The Monetary System and the Fed's Policy Rule

A monetary system is an arrangement through which people express economic values and carry out transactions with each other.

The Basics of Money

A. Functions of Money

1. Medium of Exchange

   a. Money is any item that is universally accepted as a means of payment.

   b. Examples throughout history

      i. In early times, gold and/or silver was the accepted means of payment.

      ii. In the 1800s in the U.S., banknotes (since outlawed) were the medium of exchange.

iii. Now, Federal Reserve notes and coins are the accepted medium of exchange in the U.S.

2. Unit of account
    a. Money serves as a common unit to measure the value of goods and services.
    b. Ex. the U.S. dollar is the unit of account in the U.S. and the Euro is the unit of account in the European Union.
3. Store of value
    a. Money is an asset that people use to store their wealth.
    b. People prefer to hold their wealth in currencies that they believe will not fall in value.

B. Definitions of money

1. Currency (CU) = paper money + coins
2. Total reserves (TR) = bank deposits held at the Fed + vault cash
3. Monetary base (M^B) = CU + TR
4. Money supply (M^S) = CU + checking deposits (ChD) [Our definition for this class.]
5. Monetary aggregates
   a. M_1 = Currency + checking deposits + savings accounts
   b. M_2 = M_1 + small time deposits (CDs) + money market mutual funds

How the Fed Adjusts the Money Supply by Changing Reserves

A. Details about the Monetary Base (M^B)

1. Total reserves (TR) equal the reserves-to-deposits ratio (rr) multiplied by checking deposits:

$$TR = rr \times ChD. \tag{1}$$

2. Currency held outside of banks equals the currency-to-deposit ratio (c = CU/ChD) multiplied by checking deposits:

$$CU = c \times ChD. \tag{2}$$

3. Substitute (1) and (2) into the equation for the monetary base to get:

$$M^B = CU + TR$$

$$M^B = c \times ChD + rr \times ChD$$

$$M^B = (c + rr) \times ChD. \tag{3}$$

B. Balance sheet items

1. Gold
2. Currency (CU)
3. Checking deposits (ChD)
4. Government bonds (B)
5. Reserves (TR)
6. Loans (L)

C. Balance sheets for three different sectors in the economy

1. The Fed's balance sheet

Assets	Liabilities
Bonds	Currency
Gold	Reserves

2. Banks' balance sheet

Assets	Liabilities
Bonds	Checking deposits
Reserves	
Loans	

3. Individuals' and firms' balance sheets

Assets	Liabilities
Bonds	Loans
Currency	
Checking deposits	

D. The balance sheet impact of an increase in the money supply. (Ex. M^B increases by $100)

1. The Fed increases the monetary base (i.e., reserves) by buying bonds from Bank A.

The Fed's balance sheet

Assets		Liabilities	
Bonds	+$100	Reserves	+$100

Bank A's balance sheet

Assets		Liabilities	
Bonds	–$100		
Reserves	+$100		

2. Bank A makes a loan to Consumer 1 with the additional reserves.

Bank A's balance sheet

Assets		Liabilities
Loans	+$100	
Reserves	–$100	

3. Consumer 1 buys something from Firm 1. Firm 1 deposits a percentage of its revenue, 1/(1+c), into a checking account at Bank B and keeps the remaining percentage, c/(1+c), as cash. (Suppose c = 0.25)

Bank B's balance sheet

Assets		Liabilities	
Reserves	+$80	Check. Dpts.	+$80

4. Bank B holds a fraction of the checking deposit increase as reserves, so it only lends out (1 – rr)% of the deposit to Consumer 2. (Suppose rr = 15%)

Bank B's balance sheet

Assets		Liabilities
Reserves	–\$68	
Loans	+\$68	

5. This process continues until reserve requirements and people's cash demands completely use up the additional reserves injected by the Fed.

E. Deriving the relationship between the money supply (M^S) and the monetary base (M^B)

1. Recall our equations for TR and CU are

$$TR = rr \times ChD \quad (1)$$

$$CU = c \times ChD \quad (2)$$

2. If we substitute (1) into the M^S equation, we get

$$M^S = CU + ChD = (1 + c) \times ChD \quad (3)$$

3. If we substitute (1) and (2) into the M^B equation, we get

$$M^B = TR + CU = (rr + c) \times ChD. \quad (4)$$

4. By dividing (3) by (4), we get

$$\frac{M^S}{M^B} = \frac{(1+c) \times ChD}{(rr+c) \times ChD} = \frac{1+c}{rr+c} \quad (5)$$

5. By simplifying (5), we get the equation for the money multiplier:

$$M^S = \left(\frac{1+c}{c+rr}\right) \times M^B$$

6. The money multiplier effect gets smaller as c and rr rise.

7. Example

   Suppose c = 0.25 and rr = 0.15. If the Fed increases M^B by \$100, then how much does the money supply increase (M^S)?

   According the money multiplier:

$$\Delta M^S = [(1 + c)/(rr + c)] \times \Delta M^B$$
$$\Delta M^S = [(1 + 0.25)/(0.15 + 0.25)] \times 100$$
$$\Delta M^S = 3.125 \times 100$$
$$\Delta M^S = \$312.5$$

The Fed’s tools to conduct monetary policy.

A. Open-market operations (The Fed’s main policy tool.)

   1. Open-market sale

      a. The Fed sells bonds for reserves.

      b. This action reduces the money supply.

   2. Open-market purchase

      a. The Fed buys bonds for reserves.

      b. This action increases the money supply.

B. Discount rate

   1. The Fed charges this interest rate on loans made to banks.

   2. Higher rates discourage borrowing and lower the money supply.

   3. This is an imperfect tool for monetary policy.

C. Interest rate on reserves

1. In 2008, federal legislation gave the Fed the authority to pay interest on reserves.
2. The Fed usually sets the interest rate on reserves at or above the overnight interest rate (federal funds rate), so banks have an incentive to hold excess reserves.
3. Since 2008, the Fed has used excess reserves to fund its purchases of long-term bonds/mortgage-backed securities.

Banks and the Market for Reserves

A. The amount of reserves in the banking system is called total reserves.

B. Banks that do not have a sufficient amount of reserves can acquire additional reserves in two ways.

   1. Banks can borrow reserves from other banks that have excess reserves in the federal funds market.

      a. The federal funds rate is the interest rate that one bank charges another for borrowing reserves.

      b. This is the primary place banks go to acquire reserves.

2. Banks can also borrow reserves directly from the Fed at the discount window.

   a. The discount rate is the interest rate that the Fed charges banks for borrowing reserves.

   b. Reserves borrowed directly from the Fed at the discount window are called borrowed reserves.

   c. All the remaining reserves are called nonborrowed reserves. Thus, borrowed reserves + nonborrowed reserves = total reserves.

   d. The discount rate is almost always equal to or greater than the federal funds rate.

   e. Restrictive regulations on the use of borrowed reserves strongly discourage banks from going to the discount window.

The Demand for Money

A. What is the opportunity cost (OC_M) of holding money?

1. The interest rate, R, is the return on bonds that people forgo when they hold their assets as money instead of bonds.

2. The own rate on money, R_M, is the interest rate earned from holding assets as money.

3. R_M can be above zero for checking deposits but is always zero for currency.

4. The opportunity cost of holding money (OC_M) equals

$$OC_M = R - R_M.$$

5. Ex. Suppose R = 7% and R_M = 2%.

$$OC_M = 7 - 2 = 5\%.$$

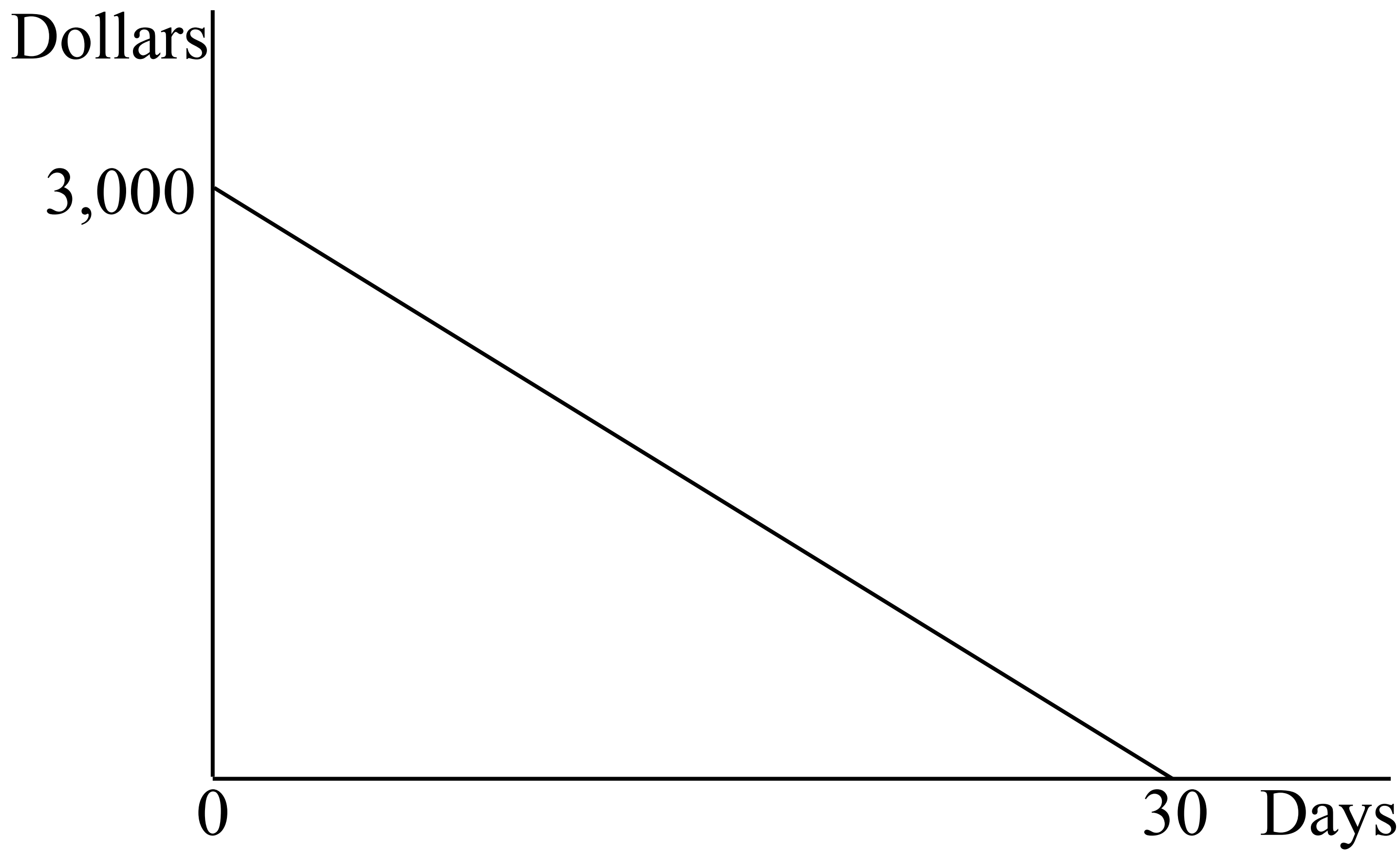
6. As the opportunity cost of money rises, the demand for money falls.

B. The transactions demand for money: an inventory approach

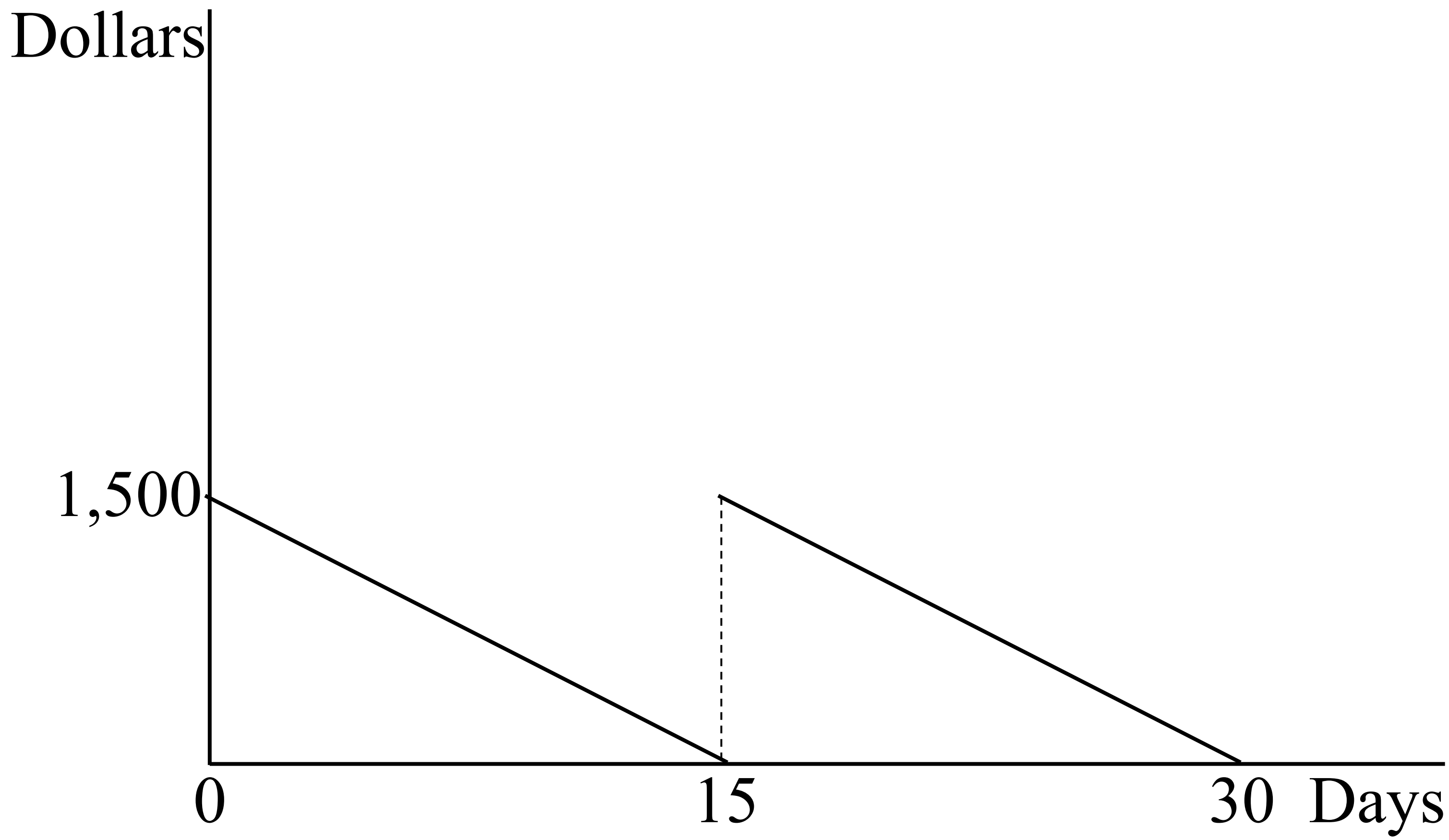
1. People earn and spend Y_M every month. The income is received at the start of each month, but spending occurs in equal amounts every day over the month. Thus, it is necessary for households to hold a stock of currency.

2. Consider the following example: Monthly earnings (Y_M) are $3,000 and expenses are $100 a day.

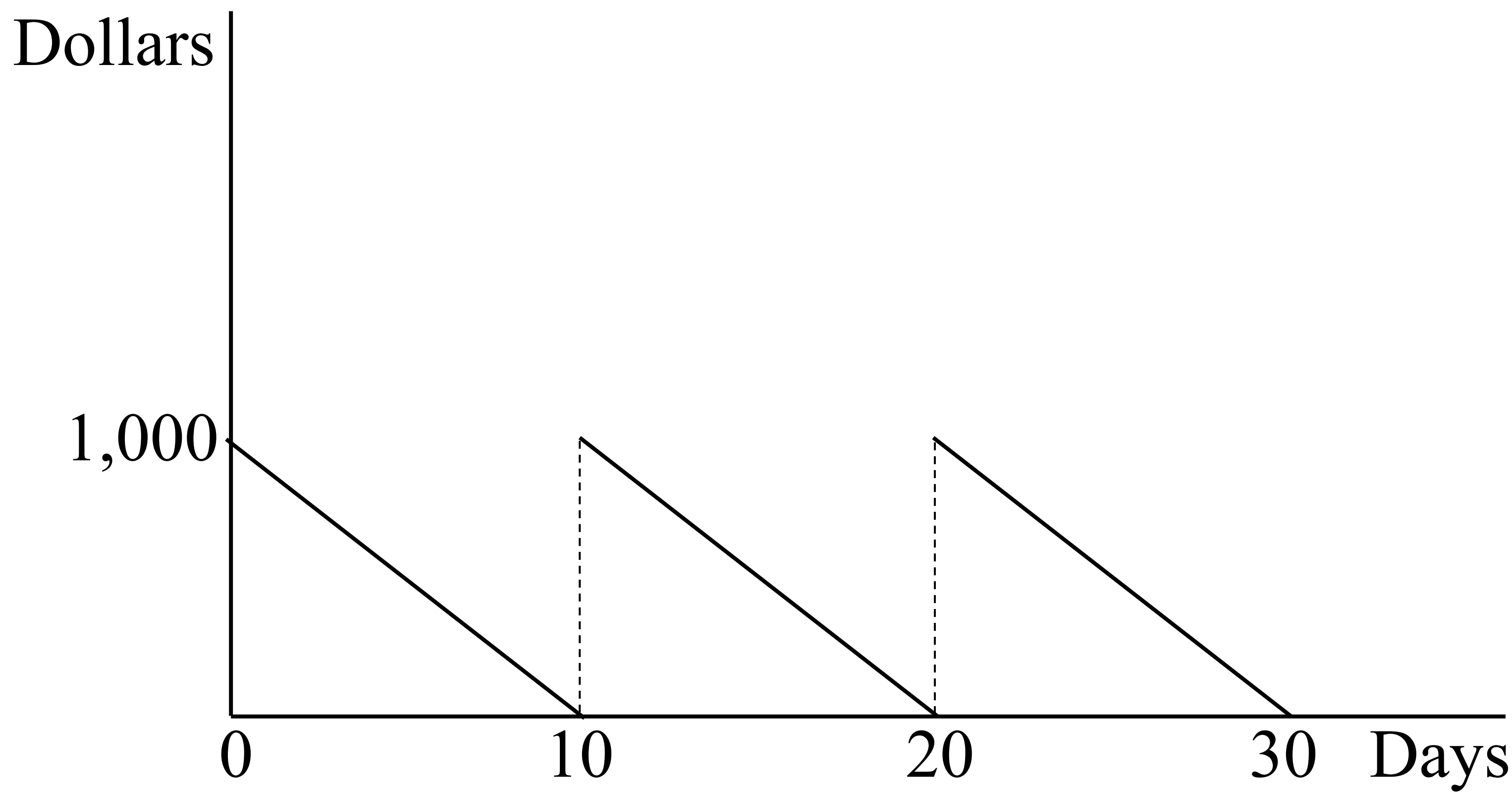
a. If all \$3,000 (Y_M) is deposited in one's checking account, then the average monthly money balances ($M = Y_M/2$) are \$1,500. (one transfer)



b. If \$1,500 ($Y_M/2$) is deposited in one's checking account and \$1,500 ($Y_M/2$) is deposited in interest-bearing assets, then those remaining balances will be transferred to one's checking account in the middle of the month. Thus, the average monthly money balance ($M = Y_M/4$) is \$750. (two transfers)



c. If \$1,000 ($Y_M/3$) is deposited in one's checking account and \$2,000 ($2Y_M/3$) is deposited in interest-bearing assets, then those remaining balances will be transferred to one's checking account in two \$1,000 ($Y_M/3$) increments during the month. Thus, the average monthly money balance ($M = Y_M/6$) is \$500. (three transfers)



d. If people do *z* transfers in a month, one's average monthly money balance, M, is $Y_M/(2\times z)$.

3. Optimal level of money balances (M)

   a. Each transfer costs *k*. This cost includes the time it takes to make the transfer.

   b. The total explicit cost of transferring funds each month is the number of times transfers are made, $(z = Y_M/(2\times M))$, multiplied by the cost of each transfer, *k*.

   c. Each month, people also incur the lost interest revenue $(M\times OC_M)$ from holding money.

   d. People select a level of M that minimizes their total costs (TC):

$$TC = (Y_M/(2\times M))\times k + M\times OC_M \qquad (6)$$

e. The cost minimizing level of money balances is found by taking the derivative of TC with respect to M and setting it equal to zero:

$$dTC/dM = -(Y_M/(2\times M^2))\times k + OC_M = 0 \tag{7}$$

f. Solving (7) for M yields the optimal level of money balances:

$$M = ((k\times Y_M)/(2\times OC_M))^{1/2}$$

g. Thus, money balances (M) rises as

   1. income (Y_M) rises
   2. transfer costs (k) rise
   3. the opportunity cost of money (OC_M) falls

C. The demand for money as a store of wealth

1. People save some wealth in the form of money in case of an emergency need for liquid assets.
2. Some people save their wealth in the form of money because of the anonymity it provides the holder. (This case is especially true in criminal activities where individuals are seeking to avoid detection.)

D. Recent trends in currency and checking deposits.

1. Currency holdings fell from the 1960s to the 1980s as new transactions technology reduced the need for currency.
2. Currency holdings since the mid-1980s have risen due to increased foreign demand for the U.S. dollar. (Foreigners in some politically unstable countries like to store their wealth in the U.S. dollar.)

3. The amount of money held in checking accounts declined from 1960-1980 as higher interest rates encouraged household to learn to economize on their checking balances.

4. The amount of money held in checking deposits has fluctuated with its opportunity cost since interest rates peaked in 1980.

E. The demand for currency (D_{CU}) and checking deposits (D_{ChD})

1. The D_{CU} and D_{ChD} decline as the opportunity cost of money, OC_M, rises.

   a. As R rises, OC_M increases, which causes D_{CU} and D_{ChD} to fall.

   b. As R_M rises, OC_M falls, which causes D_{ChD} to increase. (note: the own rate of currency is always zero)

2. D_{CU} and D_{ChD} increases as output rises.

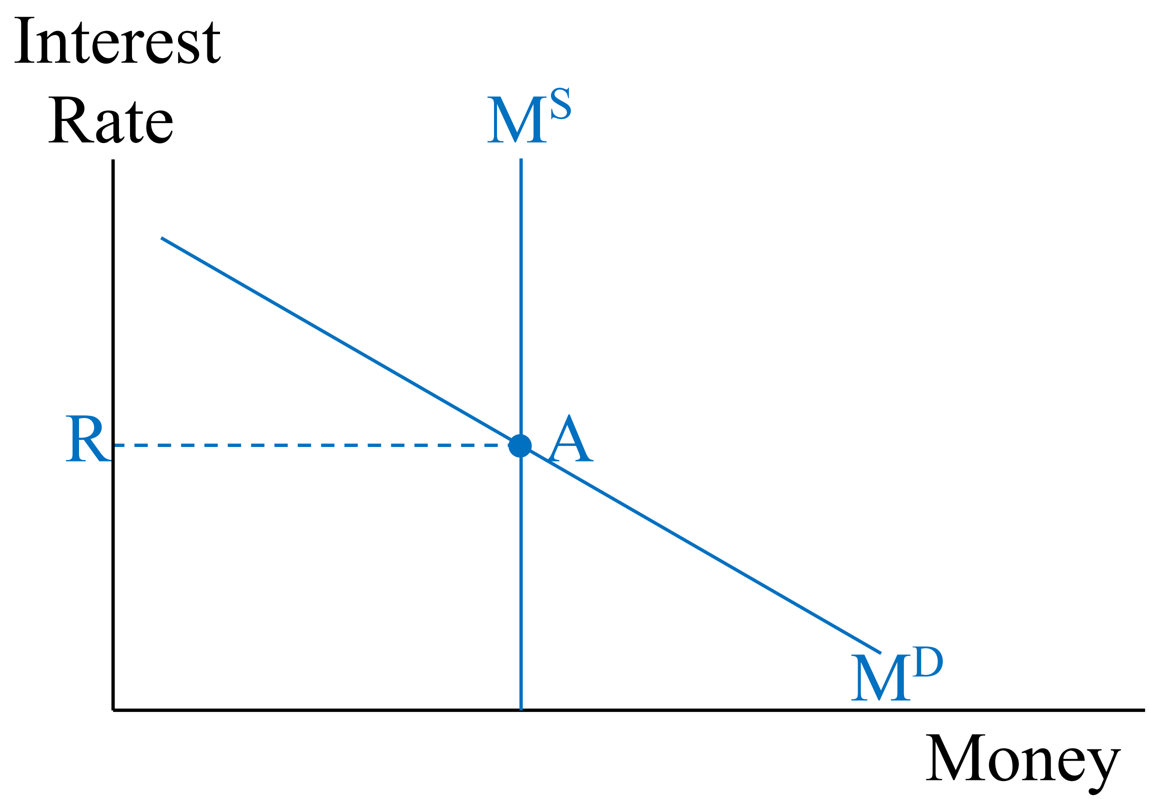
3. D_{CU} and D_{ChD} increases as the price level rises.

The Monetary Policy Rule

A. Setting Money Growth or Interest Rate Targets

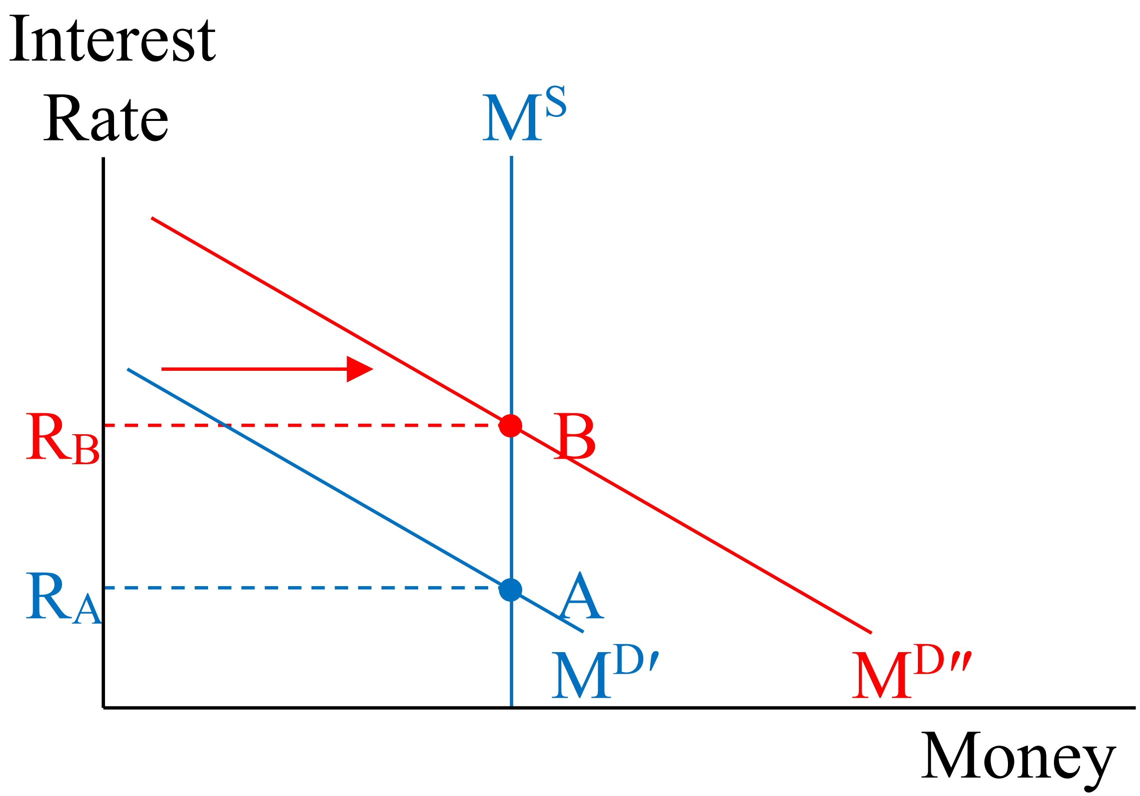
1. Monetary policy by money supply growth targets

   a. The Fed sets a M^S growth rate target and then estimates the money multiplier to determine how much the M^B needs to increase to reach its M^S growth rate target.



b. One problem with this approach is that a bad estimate of M^D or a shock to M^D will cause fluctuations in R, which leads to undesirable movements in I and Y.

Suppose the Fed estimated M^D to be $M^{D'}$ but the actual M^D is higher, $M^{D''}$. In this case, R will be higher, R_B, than it should be, R_A, so Y will lower than expected.

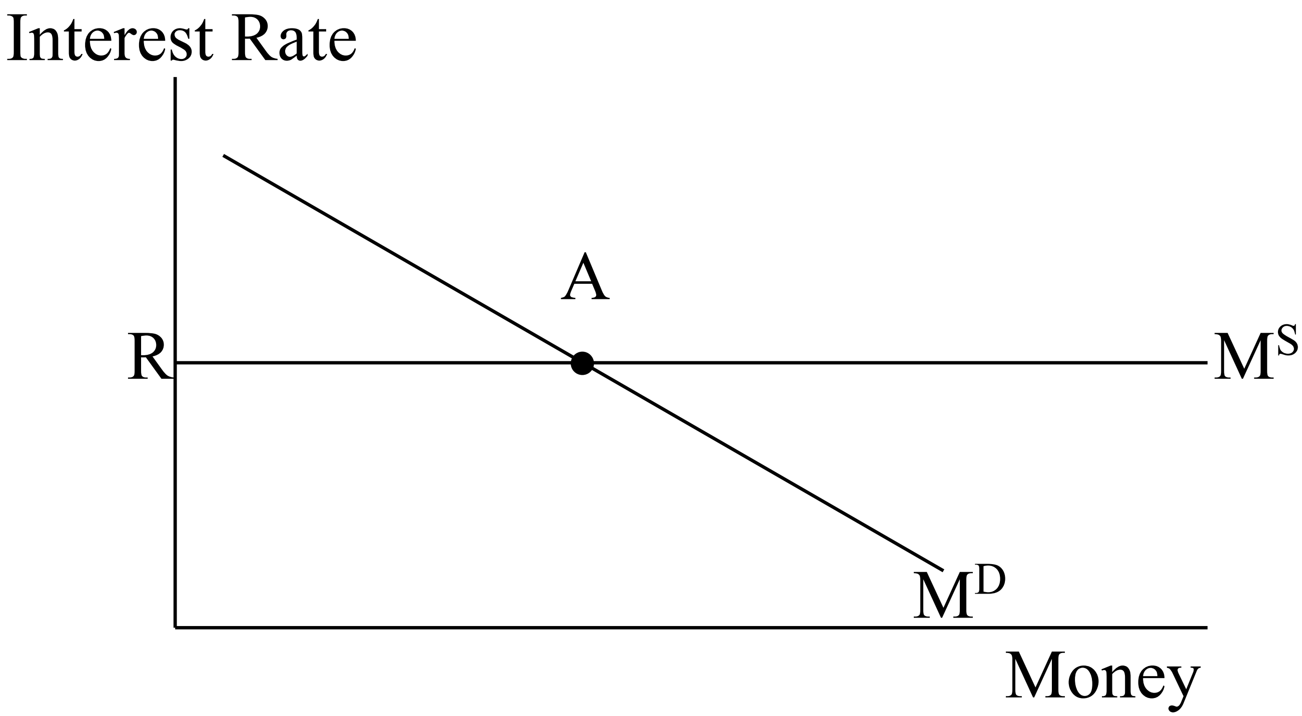


c. Another problem is what measure of money growth should the Fed target? M_1? M_2?

d. Money growth targets were used primarily by the Fed in the early 1980s when the money demand function was predictable and when inflation expectations were volatile.

2. Monetary policy by interest rate targets

   a. The Fed sets a nominal interest rate target and then estimates the money multiplier to determine how much the M^B needs to increase to reach its nominal interest rate target.



b. One problem with this approach is that a bad estimate of inflation expectations causes an unintentional change in the real interest rate. Unplanned changes in the real interest rate leads to undesirable movements in I and Y.

c. Interest rate targets have been used primarily by the Fed since the mid-1980s because inflation expectations have been low and predictable while the money demand function has been volatile.

B. Reacting to events in the economy

1. Objectives of the Fed

    a. Keep inflation low and stable

    b. Keep deviations of real GDP from its potential, $[(Y-Y^*)/Y^*]$, small

2. A monetary policy rule describes how the Fed sets the money growth rate or the interest rate in response to variables in the economy.

3. A monetary policy rule describing an interest rate target is given by the equation

$$R = \pi + \beta_{\pi}\times(\pi - \pi^{*}) + \beta_{Y}\times[(Y - Y^{*})/Y^{*}] + r^{e*}$$

where

π is the actual inflation rate.

π^{*} is the target inflation rate.

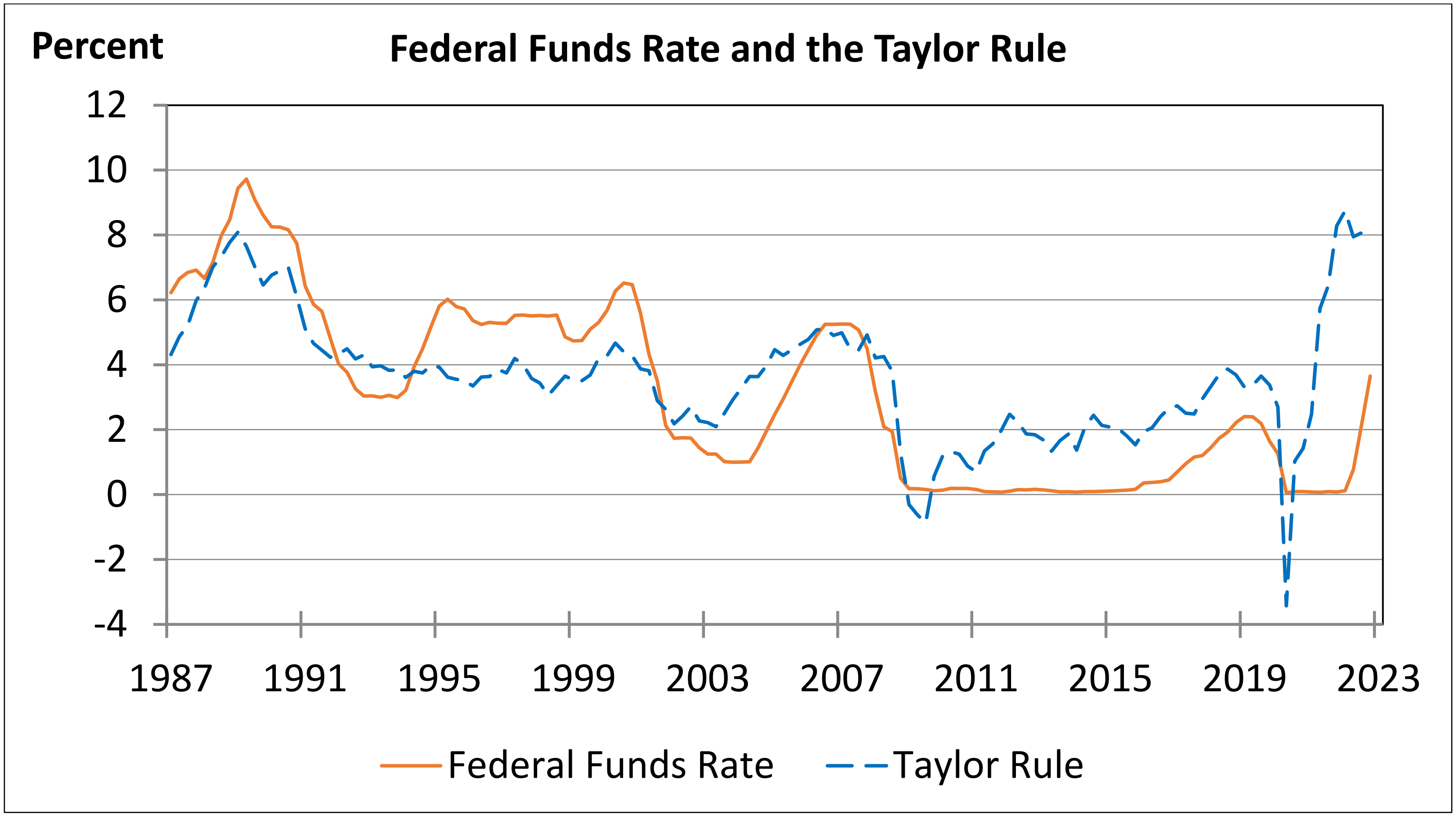
$(Y - Y^{*})/Y^{*}$ is the percent deviation of Y from Y^{*}.

r^{e*} is the Fed's belief of the value of the real interest rate when Y is at Y^{*}.

β_{π} and β_{Y} are constant coefficients that are greater than zero.

4. An example of a monetary policy rule: The Taylor Rule [$\beta_\pi = 0.5$, $\beta_y = 0.5$, $\pi^* = 0.02$, and $r^{e*} = 0.02$]

$$R = \pi + 0.5\times(\pi - 0.02) + 0.5\times[(Y - Y^*)/Y^*] + 0.02$$



This rule does a good job of explaining Fed behavior since the mid to late 1980s.

C. Reacting to changes in the real interest rate

1. A simple model

   a. Suppose $Y=Y^*$, $\pi^*=0.02$ and $\beta_\pi=0.5$.

   b. Thus, the monetary policy rule is

   $$R = \pi + 0.5\times(\pi - 0.02) + r^{e*}$$

   c. Recall, $R = r + \pi^e$, where r is the actual real interest rate

   d. Lets assume $\pi = \pi^e$.

   e. To solve for the inflation rate, substitute the equations in part b, c, and d so that

   $$r + \pi = \pi + 0.5\times(\pi - 0.02) + r^{e*}$$

   $$\pi = 2\times(r - r^{e*}) + 0.02$$

2. Suppose $r = 0.02$ and $r^{e*} = 0.02$. Thus, the inflation rate is

   $$\pi = 0.02$$

3. Now, suppose the real interest rate rises to 0.03 but the Fed keeps r^{e*} at 0.02.
   a. In this case, the inflation rate is

$$\pi = 0.04$$

   b. Thus, the inflation rate rises if r increases and the Fed does not increase r^{e*}.
4. Now, suppose the Fed raises r^{e*} to 0.03 when the real interest rate increases to 0.03.
   a. In this case, the inflation rate is

$$\pi = 0.02$$

   b. Thus, the inflation rate does not change if the Fed raises r^{e*} when r increases.