Money Supply
ECON 40364: Monetary Theory & Policy

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Readings

- Mishkin Ch. 3
- Mishkin Ch. 14
- Mishkin Ch. 15, pg. 341-348
Money

- Money is defined as anything that is accepted as payments for goods or services or in the repayment of debts.
- Money serves three functions:
  1. Medium of exchange
  2. Unit of account
  3. Store of value
- Any asset can serve as a store of value (e.g. house, land, stocks, bonds), but most assets do not perform the first two roles of money.
- Money is a stock concept – how much money you have (in your wallet, in the bank) at a given point in time. Income is a flow concept.
Roles of Money

- Medium of exchange role is the most important role of money:
  - Eliminates need for barter, reduces transactions costs associated with exchange, and allows for greater specialization
- Unit of account is important (particularly in a diverse economy), though anything could serve as a unit of account
- As a store of value, money tends to be crummy relative to other assets like stocks and houses, which offer some expected return over time
  - An advantage money has as a store of value is its liquidity
  - Liquidity refers to ease with which an asset can be converted into a medium of exchange (i.e. money)
  - Money is the most liquid asset because it is the medium of exchange
  - If you held all your wealth in housing, and you wanted to buy a car, you would have to sell (liquidate) the house, which may not be easy to do, may take a while, and may involve selling at a discount if you must do it quickly
Evolution of Money and Payments

- Commodity money: money made up of precious metals or other commodities
  - Difficult to carry around, potentially difficult to divide, price may fluctuate if precious metal or commodity has consumption value independent of medium of exchange role

- Paper currency: pieces of paper that are accepted as medium of exchange. May be “backed” by some commodity (e.g. government guarantees conversion of paper into gold)
  - Problems: easily stolen, difficult to track, and difficult to transport

- Checks: instructions for holder of your money (a bank) to transfer money to another person or institution. Eliminates need to carry currency around
  - Problems: processing of checks and transfer is potentially costly

- Electronic payment and e-money: like checks, but transfer happens instantaneously with a complete record (e.g. debit card)
Fiat Money

- Fiat money is currency, checks, and/or electronic entries that are not backed by any commodity or precious metal.
- In other words, fiat money is not “convertible”: you can’t trade it in for pieces of gold, for example.
- It is only backed by the “full faith and credit” of an issuing government.
- Fiat money has no “fundamental” value – it is only valuable because people accept it in exchange. For this reason, sometimes people say fiat money is a “bubble”.
- Advantages: easily divisible, can be fully electronic, value does not fluctuate due to demand and supply of a commodity, easy for government to change quantity.
- Potential problems: maybe too easy for government to manipulate quantity to pays its bills (inflation tax). Precarious in the sense of being a bubble – only has value because people believe it does.
Measures of the Money Supply

- Most basic definition of the money supply is “currency in circulation,” C. Also called “M0”
- Obviously currency isn’t the only thing that can be used in exchange – checks can as well
- M1: cash in circulation plus demand deposits (money held in checking accounts), plus travelers checks, plus “other” checkable deposits (interest-bearing checking accounts)
- M2: M1 + savings deposits and money market deposit accounts, small time deposits (e.g. CDs), and money market mutual funds
- Descending order of liquidity – M2 includes less liquid assets than M1
<table>
<thead>
<tr>
<th>Measure</th>
<th>Value as of August 18, 2014, ($ billions)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M1 = Currency</strong></td>
<td>1,206.1</td>
</tr>
<tr>
<td>+ Traveler’s checks</td>
<td>3.3</td>
</tr>
<tr>
<td>+ Demand deposits</td>
<td>1,089.9</td>
</tr>
<tr>
<td>+ Other checkable deposits</td>
<td>477.4</td>
</tr>
<tr>
<td><strong>Total M1</strong></td>
<td>2,776.7</td>
</tr>
<tr>
<td><strong>M2 = M1</strong></td>
<td>11,290.4</td>
</tr>
<tr>
<td>+ Small-denomination time deposits</td>
<td>533.0</td>
</tr>
<tr>
<td>+ Savings deposits and money market deposit accounts</td>
<td>7,338.2</td>
</tr>
<tr>
<td>+ Money market mutual fund shares (retail)</td>
<td>642.5</td>
</tr>
</tbody>
</table>

We often think of the central bank (e.g. the Federal Reserve) as setting the money supply. This is not quite accurate, though in normal times it is not a bad approximation. The money supply is jointly set by three actors:

1. Central bank
2. Commercial banks
3. Depositors
T-Accounts

- In thinking about the money creation process, it is useful to use T-Accounts, which are tabular depictions of an institution’s balance sheet.

- A balance sheet shows the assets and liabilities of an institution.

- Asset: a piece of property, note, or electronic entry that is valuable and entitles the holder to some payout (e.g. stock, bond, cash).

- Liability: a liability is an obligation that requires the holder to pay at some point in the future as a result of some past transaction.

- For example, if I make you a loan, the loan is an asset to me (it’s a piece of paper that says you have to pay me back), but a liability for you.

- Equity (or sometimes “capital”) is the difference between the values of assets and liabilities. If you liquidated all assets and paid off all liabilities, how much money would you be left with?
Example T-Account for a Homeowner

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities + Equity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of Home</td>
<td>$100,000</td>
</tr>
<tr>
<td>Checking account</td>
<td>$10,000</td>
</tr>
<tr>
<td>Stocks</td>
<td>$50,000</td>
</tr>
<tr>
<td></td>
<td>Mortgage</td>
</tr>
<tr>
<td></td>
<td>Student loans</td>
</tr>
<tr>
<td></td>
<td>Credit card debt</td>
</tr>
<tr>
<td></td>
<td>Equity</td>
</tr>
</tbody>
</table>

Equity is just the difference between total value of assets and total value of liabilities.
## Balance Sheet for the Fed

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Securities</td>
<td>Currency in circulation</td>
</tr>
<tr>
<td>Loans</td>
<td>Reserves</td>
</tr>
</tbody>
</table>

- Monetary liabilities are not really liabilities in the formal sense – these are IOUs to be paid off with other IOUs
- Monetary liabilities of the Fed: monetary base (currency plus reserves)
- It can freely create these liabilities, and hence controls the monetary base
- Reserves: deposits banks hold at the Fed plus currency in bank vaults
- Securities: holdings of US government bonds and private sector stocks and bonds
- Loans: loans made to financial institutions
### Balance Sheet for the Banking System as a Whole

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans</td>
<td>Demand deposits</td>
</tr>
<tr>
<td>Securities</td>
<td>Savings deposits</td>
</tr>
<tr>
<td>Reserves</td>
<td>Borrowings</td>
</tr>
<tr>
<td></td>
<td>Equity</td>
</tr>
</tbody>
</table>

- Loans are assets for banks because they are IOUs that promise the bank back its money.
- Deposits are liabilities: banks have to pay out cash on demand.
- Reserves: vault cash and deposits at central bank.
- Borrowings: loans bank has taken out from Fed or other institution.
The Monetary Base

- The monetary base is the sum of currency in circulation plus reserves:
  \[ MB = C + R \]

- The Fed can affect the base through open market operations and loans to financial institutions.

- The split between currency and reserves is determined by the public’s desire to hold cash versus deposits.

- An open market operation involves the purchase (or sale) of securities (short term government securities, Treasury Bills, Notes, and Bonds).

- Open market operations create (or eliminate) monetary liabilities and alter the asset position of the banking system.
Open Market Purchase

- Suppose that the Fed decides to purchase $100 of securities from the banking system.
- To do this, the Fed simply creates reserves – it credits the banking system with reserves in exchange for the securities.
- For the Fed:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Securities</td>
<td>+$100</td>
</tr>
</tbody>
</table>

- For the banking system as a whole:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Securities</td>
<td>-$100</td>
</tr>
</tbody>
</table>

- An open market purchase increases reserves (and hence the monetary base), while a sale does the opposite.
Loans to Financial Institutions

- Commercial banks can borrow directly from the Fed through the discount window or other lending facilities.
- Suppose the Fed loans the banking system $100. Fed balance sheet:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans +$100</td>
<td>Reserves +$100</td>
</tr>
</tbody>
</table>

- Banking system balance sheet:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reserves +$100</td>
<td>Borrowings +$100</td>
</tr>
</tbody>
</table>
Currency Withdrawal

- The Fed cannot directly control reserves
- Suppose that depositors want to withdraw $100
- Banking system has to meet this withdrawal demand by drawing down reserves

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reserves</td>
<td>-$100</td>
</tr>
<tr>
<td>Deposits</td>
<td>-$100</td>
</tr>
</tbody>
</table>

- Withdrawals reduce reserves, but increase currency in circulation
- Hence, Fed can control $MB$, but not $C$ or $R$ directly
Borrowed vs. Non-Borrowed Reserves

- Even though the Fed can completely control open market operations, there is some uncertainty about loans to financial institutions.
- It is therefore convenient to split the monetary base into two components: the non-borrowed monetary base and borrowed reserves:

\[ MB = MB_n + BR \]

- Where \( MB_n \) is the non-borrowed monetary base and \( BR \) is borrowed reserves (e.g. discount loans).
- Because the Fed has complete control of \( MB_n \) through open market operations, it can always adjust \( MB_n \) given fluctuations in \( BR \) to hit a target \( MB \).
- We therefore think of the Fed as directly controlling the monetary base.
- But what about the money supply?
From Monetary Base to Money Supply

- The Fed can directly control the monetary base
- But what about the money supply?
- For these purposes, think of the money supply as currency in circulation plus demand deposits (so M1)
- There exists a relationship between the monetary base and the money supply, but it is not directly controlled by the Fed
In a “fractional reserve” banking system, banks do not hold the total value of deposits in reserves.

The Fed stipulates by law a minimum fraction of total outstanding deposits that commercial banks must hold.

Call this the required reserve ratio, or \( rr \).

Suppose, for simplicity, that banks do not hold any “excess reserves” (reserves in excess of what is required by the Fed).
A Hypothetical Bank Balance Sheet

Suppose a bank, call it Bank A, has the following balance sheet:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans $1000</td>
<td>Deposits $1000</td>
</tr>
<tr>
<td>Securities $100</td>
<td></td>
</tr>
<tr>
<td>Reserves $100</td>
<td></td>
</tr>
</tbody>
</table>

Assume that $rr = 0.1$. So deposits are a multiple of reserves. Bank equity in this example is $200. The bank makes money (return on equity) by earning returns on its loans and securities. Reserves (i.e. cash in vault) earn nothing and hence do not create equity.
Open Market Operation

- Suppose that the Fed purchases $100 of securities from the bank. Balance sheet goes from:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans</td>
<td>$1000</td>
</tr>
<tr>
<td>Securities</td>
<td>$100</td>
</tr>
<tr>
<td>Reserves</td>
<td>$100</td>
</tr>
</tbody>
</table>

  to:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans</td>
<td>$1000</td>
</tr>
<tr>
<td>Securities</td>
<td>$0 (-$100)</td>
</tr>
<tr>
<td>Reserves</td>
<td>$200 (+$100)</td>
</tr>
</tbody>
</table>

- The direct effect of the open market operation is to alter the composition of assets at a bank.
Excess Reserves

- Now the bank is holding 20 percent of its deposits as reserves. This is more than $rr = 0.1$
- Reserves don’t make money. Loans or securities do
- Suppose bank makes a loan for $100 (equal to the value of the excess reserves)
- When it does this, it just creates a deposit for the person getting a loan. The bank creates a liability (deposit) at same time it creates an asset (loan) (without affecting equity). Can do this because of fractional reserve requirement
- New balance sheet:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans</td>
<td>$1100 (+$100)</td>
</tr>
<tr>
<td>Securities</td>
<td>$0</td>
</tr>
<tr>
<td>Reserves</td>
<td>$200</td>
</tr>
<tr>
<td>Deposits</td>
<td>$1100 (+$100)</td>
</tr>
</tbody>
</table>
Suppose that Bank B has an initial balance sheet that looks just like Bank A’s, but Bank B didn’t sell securities to the Fed.

Initial balance sheet:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans $1000</td>
<td>Deposits $1000</td>
</tr>
<tr>
<td>Securities $100</td>
<td></td>
</tr>
<tr>
<td>Reserves $100</td>
<td></td>
</tr>
</tbody>
</table>

The person getting the loan from Bank A isn’t getting a loan to keep deposits with bank A. He/she is getting the loan to buy something.

Suppose that person uses the $100 deposit and buys something, and the seller then deposits the $100 in Bank B.
New Balance Sheets for Banks A and B

▶ Bank A:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans $1100</td>
<td>Deposits $1000 (-$100)</td>
</tr>
<tr>
<td>Securities $0</td>
<td></td>
</tr>
<tr>
<td>Reserves $100</td>
<td>(-$100)</td>
</tr>
</tbody>
</table>

▶ Bank B:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans $1000</td>
<td>Deposits $1100 (+$100)</td>
</tr>
<tr>
<td>Securities $100</td>
<td></td>
</tr>
<tr>
<td>Reserves $200</td>
<td>($+100)</td>
</tr>
</tbody>
</table>

▶ Now bank B is holding reserves equal to 0.1818 of deposits, in excess of $rr = 0.1$

▶ Bank B will not want to sit on these excess reserves
Bank B Makes Loans

- Suppose that Bank B makes a loan for $90, equal to its excess reserves:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans</td>
<td>Deposits</td>
</tr>
<tr>
<td>$1090 (+$90)</td>
<td>$1190 (+$90)</td>
</tr>
<tr>
<td>Securities</td>
<td>$100</td>
</tr>
<tr>
<td>Reserves</td>
<td>$200</td>
</tr>
</tbody>
</table>

- The deposits created for Bank B will only temporarily be there. The borrower will deposit them in another bank, call it Bank C, and Bank B’s balance sheet will revert to:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans</td>
<td>Deposits</td>
</tr>
<tr>
<td>$1090</td>
<td>$1100 (-$90)</td>
</tr>
<tr>
<td>Securities</td>
<td>$100</td>
</tr>
<tr>
<td>Reserves</td>
<td>$110 (-$90)</td>
</tr>
</tbody>
</table>
Initial balance sheet looks like all the others:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans $1000</td>
<td>Deposits $1000</td>
</tr>
<tr>
<td>Securities $100</td>
<td>Deposits $1000</td>
</tr>
<tr>
<td>Reserves $100</td>
<td>Deposits $1000</td>
</tr>
</tbody>
</table>

After getting the deposit, its balance sheet will be:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans $1000</td>
<td>Deposits $1090 ($+90)</td>
</tr>
<tr>
<td>Securities $100</td>
<td>Deposits $1090 ($+90)</td>
</tr>
<tr>
<td>Reserves $190 ($+90)</td>
<td>Deposits $1090 ($+90)</td>
</tr>
</tbody>
</table>

But now Bank C is sitting on $81 in excess reserves. It will want to loan it out.
Bank C Makes Loans

- Suppose that Bank C makes a loan for $81, equal to its excess reserves:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans</td>
<td>$1081 (+$81)</td>
</tr>
<tr>
<td>Securities</td>
<td>$100</td>
</tr>
<tr>
<td>Reserves</td>
<td>$190</td>
</tr>
<tr>
<td>Deposits</td>
<td>$1171 (+$81)</td>
</tr>
</tbody>
</table>

- The deposits created for Bank C will only temporarily be there. The borrower will deposit them in another bank, call it Bank D, and Bank C’s balance sheet will revert to:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans</td>
<td>$1081</td>
</tr>
<tr>
<td>Securities</td>
<td>$100</td>
</tr>
<tr>
<td>Reserves</td>
<td>$109 (-$81)</td>
</tr>
<tr>
<td>Deposits</td>
<td>$1090 (-$81)</td>
</tr>
</tbody>
</table>
Multiple Deposit Creation

▶ The open market operation increases reserves for Bank A
▶ Bank A then makes a loan, which generates $100 additional deposits for Bank B
▶ Bank B then makes a loan, which generates $90 additional deposits for Bank C
▶ Bank C then makes a loan, which generates $81 additional deposits for Bank D
▶ And so on!
▶ Total change in deposits for a $1 open market purchase:

\[ \Delta D = 1 + (1 - rr) + (1 - rr)^2 + (1 - rr)^3 + \ldots \]

▶ This simplifies to an expression called the “simple deposit multiplier”:

\[ \Delta D = \frac{1}{rr} \]
Deposit Creation and the Money Supply

- Recall that we are thinking of the money supply as M1 – currency in circulation plus deposits
- An open market purchase of $100 increases deposits by $100 \times \frac{1}{rr}$
- Hence, the change in the money supply is $\frac{1}{rr}$ times the change in reserves, or more generally times the change in the monetary base:

\[ \Delta M = \frac{1}{rr} \Delta MB \]

- We could call the money multiplier the simple deposit multiplier:

\[ mm = \frac{1}{rr} \]

- Then we have a relationship between the monetary base and the money supply:

\[ M = mm \times MB \]
The Simple Model is too Simple

The simple model assumes the following:

1. Banks hold no excess reserves: they either make loans or buy securities to just satisfy the reserve requirement
2. Lenders who get loans deposit the entirety of the loan in a bank – there is no currency holding

Holding excess reserves or currency outside of a bank will “slow down” multiple deposit creation and lower the money multiplier
A More General Model

- Let $c = \frac{C}{D}$ be the desired currency to deposit ratio and $e = \frac{ER}{D}$ be the excess reserve ratio held by banks. $rr = \frac{RR}{D}$ is the required reserve ratio, which the central bank can set. Total reserves, $R = ER + RR$

- Recall $MB = C + R$ and $M = C + D$

- Can derive an expression:

$$M = mm \times MB$$

- Where:

$$mm = \frac{1 + c}{rr + e + c}$$

- If $c = e = 0$, this reduces to simple multiplier
What Can a Central Bank Control?

- The Fed can control the monetary base, $MB$, and the required reserve ratio, $rr$
- It cannot influence currency holdings, $c$, or excess reserves, $e$
- In “normal” times $c$ and $e$ are pretty stable, so the Fed can control $M$ pretty well
- In extreme circumstances, not so:
  - In Great Depression, currency holdings shot up (bank runs) and the money multiplier fell. The Fed did not adjust the base much, so the money supply fell
  - In Great Recession, excess reserves went up. The Fed massively raised the monetary base, but because of the decline in the money multiplier, this had only limited effect on the money supply
The Taylor Rule

- With the exception of a brief period in the early 1980s, the Fed focuses more on interest rates than monetary aggregates.
- For the most part, these are equivalent ways of thinking about policy.
- John Taylor (1993) posited that the Fed sets interest rates (the Federal Funds rate) as a function of the deviations of inflation from target and output from “potential”:

\[ i_t = r^P + \pi^*_t + \phi_{\pi}(\pi_t - \pi^*_t) + \phi_Y(Y_t - Y^*_t) + e_{i,t} \]

- \(r^P\) is the natural rate of interest (think about this as long run average real interest rate), \(\pi^*_t\) is an exogenous inflation target, \(Y^*_t\) is “potential output,” and \(e_{i,t}\) is an exogenous shock (0 on average).
- Taylor argued that roughly: \(r^P = 2, \pi^*_t = 2, \phi_{\pi} = 1.5,\) and \(\phi_Y = 0.5\).
- Some ambiguity about how to measure \(Y^*_t\).
How Does Fed Target FFR?

- The Federal Funds Rate (FFR) is the interest rate on interbank loans on reserves.
- Banks have to meet their reserve requirement daily. If they have too few reserves, they can go to the Federal Funds market and borrow. If they have too many reserves, they can go to the Federal Funds market and lend.
- The FFR is an *equilibrium* interest rate that balances the supply and demand for reserves in the interbank market. The Fed does not literally “set” the FFR.
- Alternatively, if a bank has a reserve deficiency, it can borrow reserves directly from the Fed at the discount rate. The discount rate is set by the Fed.
- If banks have excess reserves, they may be able to earn interest (since 2008) on reserves held at the Fed. This is the interest rate on reserves.
Demand for Reserves Federal Funds market

- Banks are required to hold reserves and can choose to hold excess reserves
- Excess reserves are insurance against withdrawals
- The FFR represents an opportunity cost of holding excess reserves — the higher it is, the more interest a bank is giving up by holding excess reserves
- Hence, the demand for excess reserves (and hence the total demand for reserves) is decreasing in the FFR
- The demand for reserves is bound from below by the interest rate on reserves: won’t demand reserves in interbank market if you can earn more by holding reserves
- Notation: $i_{ff}$ is the FFR, $i_d$ is the discount rate, and $i_{or}$ is the interest rate on reserves
Demand in the Federal Funds Market

\[ R_d \]

\[ i_{ff} \]

\[ i_d \]

\[ i_{or} \]

\[ R \]
Supply for Reserves Federal Funds market

- If \( i_{ff} < i_d \), banks will not borrow from the Fed. Hence, the supply of reserves just equals non-borrowed reserves, which the Fed can set.

- Hence, the supply curve for reserves is vertical at \( i_{ff} < i_d \).

- But \( i_d \) places a ceiling on \( i_{ff} \). If \( i_{ff} > i_d \), then banks would borrow from the Fed to lend in the interbank market (i.e. engage in arbitrage). Hence, borrowed reserves would rise infinitely with \( i_{ff} > i_d \).

- Therefore, the supply curve of reserves, which is the sum of non-borrowed reserves (\( NBR \), which the Fed sets) and borrowed reserves (\( BR \), which is determined by banks borrowing at the discount window), is horizontal at \( i_{ff} = i_d \).
Supply in the Federal Funds Market

The graph shows the supply curve in the Federal Funds Market. The supply curve is horizontal, indicating that the supply of funds is constant. The supply curve is labeled with \( R^s \), \( i_{ff} \), \( i_d \), and \( i_{or} \). The x-axis is labeled \( NBR \) and the y-axis is labeled \( R \).
Prior to the Great Recession, we had $i_{or} = 0$ and $i_{ff} < i_d$

Hence, the equilibrium FFR was determined where the downward-sloping demand for reserves intersects the vertical supply of reserves set by the Fed

Call this equilibrium FFR $i_{ff}^*$
Equilibrium in the Federal Funds Market

\[ R_d \quad R_s \]

\[ i_{ff} \quad i_d \quad i^*_f \quad i_{or} \]

\[ NBR \quad R \]
How Does Fed Target FFR?

- Since 1994, the Fed formulates its target monetary policy through a target (range) for the FFR, $i_f^*$.
- How can it do this? Four ways:
  1. Open market operations: change position of supply curve.
  2. Reserve requirement: change demand for reserves.
  3. Discount rate: change upper bound on reserve demand and supply.
  4. Interest on reserves: change lower bound on reserve demand.
- In “normal” times, (3)-(4) do not affect the FFR.
- In practice, open market operations the most important tool.
Open Market Purchase

- An open market purchase shifts the supply curve of reserves to the right, which lowers the FFR in normal times.
- More reserves results in more money supply via the standard money multiplier argument.
- Hence, can think of lowering the FFR as equivalent to increasing the money supply.
- And vice-versa.
Changes in Discount Rate

▶ In ordinary circumstances, changes in the discount rate have no effect on the FFR
▶ For example, a (sufficiently small) cut in the discount rate shifts the flat portion of the supply curve down, but this does not affect the FFR
▶ But if demand intersects supply at the flat portion, a cut in the discount rate results in the FFR falling
▶ If $i_f = i_d$, then there will be some borrowed reserves, $BR$
▶ A cut in the discount rate will lead to an increase in borrowed reserves and therefore an increase in total reserves and an expansion in the money supply
“Non-Binding Cut” in Discount Rate
"Binding" Cut in Discount Rate

\[
R_d \leq i_{ff} = i^*_f
\]

\[
i_d^0 = i^*_f
\]

\[
i_d^1 = i^{**}_f
\]
Changes in Required Reserve Ratio

- A higher reserve requirement means banks will want more reserves, other things being equal.
- Increase in the reserve requirement increases the demand for reserves.
- The rightward shift of the demand curve will result in the FFR rising.
- Though total reserves don’t change (in normal times), the money multiplier will be smaller, so the money supply falls.
Increase in the Required Reserve Ratio

\[ R^d \]

\[ R^s \]

\[ NBR \]

\[ i_{or} \]

\[ i_{ff} \]

\[ i^* \]

\[ i^{**} \]

\[ i_d \]
Changes in Interest on Reserves

- In ordinary circumstances, increasing the interest on reserves does not affect the FFR.
- But if equilibrium initially occurs on the flat portion of the demand curve, an increase in the interest rate on reserves raises the FFR.
- It does this without affecting the quantity of reserves or the money supply.
- Relevant for thinking about “post-crisis” monetary policy – reserves have been increased so much that equilibrium is now on the flat portion of the demand curve.
"Non-Binding" Increase in Interest on Reserves

\[ R_d \quad R_s \]

\[ \iff \]

\[ i_d \]

\[ i_{ff} \]

\[ i_0 \quad i_{or} \]

\[ R \]

\[ NBR \]
“Binding” Increase in Interest on Reserves

\[ R_s \]

\[ R^d \]

\[ i_{ff} \]

\[ i_d \]

\[ i^{**} = i^1_{or} \]

\[ i^* = i^0_{or} \]
Target FFR on Interest on Reserves Post-Crisis
Summary: Tools of Managing Money Supply

- The Fed attempts to control the money supply
- In practice, it tends to target interest rates (the FFR) rather than monetary aggregates (M1 or M2)
- Can target the FFR through four tools:
  1. Open market operations
  2. Required reserve ratio
  3. Discount rate
  4. Interest on reserves
- With exception of (4), these move the money supply and the FFR in opposite directions