, but at a high level of excess reserves. Questions:
 1. To what extent are excess reserves held to support deposit taking?
 - Alternative: Reserve holdings to earn IOR = for investment purposes.
 2. What open market sales would eliminate excess reserves motivated by IOR?
 - Define e_D = excess reserves ratio desired for deposit taking.
 - If $e_D=0$, then open market sales would reduce ER to zero.
Math: $e=0 \Rightarrow m = \frac{1+c}{r+c} = \frac{1+0.7604}{0.1+0.7604} = 2.04.$ Need only $R = 217$ for $M1 = 3820.$
 \Rightarrow Fed could reduce securities holdings by $\sim \$1400$ billion.
 - Problem: if $e_D > 0$, $m < 2.04$. Then reduced securities holdings would reduce M1.
 3. How can the Fed control M1? If not by OMO, then how?
 - Answer: via interest rates - to be examined. Next: Fed funds market.