Multiple Deposit Creation and Money Multipliers

Multiple Deposit Creation

Many economists closely monitor M1 and M2. Though these measures are conceptually distinct from the monetary base, they are linked to the base through the money multiplier. The key to understanding this multiplier is in understanding multiple deposit creation and we turn to this task now.

Consider Bank A, a fractional reserve bank with a reserve ratio of 10% and deposits of $5 million. This means that the bank currently holds $500,000 in reserves. Now, suppose that Zack, a depositor at Bank A, finds $10,000 in cash buried in his back yard. Zack would probably take some of the money and throw a big party, but to keep things simple suppose he rushes down to the bank and deposits his bonanza. All of the sudden Bank A has $10,000 more cash in its vault. It will want to keep 10% of this amount on reserve to back the new deposit. What will it do with other $9,000? Banks are in the business of lending and when they find a willing borrower, a new loan will be issued.

Suppose Susan comes by Bank A to see if she can get a loan for a new motorcycle. It turns out that she needs $9,000. Susan has fine credit and Bank A lends her the funds. There are many ways for the bank to transfer the funds to Susan. If she is a depositor of the bank, $9000 could be credited to her account, or Bank A could issue her a check. For simplicity, let's assume that she takes the loan in cash and goes directly to Jake's Cycle Shop. She buys her bike and roars off.

Jake now has $9,000. He banks at Bank B and deposits his cash there at the end of the day. Bank B is also a fractional reserve bank with a reserve ratio of 10%. The bank will keep $900 of Jake's new deposit in reserves and will try to lend the rest. As it happens, Scott is on his way to Bank B for a loan of $8,100 to buy a hottub. When he arrives with a stellar credit report, Bank B is happy to lend him the money. Scott takes the $8,100 in cash and heads down to Pat's
HoTTub Bazaar where he plunks it down for a snazzy new tub. At the end of the day, Pat deposits the money in her bank, Bank C.

You can see how this story is going and it is a good time to summarize the action. Table 1 records the loans, deposits, and the reserves for each transaction. There are two question marks because we stopped just as Bank C received a new deposit. What will they do?

<table>
<thead>
<tr>
<th></th>
<th>deposit</th>
<th>loan</th>
<th>reserves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank A</td>
<td>$10,000 (Zack)</td>
<td>$9,000 (Susan)</td>
<td>$1,000 (Bank A)</td>
</tr>
<tr>
<td>Bank B</td>
<td>$9,000 (Jake)</td>
<td>$8,100 (Scott)</td>
<td>$900 (Bank B)</td>
</tr>
<tr>
<td>Bank C</td>
<td>$8,100  (Pat)</td>
<td>?</td>
<td>?</td>
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Bank C will keep 10% on hand as reserves, which amounts to $810 now, and loan out the remaining $7,290. And where will this $7,290 end up? After it is spent by the borrower, Bank D will have it in their vault.

Now let's see how many dollars of deposits have been created. The initial deposit of $10,000 set off a chain of events that has so far accounted for an increase in total deposits of

$$34,390 = 10,000 + 9,000 + 8,100 + 7,290$$

But the story doesn't stop here. It keeps going and going and going. How can we find the total amount of deposits that will ultimately be created in this infinite progression? Notice that each new deposit is 90% of the previous one: $9,000 = (.9)$10,000, $8100 = (.9)$9,000, and $7,290 = (.9)$8,100. This means that we can write the total amount of new deposits as

$$\text{total new deposits} = 10,000 + (.9)10,000 + (.9)(.9)10,000 + (.9)(.9)(.9)10,000 + ...$$

$$= 10,000(1 + .9 + .9^2 + .9^3 + ...)$$
The sum in parentheses may be recognized as a geometric sum and it has the solution\(^1\)

\[
\frac{1}{1-.9} = 1 + .9 + .9^2 + .9^3 + \ldots
\]

or

\[
10 = 1 + .9 + .9^2 + .9^3 + \ldots,
\]

and so

\[
\text{total new deposits} = (10)\$10,000
\]

or

\[
= \$100,000.
\]

**Multipliers**

This result may be obtained with less pain, but also with less insight. To see how, let CD be the checkable deposits in the economy, RR be the dollar value of reserves, and let rr be the reserve ratio. By the definition of the reserve ratio we have

\[
\text{RR} = \text{rr} \cdot \text{CD}.
\]

We take the reserve ratio to be constant (in the example it was .1 or 10\%). This means that

\[
\Delta \text{RR} = \text{rr} \cdot \Delta \text{CD}
\]

or

\[
\frac{\Delta \text{RR}}{\text{rr}} = \Delta \text{CD}.
\]

---

\(^1\) This solution turns out to be straightforward, as these things go anyway, to find. A geometric sum, S, is given by \( S = 1 + x + x^2 + x^3 + \ldots \). This sum converges to a number so long as the absolute value of x is less than one. Whatever this sum is, multiply it by x to get \( xS = x + x^2 + x^3 + \ldots \). Now all we do is to subtract \( xS \) from \( S \) to get \( S-xS = 1 \), because the \( x \) and \( x^2 \) and \( x^3 \) and so on will cancel out. Now just factor out the \( S \) to get \( S(1-x) = 1 \) and divide to get \( S = 1/(1-x) \). In the present case \( x \) equals .9 so that \( S = 1/.1 \) or \( S = 10 \).
In the example the change in reserves is the $10,000 that Zack found and \( rr = .1 \) so that the change in deposits is the same $100,000 that we found above.

Just a bit more algebra provides the link from the monetary base to the M1. Recall that M1 is the sum of currency held by the public, which we write as \( CP \), and checkable deposits, which is again \( CD \). The monetary base is \( B = CP + RR \), the sum of currency held by the public and bank reserves. Two ratios are important: the reserve ratio \( rr = RR/CD \) and the currency-to-deposit ratio \( k = CP/CD \). The last ratio reflects the relative demands for cash and deposits. For example, a rumor of a bank panic will sharply increase \( k \), while the spread of credit cards will tend to decrease \( k \).

Now we are ready to derive the money multiplier. We first write out the definition of M1 and the monetary base

\[
M1 = CD + CP \\
BASE = CP + RR.
\]

The reserve and currency-to-deposit ratios imply that

\[
CP = k \cdot CD \\
RR = rr \cdot CD.
\]

We can substitute these expressions into the definitions of M1 and the monetary base to get

\[
M1 = CD + k \cdot CD = (1 + k)CD \\
BASE = kCD + rr\cdot CD = (k + rr)CD.
\]

Dividing the base by checkable deposits gets us
BASE/(k + rr) = CD

and substituting this expression for checkable deposits into the definition of M1 yields

\[ M1 = \left(\frac{1 + k}{k + rr}\right)BASE. \]

The term in brackets is called the M1 money multiplier. It is the link from the base to M1 in the sense that if you know the base and the multiplier, then you can calculate M1. It is important to note that if the currency-to-deposit ratio and the reserve ratio are relatively stable, then the money multiplier is also stable and the growth rate in the base and the growth rate in M1 will be very similar. In this case the practical difference in following M1 or the base is small.

However, there are times when the two measures behave in dramatically different ways. For example, in December of 1929 the currency-to-deposit ratio was about .17 and the reserve ratio was about .14. These numbers imply that the money multiplier was about 3.77, and since the monetary base was about $7 billion dollars, M1 stood at about $26.4 billion. Over the next four years the U.S. experienced the worst series of banking panics in its history. By 1933 the panics had driven the currency-to-deposit ratio up to .33 and the reserve ratio to .21. The money multiplier in December of 1933 was therefore about 2.46, only two-thirds its 1929 value, and even though the monetary base increased over the same period to $8.3 billion, M1 fell to about $20 billion.\(^2\) During this period an increase in the base of a bit over 4% per year occurred at the same time that M1 was falling at a rate of about 6.5% per year!

Some additional insight into the connection between M1 and the Base may be had by further examining the reserve ratio. The level of total reserves, RR, is comprised of legally required reserves, RRQ, and reserves held in excess of the legal requirement, RRX, called excess reserves. So we have

\[ RR = RRQ + RRX \]

and then dividing by checkable deposits gives us

\[^2\text{These numbers are found or derived (using the money multiplier in the text) from figures in the appendices of Milton Friedman and Anna Schwartz A Monetary History of the United States, 1867 - 1963 Princeton University Press, Princeton, N.J., 1963.}\]
\[
RR/CD = RRQ/CD + RRX/CD
\]

If we let \( r rq \) be the required reserve ratio and \( r rx \) be the excess reserve ratio, then we have

\[
rr = r rq + r rx.
\]

Since the Monetary Control Act and Depository Deregulation Act of 1980, the Fed has set \( r rq \). It is currently 10%.\(^3\) Banks chose the excess reserve ratio. Since excess reserves do not earn interest, banks hold small stocks of such reserves. The excess reserve ratio is less than 1/2%.

The Fed can closely control the monetary base even over relatively short periods of time. The effects of a change in the float or the Treasury's behavior can be offset with a defensive open market operation. The Fed does not control the money multiplier. Households and firms determine the currency to deposit ratio, and the Fed sets the required reserve ratio and influences bank's reserve ratios, but the reserve ratio also depends on the excess reserve ratio which is in the hands of banks.

A money multiplier can also be derived for \( M_2 \) and other measures of money. The expression for \( M_2 \) is given by

\[
M_2 = \frac{(1 + k + tr)/(k + rr)}{BASE}
\]

where \( tr \) is the ratio of non-M1 deposits, savings and small time deposits and balances in retail money market mutual funds, to checkable deposits. \( M_2 \) is a broader definition of money. The reason for taking the time to write this multiplier down is to point out that \( M_1 \) and \( M_2 \) can grow at different rates. For example, suppose households liquidate some of their stock portfolio and deposit the proceeds in their savings accounts. This will increase \( tr \) and \( M_2 \) will increase. On the other hand, there will not be any change in \( M_1 \). If you observe different behavior in \( M_1 \) and \( M_2 \), the explanation will rest in the changing behavior of the \( tr \) ratio.

\(^3\) In practice reserve requirements vary with the amount of deposits. The reserve requirement is zero on the first $6.6 million dollars of deposits, 3% on deposits from $6.6 to $45.4 million dollars, and 10% on the amount of deposits in excess of $45.4 million. For more details on reserve requirements visit http://www.federalreserve.gov/monetarypolicy/reservereq.htm#table1.
Review Questions

What would happen to the money supply if:

a) the Fed sells $5,000,000 of government bonds to the public
b) the Fed raises the discount rate from 6% to 6.5%
c) the Fed decreases the reserve requirement from 15% to 10% (this is a trick question)