The Determination of the Federal Funds Rate

Toward the end of any business day, some banks will hold more reserves than are legally required, while other banks will hold fewer reserves than are legally required. In this case, a bank that is short on reserves may borrow from a bank that is long on reserves. The market for very short-term, most often literally overnight, interbank loans of reserves is called the federal funds market. The interest rate on these loans is called the federal funds rate, and it is this rate that the Federal Open Market Committee of the Federal Reserve System targets. The federal funds rate is the opportunity cost to a bank of holding reserves in excess of the legal requirement since a bank forgoes an interest income determined by this rate on each dollar of excess reserves it holds. We analyze the determination of the federal funds rate in the context of the market for the reserves.

The Demand for Reserves

The demand for reserves can be broken down into parts in at least two different ways. We first break reserve demand into the demand for required reserves and the demand for excess reserves. The key determinant of the demand for required reserves is the required reserve ratio, \( r_{rq} \). Other things the same, an increase in the required reserve ratio will increase the demand for required reserves and for reserves in general. Excess reserves are the amount of reserves banks hold in excess of the legal requirement. A dollar held in reserves is a dollar that is not earning interest and so there is an interest opportunity cost of holding excess reserves.

Which interest rate should we use to measure this interest opportunity cost? The federal funds market emerged in the 1920s as a very short term market, literally overnight, in which banks could borrow and lend reserve balances. The market originated among a few New York City banks and has grown to a market where on average over 1,000 trades are made per day at an average size of over $75 million. A bank that holds a $1 in excess reserves gives up interest income that it could have received if it had loaned the $1 in the federal funds market. The federal funds rate, \( R^{ff} \), is the interest rate on loans in the federal funds market and we take it as a
measure of the interest opportunity cost of hold $1 in excess reserves. An increase in the federal funds rate increases the opportunity cost of holding excess reserves and lowers the demand for excess reserves.

We can also break reserves into borrowed and non-borrowed reserves. Borrowed reserves refers to the reserves borrowed from the Fed. The interest rate at which a bank can borrow from the Fed is popularly called the discount rate. In the original design of the Fed, the discount rate played a key role. If the Fed wanted to increase reserves in the banking system, it would lower the discount rate to stimulate borrowing and an increase in total reserves. In 2003 the Fed change its discount policy. The discount rate, now called the primary credit rate, is set above the Fed’s target for the federal funds rate. The Fed will lend to banks at this rate, but since banks can borrow in the federal funds market at a lower rate, only banks that can’t find willing lenders in the federal funds market will turn to the Fed for a discount loan. Borrowing from the Fed thus sends a negative signal about the banks health and banks are understandably reluctant to send such a signal. Although there is always some borrowing from the discount window, we will assume that this borrowing is zero unless the federal funds rate equals or exceeds the discount rate.

It is useful to express reserve demand in real terms and we write the demand for real reserves as

\[ \frac{RR^D}{P} = RR^D(R^{ff}, R^{dis}, rrq, other) - - + \]

where we will take account of the possible effect of changes in the discount rate below and where "other" in the above equation represents other factors that affect reserve demand. For example, suppose that there has been a run on banks in the next county, it is reasonable to expect that for a given federal funds rate, a given discount rate, and given reserve requirement would desire to increase their holdings of excess reserves.

In Figure 1 the federal funds rate is plotted on the vertical axis and the real reserves is plotted on the horizontal axis. In Figure 1 when the federal funds rate is 2% the real demand for reserves is 700 billion inflation-adjusted dollars.\(^1\) When the federal funds rate rises to 5%, the opportunity cost to banks of holding excess reserves increases; so, at a given price level, banks

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\(^1\) This is the terminology often used in the media to identify a real variable.
Figure 1: The Demand for the Reserves

Figure 2: Shifts in the Demand for the Monetary Base: An Increase in the Required Reserve Ratio
hold fewer excess reserves and the demand for total reserves declines, in Figure 1 it declines to 650 inflation-adjusted dollars.

Changes in the federal funds rate cause movements along this demand curve. Changes in the other variables that determine real reserve demand cause shifts in the demand curve. For example, an increase in the required reserve ratio increases the demand for required reserves and so for total reserves. If the interest rate is 5% and the required reserve ratio increases from, say 12% to 15%, then banks will want to hold more reserves, say an increase of 20 billion units. This change means that the real reserve demand curve shifts from \((RR/P)^d\) to \((RR/P)^d'\), and this shift is depicted in Figure 2.

**The Monetary Base**

The monetary base is comprised of the reserves held by banks and currency held by the public. In short,

\[
M = \text{Reserves} + \text{Currency Held by the Non-Bank Public}
\]

or in briefer notation

\[
M = \text{RR} + \text{CP}.
\]

We can rearrange the above to focus on reserves to get

\[
\text{RR} = M - \text{CP}
\]

The supply of reserves depends on the monetary base, the supply of which is determined by the Fed, and the demand for currency. When the demand for currency increases, it drains reserves from the banking system.

**The Demand for Currency**
The demand for currency by the non-bank public is far and away the largest component of the demand for the monetary base, making up on the order of 90% of the base. Since people hold money to buy goods and services, we are interested in the demand for real currency. The real demand for currency depends on real income, the interest rate that can be earned on other assets, the expected rate of inflation, and the cost of transforming other assets into cash. The higher is real income, the greater will be the volume of transactions, and since money is used to carry out a significant portion of those transactions, the real demand for currency will rise. On the other hand, if the interest that households or businesses can earn on other assets increases, then people will want to hold less of their wealth in currency, and the real demand for currency will fall. The rate of inflation may be thought of as the rate at which the purchasing power of currency falls. Higher prices in the future means a dollar will buy less. If people expect more rapid inflation, they will attempt to reduce their money holdings before the purchasing power of currency falls. As a result, households decrease their demand for currency when expected rate of inflation, $\pi^e$, increases. Finally, if it is relatively expensive to transform other assets into cash, people will hold more cash because they don't want to pay the high transactions cost very often. For example, suppose the charge on a withdrawal from an ATM machine increased to $25 per transaction. Would you take more cash out each visit or less? No doubt more cash and as a result on average you would hold more currency. We write the transaction cost of converting other assets into currency as $\gamma$. The real demand for currency can now be written as

$$CPD/P = CPD(Y, R, \gamma, \pi^e),$$

where the signs underneath the variables indicate their relationship to real currency demand. So, an increase in the interest rate on assets or an increase in expected inflation will decrease the demand for currency. An increase in real income or an increase in transactions costs will increase the demand for currency.

**The Supply of Reserves**
We are now in a position to write out the supply of reserves. We have developed currency demand in real terms, so we write the supply of real reserves as

\[ \frac{RR^S}{P} = \frac{M}{P} + CP^D(Y, \gamma, \pi^e). \]

We will focus on the short run, so for most of our analysis we will hold the price level constant. Later we will discuss the important implications of letting the price level adjust. We will also assume the Fed controls the monetary base, \( M \). We know that changes in treasury deposits, the float, or the accounts of foreign central banks can alter the base. However, within a very short period of time, the Fed can offset any of these changes and hit a base target. The quantity of the base that is available to serve as reserves depends on the drain into currency which depends, in turn, on fluctuations in real income, the interest rate, transactions costs, and expected inflation.

The supply of reserves is plotted in Figure 3. The supply is vertical until the federal funds rate equals the discount rate. The assumption here is that no bank will borrow reserves from the Fed so long as the funds can be had cheaper in federal funds market. If the Fed is
willing to lend to all applicants, then the federal funds rate will never exceed the discount rate; and the supply of reserves becomes perfectly elastic at the discount rate. For a given discount rate, an increase in the supply of reserves, say as a result of an open market purchase, will cause a shift in the vertical portion of the supply curve to the right, but the supply curve remains perfectly elastic at the discount rate.

The Equilibrium Federal Funds Rate

The federal funds rate is determined in the market for reserves. The demand for and supply of the real reserves jointly determine the equilibrium federal funds rate, $R^{FF*}$. The demand and supply of real reserves are plotted in figure 4; and the equilibrium federal funds rate is found where the demand and supply curves cross at $R^{FF*}$. Now, are there forces at work that will drive the federal funds rate to its equilibrium? The answer is yes. Suppose the funds rate is $R^{FFH}$, then there will be an excess supply of reserves. When banks have an excess supply of reserves, they will be eager to lend out the excess. Willing lenders competing for scarce borrowers will bid the federal funds rate down. Similarly, if there is an excess demand for reserves, there will be numerous eager borrowers seeking willing lenders. Competition among
the eager borrowers drives the federal funds rate up. So, there are forces at work that will drive the federal funds rate to its equilibrium value at $R^{FF*}$.

The current policy of the Fed sets a target for the federal funds rate and hits that target by manipulating the supply of the monetary base. For example, suppose the current equilibrium federal funds rate is $R^{FF*}$ and the Fed desires to hit a target, $R^{FFT}$, that is below the current equilibrium. In the short run, we take the price level to be fixed, so to hit the target the Fed buys government securities to increase the monetary base and the supply of reserves. The increase in the supply of Reserves, from $RR$ to $RR'$ in Figure 5, induces a decline in the federal funds rate. As we know, factors outside the control of the Fed affect the demand for and supply of real reserves and so the federal funds rate. Suppose that the Fed has hit its target at $R^{FFT}$, but now the economy grows. The increase in income increases the demand for currency, and the supply of reserves shifts back and to the left. This is shown in Figure 6. Other things the same, this will cause the federal funds rate to increase. In order to maintain the federal funds rate at its target, the Fed must increase the supply of the reserves to offset the drain caused by the increase in income. The Fed will purchase government securities, increase the monetary base, and the
supply of reserves as well. Thus, when the Fed commits itself to hitting a particular target federal funds rate, it loses control of the monetary base in the sense that the supply of the monetary base must change in reaction to forces, such as changes in income, that are outside of the Fed's control. The Fed may hit a target federal funds rate or it may hit a target value for the monetary base, but it can't hit both at the same time.

The Neutrality of Money

An important implication of the relationship between targeting an interest rate and monetary control involves the notion of the neutrality of money. Money is neutral when a change in the money supply results in a proportionate change in the price level and no change in any real variables. The neutrality of money is a basic result of macroeconomics and is generally accepted as valid in the long run. For example, if the money supply doubled today, then twenty years from now the only remnant of this doubling would be a price level twice as high as it otherwise would be. The time it takes for prices to fully adjust is a point of some controversy that need not delay us here. The key point for what we have to say now is that an increase in the monetary base will ultimately result only in a proportionately higher price level.
To see the implications of money neutrality, suppose the long-run equilibrium federal funds rate is $R^{FF*}$. Now imagine that, for some reason, the Fed sets the target federal funds rate below this long-run equilibrium, say at $R^{FFT}$. To hit this target the Fed must increase the supply of reserves and so the monetary base. The Fed will achieve its target in the short-run while the price level is constant. However, eventually the neutrality of money requires the price level to rise. In the long-run, the price level will rise to restore the real monetary base to its original level, say this level is $P'$, and the federal funds rate will return to $R^{FF*}$.

What happens if the Fed insists on hitting a target below the long-run equilibrium level? The answer is straightforward. To keep the federal funds rate below its long-run value, the Fed must continually increase the monetary base. This, in turn, will cause the price level to continually rise. In short, the attempt to keep the target rate too low will generate inflation. This consequence of monetary neutrality and interest rate targeting highlights an important tension that the Fed confronts. On the one hand, there may be times, such as during economic slowdowns, when the Fed may wish to keep the federal funds low to encourage spending on investment goods and consumer durables. On the other hand, if rates are kept too low for too long, this policy will generate inflation. So, the Fed may face a trade-off between stimulating the demand for goods and so promoting employment and output, and stabilizing the price level.

Conclusion

The federal funds rate is the interest rate that the Fed targets. When the media reports that the Fed has decided to raise or lower interest rates, it is the federal funds rate that is to be raised or lowered. We have developed a model of the demand for and supply of the monetary base to explain how the Fed uses open market operations to hit its targets. We have also pointed out the constraints implied by selecting and hitting targets. In particular, the commitment to a federal funds rate target obliges the Fed to relinquish control over the supply of the base, and if the Fed selects and persists on hitting a target federal funds rate below the long-run equilibrium rate, the Fed will generate inflation as a result.
Figure 6: Hitting the Target Again
Figure 7: Targets and the Price Level