

Rewriting Monetary Policy 101: What's the Fed's Preferred Post-Crisis Approach to Raising Interest Rates?[†]

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For several decades prior to the global financial crisis that started in 2007, the Federal Reserve through its Federal Open Market Committee (FOMC) primarily implemented monetary policy in a certain way: It set a target for the federal funds rate, which is an overnight interbank borrowing rate—that is, an interest rate paid when banks borrow from other banks in the very short-term. The Fed pursued its desired federal funds interest rate target through “open market operations” that involved modest purchases and sales of Treasury securities. However, in the aftermath of the financial crisis and with a superabundant level of reserve balances in the banking system having been created as a result of the Federal Reserve's large-scale asset purchase programs, implementing monetary policy through this traditional approach will no longer work. Instead, the Fed intends to affect the federal funds interest rate by using policy tools like the interest rate paid on excess reserves and a facility to extend overnight reverse repurchase agreements.

Being able to explain and to understand this fundamental change in the Fed's main tools for the implementation of monetary policy has implications for a number of groups. It obviously matters for the Fed itself; in particular, the Federal Reserve has been influenced in recent years by academic research showing that communication and transparency have substantial effects on the credibility and strength of monetary policy. Many investors and market-watchers seek to look below the

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surface of Fed decisions—like the announced target for the federal funds interest rate—and to understand how such decisions are actually implemented. The shift in policy tools also affects the task of some of society’s explainers, including journalists and teachers of economics, because most of the past textbook descriptions of how monetary policy works will not be accurate for years to come.

Of course, the Federal Reserve is not the only central bank that will face the challenge of tightening monetary policy while holding a much larger balance sheet than it held in the past. The Fed has seen its assets rise from about \$900 billion in 2006 to about \$4.5 trillion today, or from 6 percent of nominal gross domestic product (GDP) to about 26 percent of nominal GDP. Other central banks have had similar or larger increases. For example, assets of the Bank of Japan have increased from about 20 percent of nominal GDP to more than 60 percent of nominal GDP over this period, and assets of the Swiss National Bank have increased from 20 percent of nominal GDP to more than 80 percent of nominal GDP. The net increase in assets of the European Central Bank has so far been more modest, with assets increasing from less than 10 percent of nominal GDP for the euro zone to more than 20 percent of nominal GDP—but its quantitative easing program is still underway.

Though other central banks also will be confronted with similar issues, this paper focuses on the Federal Reserve’s past, present, and future approach to implementing monetary policy. In particular, we provide a primer on how the Federal Reserve will implement monetary policy when the Federal Open Market Committee decides it is time to raise interest rates. We begin with the standard textbook model of reserve balances to illustrate the approach used by the Federal Reserve before the financial crisis to keep the federal funds rate near its desired target. We explain why that pre-crisis approach will not work in the current environment. We then discuss the policy tools available to implement monetary policy, and explain the approach that the Committee intends to take when it decides to begin raising short-term interest rates. For additional detail on the issues discussed in this paper, a useful starting point is our discussion paper Ihrig, Meade, and Weinbach (2015).

How Did the Fed Implement Monetary Policy Prior to the Financial Crisis?

The textbook explanation of open market operations is based on two key features: 1) requirements that banks hold reserve balances in amounts determined by the Federal Reserve; and 2) banks trying to keep these balances to a minimum, in part because before the financial crisis the balances earned no return.

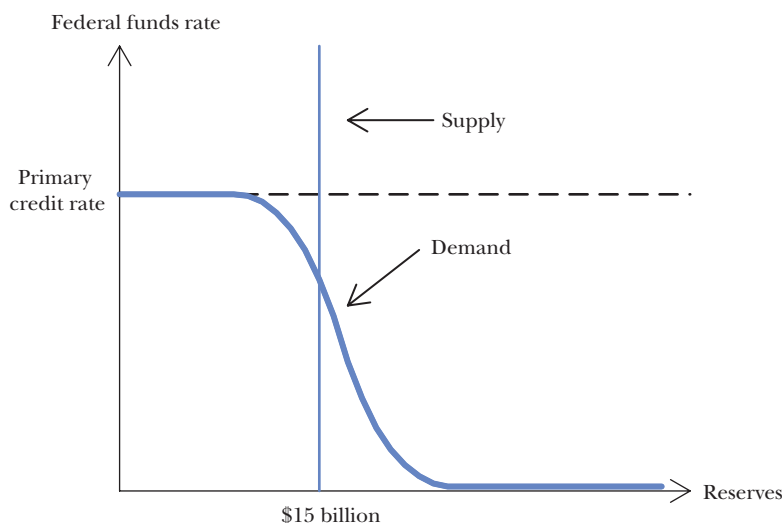
The original Federal Reserve Act (as amended by the Monetary Control Act of 1980) and the International Banking Act of 1978 impose reserve requirements on most deposit-taking institutions in the United States, requiring that commercial banks, savings banks, thrift institutions, and credit unions—as well as most US branches and agencies of foreign banks—(hereafter “banks,” for simplicity) are assessed reserve requirements against certain deposit liabilities. For example, as of January 22, 2015,

institutions needed to hold reserves equal to 3 percent of any net transaction accounts between \$14.5 million and \$103.6 million, and 10 percent of any net transaction accounts above \$103.6 million (<http://www.federalreserve.gov/monetarypolicy/reservereq.htm#table1>). Banks are required to satisfy their reserve requirements in the form of vault cash, which they hold primarily to meet the liquidity needs of their customers and, if the quantity of vault cash held is insufficient, also in the form of a balance maintained at the Federal Reserve. Prior to the financial crisis, many banks in the United States satisfied their reserve requirement with vault cash, though about 900 banks did not and so also needed to maintain reserve balances at the Fed. The balances that banks maintain at the Federal Reserve that are necessary for meeting reserve requirements are “required reserve” balances; any reserve balances held in excess of what is necessary to meet reserve requirements are termed “excess reserve” balances.¹ Before the financial crisis and recession that started in 2007, total reserve balances in the US banking system hovered around \$15 billion, with excess balances making up less than \$2 billion of this total. As discussed in greater detail below, reserve balances have grown tremendously since the financial crisis.

The combination of Federal Reserve–created demand for reserve balances and the desire of banks to limit such balances drove an active interbank market, known as the federal funds market, in which banks borrowed from and lent funds to each other on a daily basis at an interest rate known as the federal funds rate. With reserve balances generally scarce, the Federal Reserve could affect the market-determined level of the federal funds rate and keep it close to target level by a combination of announcing a target level for the federal funds rate and making small changes in the supply of aggregate reserves as needed.

Figure 1 presents the standard demand and supply framework for reserve balances shown in many textbooks. The demand by banks for reserves is downward sloping because of the opportunity cost of holding reserve balances (which in the past paid no interest). Conversely, as the price of overnight borrowing falls, banks are generally inclined to hold more reserves in order to satisfy their reserve requirements and also possibly to leave themselves with modest excess balances to protect against unexpected outflows that can cause reserve balance deficiencies—for which banks are charged a penalty. The upper left-hand side of the demand curve becomes horizontal at the “primary credit rate,” which is the interest rate that the Fed charges banks to borrow overnight (as part of the Fed’s discount window). Borrowing at the primary credit rate provides banks with a source of back-up funding at an interest rate that is well above

¹ In practice, banks meet their required reserve balances (also referred to as “reserve balance requirements”) with some leeway. A penalty-free band is used to create a range on both sides of the required reserve balance within which a bank needs to maintain its average balance over a given period. For more information on reserve requirements, see the Federal Reserve Board’s “Reserve Maintenance Manual” at <http://www.federalreserve.gov/monetarypolicy/2015-reserve-maintenance-manual-about-this-manual.htm> or its web page on “Reserve Requirements” at <http://www.federalreserve.gov/monetarypolicy/reservereq.htm>. Data on reserve balances are published weekly on the H.3 Statistical Release at <http://www.federalreserve.gov/releases/h3/current>.

*Figure 1***Banks' Demand for and the Fed's Supply of Reserve Balances before the Financial Crisis**

Source: Authors.

the Fed's target federal funds rate.² Although, in theory, banks should be unwilling to pay more than the primary credit rate for overnight funding, they sometimes do. Borrowing from the Fed involves higher transactions costs as well as possible reputational effects (termed "stigma") in which banks fear that borrowing from the Fed sends a signal that they are not regarded by other financial institutions as a good credit risk. For these reasons, some banks may choose to borrow from other institutions in the federal funds market at interest rates that exceed the primary credit rate.

The Fed's supply curve for reserve balances is vertical because the Fed is a monopolistic supplier of reserves; the supply curve shifts to the right or left when the Fed adds or subtracts reserves from the banking system using open market operations. The intersection of the demand and the supply curves occurs at the market federal funds rate.

Prior to the financial crisis, the supply and demand curves for bank reserves intersected on the downward-sloping portion of the demand curve. As a result, if the market federal funds rate was above the target federal funds rate, then the Fed would execute purchases of securities that would add reserve balances to the banking system and shift the supply curve to the right. Conversely, if the market federal funds rate was below the target federal funds rate, then the Fed

² Data on banks' aggregate borrowings from the Fed are published weekly on the H.3 Statistical Release at <http://www.federalreserve.gov/releases/h3/current>. For more information on the Fed's discount window programs, see *Purposes & Functions* (Federal Reserve System 2005).

would execute sales of securities that would drain reserve balances from the banking system and shift the supply curve to the left. (Of course, when banks trade existing reserve balances among themselves in the federal funds market, that trading leaves the aggregate amount of reserve balances unchanged; see the online Appendix available with this paper at <http://e-jep.org> for a discussion of this point.) Each business day, the Federal Reserve examined demand and supply conditions and, informed by staff models, determined whether an adjustment to reserve supply was needed, including which kind was suitable and the approximate size that would be appropriate. Judson and Klee (2010) discuss how forecasts were used to determine open market operations.

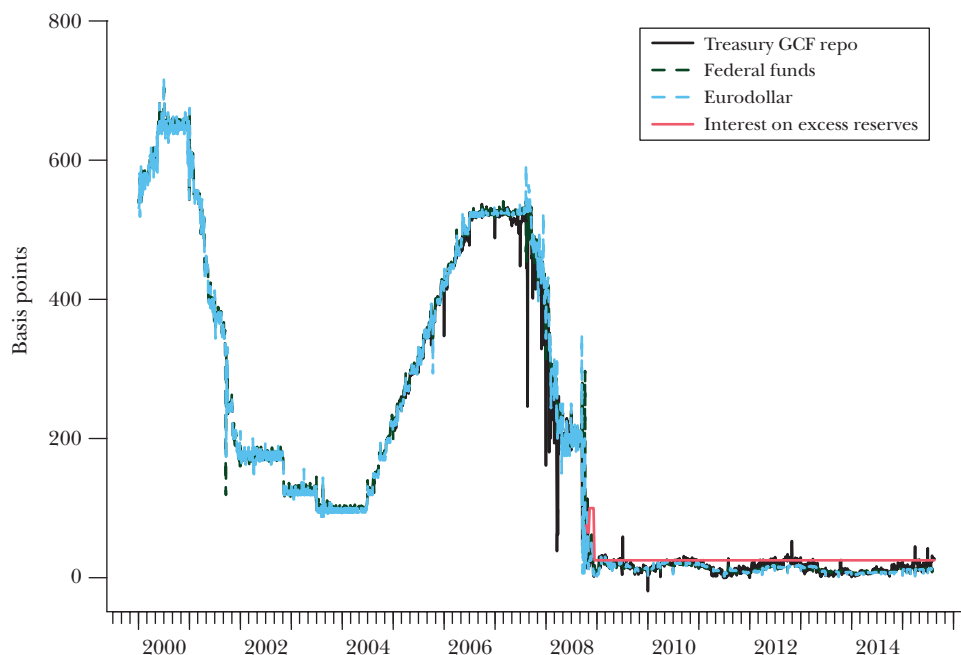
Prior to the financial crisis, the kind of open market operation that the Fed would use to produce the desired movement in reserve supply depended on its assessment of conditions in the market for reserves. For example, suppose the goal was to reduce the federal funds interest rate. In this situation, the Federal Reserve—more specifically, the Open Market Trading Desk at the Federal Reserve Bank of New York—would purchase a security from the private sector, a transaction that cleared through banks and resulted in reserve balances being added to the banking system. This purchase could be permanent or it could be temporary (the latter transaction is termed a repurchase agreement). In Figure 1, this transaction would shift the supply curve to the right for as long as the Fed owned the security, and thereby put downward pressure on the market federal funds rate. (The online Appendix available with this paper at <http://e-jep.org> describes the mechanism by which increases in the Fed’s securities holdings result in a commensurate increase in the amount of reserve balances held by the banking system.)

The Fed’s monetary policy targeted the federal funds interest rate, and then other short-term market interest rates tended to move with that rate. For example, Figure 2 shows three different overnight market interest rates. The federal funds interest rate that is targeted by the Fed reflects, as we have already discussed, a market in which banks are the borrowers, and a mixture of banks, securities dealers, and government-sponsored enterprises (financial services corporations created by Congress, such as Fannie Mae, Freddie Mac, and the Federal Home Loan Banks) are the potential lenders.

The Eurodollar market, although it started in London, is now a large global market. “Eurodollars” is a general term for large (often in the millions of dollars) US dollar-denominated deposits in banks outside the United States, usually held for a period of less than six months. Such deposits avoid regulations applicable to US-based deposits. The Eurodollar market is a place for money market funds and various financial and nonfinancial lenders to store funds for relatively short periods of time.

The repurchase agreement market, or repo market, involves a two-part transaction in which one party first sells a security to another and simultaneously agrees to repurchase that security in the near future. The original buyer of the security is in effect lending money on a short-term basis, and earns a rate of return for doing so, while the original seller of the security obtains additional cash in the short-term. The difference between the sale price and the repurchase price of the security, together with the length of time between the sale and purchase steps

Figure 2

Overnight Market Interest Rates

Source: Authors using data from Depository Trust & Clearing Corporation, Federal Reserve Bank of New York, Bloomberg, and Federal Reserve Board of Governors.

Note: GCF = General Collateral Finance.

of the transaction, implies the rate of interest earned by the party that purchased the security and loaned the funds. The repurchase market typically involves banks and securities dealers taking the role of cash borrowers—that is, they are typically sellers of securities in the first stage of a repurchase agreement. Money market funds, hedge funds, government-sponsored enterprises, and securities dealers are the lenders in this market, essentially holding the securities while lending cash for a short time until the repurchase agreement expires or is renewed. Before the financial crisis, many of the Fed’s daily open market purchases of securities were structured as repo transactions.

The market for repos is complex. There are two basic types of repo transactions: “bilateral” and “tri-party,” referring to the number of participants involved in the transaction. Within the tri-party market there is a segment called the GCF (General Collateral Finance) repo market, mostly used by securities dealers and serviced by the Fixed Income Clearing Corporation. (For more information on the structure of repo markets, see Copeland, Duffie, Martin, and McLaughlin 2012.) The term “general collateral” means that the party lending the money—that is, the party buying the security that will later be repurchased—is willing to accept a range of bonds issued by the US Treasury and by government-sponsored enterprises as collateral for the loan.

We will return to a discussion of repurchase agreements and how the Federal Reserve plans to make use of their cousin, reverse repurchase agreements, later in this paper. Here, we only wish to emphasize that overnight market interest rates tend to track each other. This pattern reflects, in part, the fact that many of the same financial institutions are active participants in the markets for various money market instruments. For example, banks are active borrowers in all three of the money markets depicted in Figure 2, and while the lenders vary a bit across the markets, there is also notable overlap. All in all, arbitrage generally works well to keep short-term interest rates highly correlated.

In broad terms, persistent changes in the level of short-term interest rates are transmitted to other, longer-term interest rates as well, including those commonly faced by businesses and households—although this connection from changes in short-term to long-term interest rates is not a simple one-to-one process. Ultimately, the Federal Reserve conducts monetary policy in order to achieve its statutory mandate of maximum employment, stable prices, and moderate long-term interest rates as prescribed by the Congress and laid out in the Federal Reserve Act. (The Federal Reserve’s statutory mandate is often referred to as a “dual mandate” of maximum employment and price stability, because of the belief that moderate long-term interest rates will result if inflation is expected to be low and stable.) Thus, as economic conditions change over time, the Federal Open Market Committee adjusts monetary policy accordingly, typically by raising or lowering its target for the federal funds rate, so as to foster economic conditions it judges to be consistent with achieving its statutory goals.

How Did the Financial Crisis Affect the Fed’s Operational Framework?

The first event commonly associated with the global financial crisis took place on August 9, 2007, when the French bank BNP Paribas suspended withdrawals from three of its investment funds due to problems in the US subprime mortgage market. At the onset of the financial crisis, the Federal Open Market Committee began reducing its target for the federal funds interest rate, and implementing policy using the conventional open market operations discussed in the previous section. The target federal funds interest rate moved down from 5¼ percent in August 2007, to its effective lower bound of 0 to 25 basis points in December 2008, where it remained in early fall of 2015.³

³ The target or “intended” federal funds rate is published on the Federal Reserve Board’s website at <http://www.federalreserve.gov/monetarypolicy/openmarket.htm>. The Federal Reserve also responded to the financial crisis with a number of credit and liquidity programs designed to support the liquidity of financial institutions and foster improved conditions in financial markets. Although these programs led to significant increases in the Federal Reserve’s balance sheet, the programs have expired or were concluded, and they are not boosting the Fed’s balance sheet today. Details of these liquidity programs are available on the Federal Reserve Board’s website at http://www.federalreserve.gov/monetarypolicy/bst_crisisresponse.htm.

Table 1
A Simplified Federal Reserve Balance Sheet: Before and After the Financial Crisis
(billions of dollars)

<i>Before:</i> <i>August 8, 2007</i>				<i>After:</i> <i>December 24, 2014</i>			
<i>Assets</i>		<i>Liabilities</i>		<i>Assets</i>		<i>Liabilities</i>	
Securities	791	Reserve balances	14	Securities	4,247	Reserve balances	2,610
Other assets	78	Currency	777	Other assets	262	Currency	1,294
		Other	45			Other	548
		Capital	33			Capital	57
Total	869	Total	869	Total	4,509	Total	4,509

Source: Authors using data from Federal Reserve Board of Governors H.4.1 Statistical Release, titled “Factors Affecting Reserve Balances.”

As short-term interest rates reached near-zero, the Federal Open Market Committee carried out a series of large-scale asset purchase programs between November 2008 and October 2014 in which the Fed purchased in the secondary market about \$1,690 billion in Treasury securities, \$2,070 billion in agency mortgage-backed securities, and \$170 billion in debt issued or guaranteed by government-sponsored enterprises.⁴ These operations were unprecedented and their effects uncertain. The programs were intended to put downward pressure on longer-term interest rates in the economy—the purchases reduced the available supply of securities in the market, leading to an increase in the prices of these securities and a reduction in their yields. Academic studies provide varying estimates of the magnitude of downward pressure that these operations have put on longer-term interest rates (Fischer 2015, table 1, titled “Empirical Studies of LSAPs”). The purchase programs taken together are estimated to have reduced longer-term interest rates by roughly 100 basis points, as reported in Ihrig, Klee, Li, Schulte, and Wei (2012). The large-scale asset purchase programs also helped to support mortgage markets (Krishnamurthy and Vissing-Jorgensen 2011).

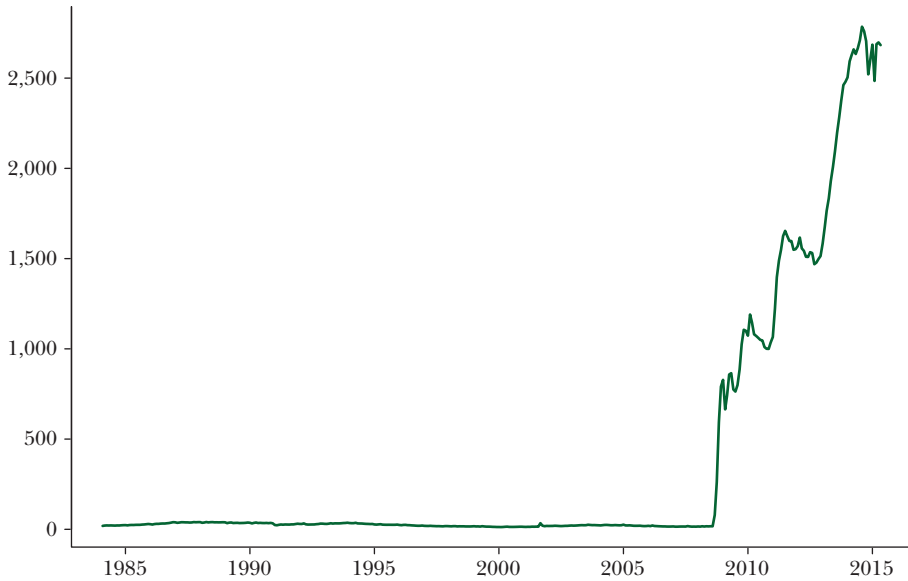
For the purposes of this paper, the key issue isn’t how these large-scale asset purchase programs affected interest rates or mortgage markets, but rather that their legacy is a dramatic alteration of the Federal Reserve’s balance sheet. Table 1 shows a simplified version of the Federal Reserve’s balance sheet before

⁴In addition, from September 2011 through December 2012, the Fed conducted a maturity extension program where it sold or redeemed \$667 billion in shorter-dated Treasury securities and purchased the same amount of longer-dated Treasury securities, as reported on Federal Reserve Board’s website at http://www.federalreserve.gov/monetarypolicy/bst_openmarketops.htm. Mortgage-backed securities are a type of asset-backed security that is secured by a package of mortgage loans and for which interest and principal payments associated with the mortgages are passed through to the holders of the securities; agency mortgage-backed securities are those issued by government-sponsored enterprises.

Figure 3

Total Reserve Balances held by Banks

(billions of dollars)



Source: Authors using data from Federal Reserve Board of Governors, H.3 Statistical Release, titled "Aggregate Reserves of Depository Institutions and the Monetary Base."

and after the financial crisis. The left panel shows that on August 8, 2007, the Federal Reserve's assets were comprised principally of Treasury securities holdings of \$791 billion; its liabilities were mainly currency (\$777 billion), with banks holding \$14 billion in reserve balances at the Federal Reserve. As the Fed made its purchases of securities, the Fed generally also reinvested payments of principal and interest to keep its portfolio of securities from shrinking. As a result, by late December 2014, the Fed's securities holdings rose to nearly 5½ times their pre-crisis level, as shown in the right panel of Table 1. In addition, reserve balances became the Fed's largest liability, amounting to \$2.6 trillion, and, as shown in Figure 3, these balances have remained in that neighborhood since then, with excess reserves making up all but about \$90 billion of this total.

Another important factor affecting the federal funds market (and thus the implementation of monetary policy going forward) is that since October 2008, the Federal Reserve has paid interest on banks' reserve balances. The Financial Services Regulatory Relief Act of 2006 authorized interest payments on reserve balances beginning in 2011, and the Emergency Economic Stabilization Act of 2008 advanced the effective date of this authority to October 2008. The Federal Reserve has designated two rates of interest on reserve balances, one rate for required reserve balances and a separate rate for excess reserve balances; the

interest rates that the Fed pays on reserves that are required and those that are excess are currently the same, although they could be set at different levels. In the discussion in this paper, for simplicity and given the predominance of excess reserve balances, we focus on the interest rate on excess reserve balances. All else equal, an increase in the interest rate on excess reserves would be expected to put upward pressure on the federal funds rate because banks would have an incentive to borrow in the federal funds market at rates below the interest rate on excess reserves and place those balances at the Fed.

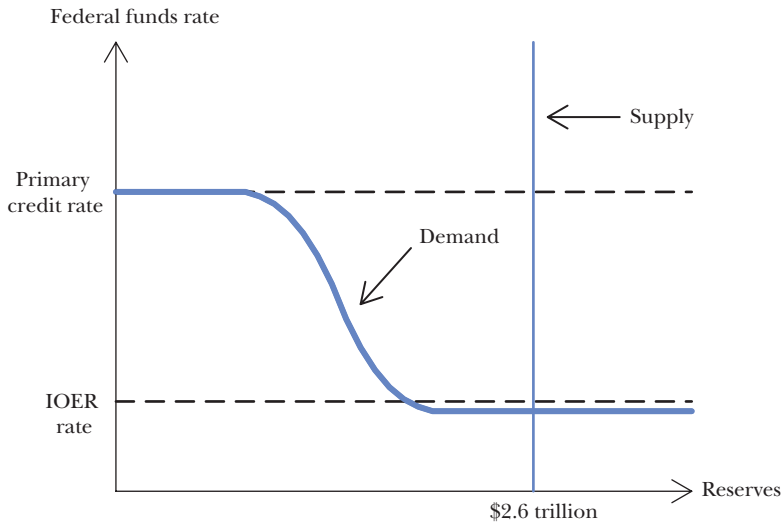
Since the Fed began paying interest on reserves, the market federal funds interest rate has generally been *below* the interest rate on excess reserves. One might think that interest on excess reserves (IOER) (see Figure 2) should provide a floor for the federal funds interest rate because banks would not lend at rates below what they could receive at the Fed. However, this situation has arisen because, in addition to banks not needing to borrow actively from each other because of the high quantity of reserves already in the banking system, the *nonbank* lenders in the federal funds market have an incentive to lend reserves at any rate above zero because they are not eligible to earn the interest rate on excess reserves on the balances they keep at the Fed. As explained above, the nonbanks that are active in the market for federal funds are government-sponsored enterprises. Banks borrow from these nonbanks to earn the spread between the market interest rate at which they borrow funds and the interest rate they earn from the Fed by holding those funds as excess reserves.

Figure 4 shows the market for reserve balances in the last few years after the expansion of bank reserves and illustrates two key differences from Figure 1. First, the supply curve for reserves is far to the right on the x-axis, representing the superabundant level of reserves in the banking system. The supply and demand curves now intersect on the flat portion of the demand curve. With the supply curve for reserves in its current position, the traditional steps to put upward pressure on market interest rates—announcing a higher target level for the federal funds rate and being prepared to conduct the appropriate open market operation by selling a small amount of securities into the market and draining an equally small amount of reserves—will no longer suffice. Second, with the Fed paying interest on reserves, the lower portion of banks' demand curve flattens out near the interest rate on excess reserves, reflecting the arbitrage activity just described. In this situation, when the time arrives to raise the target range for the federal funds interest rate, how will the desired increase be accomplished?

What Tools Could the Fed Use to Raise Interest Rates?

The Federal Reserve has a number of policy tools—some traditional, some new—that it can use to help raise the federal funds interest rate in a situation of superabundant reserves. In this section, we discuss the available policy tools, along with the ways in which those policy tools are expected to influence the federal funds rate.

Figure 4

Banks' Demand for and the Fed's Supply of Reserve Balances Today

Source: Authors.

Note: IOER = interest on excess reserves.

Channels of Influence of the Policy Implementation Tools

It is useful to summarize the three main channels through which the Fed's policy tools are generally expected to affect the market-determined federal funds interest rate and broader interest rates in the economy: encouraging arbitrage, increasing the scope of influence, and increasing reserve scarcity. We will refer to these concepts below in describing how each of the available policy tools is thought to work.

A policy tool can *encourage arbitrage* in money markets when it offers an interest rate that acts as a reservation rate—that is, the lowest rate of return that a financial institution would be willing to accept for investing its funds when assessing available investment opportunities.⁵ Generally speaking, financial institutions with access to a given policy tool have an incentive to borrow funds in money markets at rates that are below the interest rate that the Federal Reserve offers on the policy tool and invest the funds in the policy tool, putting upward pressure on money market rates.

If a policy tool establishes a reservation rate for a broader set of financial institutions than banks, we say it has an *increased scope of influence* in money markets. Access to this tool will narrow the set of institutions that might lend money below the rate earned on the policy tool and put upward pressure on the lowest interest rates in money markets.

⁵ Note that the Fed is a risk-free counterparty. Because there is no risk that the Federal Reserve will be unable to return money, banks do not require additional compensation for default risk in the rates they receive from the Fed.

Use of a policy tool can *increase reserve scarcity* by draining reserve balances and moving the level of aggregate reserves closer to its traditional position. If the aggregate level of reserve balances were reduced sufficiently, banks would need to resume borrowing federal funds to meet their demand for reserve balances, leading them to put upward pressure on the market federal funds rate.

Available Policy Tools

Rate of Interest on Excess Reserve Balances. As noted earlier, most transactions in the federal funds market today reflect arbitrage activity between banks that earn interest on reserves and nonbanks that do not (Goodfriend 2015 offers more detail). An increase in the interest rate on excess reserves should pull up the federal funds rate in these arbitrage transactions. Similarly, other money market rates should increase as banks arbitrage between holding excess reserve balances and alternative money market instruments.

Of course, banks need to be willing and able to actively perform this arbitrage for these effects to be realized. As shown in Figure 2, the federal funds rate has been highly correlated with other money market rates, which suggests that such arbitrage does happen. However, our understanding of the potential strength of these arbitrage effects may be incomplete, in part because interest on excess reserve balances has only been in effect over a period of time in which short-term interest rates have been kept near zero.

Overnight Reverse Repurchase Operations. In this type of open market operation, the Open Market Trading Desk would *sell* a security to the private sector, a transaction that would initially result in a decline in the quantity of reserve balances in the banking system, shifting the supply curve to the left. As with a repo transaction, this transaction would include a second step in which the transaction is unwound—the Desk would repurchase the security at a specified price at an agreed-upon time in the future and return the funds it had been holding, leaving reserve balances back where they started.

In the past, the Fed has conducted relatively small-dollar amounts of overnight reverse repurchase agreements with “primary dealers,” which are institutions that buy and sell Treasury securities directly from and to the Fed with the intention of acting as the “middleman” between the Fed and market participants in the private sector. A full list of primary dealers is available at http://www.newyorkfed.org/markets/pridealers_current.html. Some well-known examples include firms like Cantor Fitzgerald & Co., Citigroup Global Markets, Credit Suisse Securities (USA), Daiwa Capital Markets America, Deutsche Bank Securities, and Goldman, Sachs & Co.⁶

⁶ The Fed also regularly conducts overnight reverse repurchase agreements for international organizations, and the amount of outstanding reverse repurchase agreements reported on the Fed’s balance sheet recently includes about \$150 billion of these transactions (for more detail, see the H.4.1 statistical release at <http://www.federalreserve.gov/releases/h41>).

At present, the Fed is testing a somewhat different reverse repo transaction known as overnight reverse repurchase operations. These operations have three key differences relative to the small-scale open market operations used in the Fed's monetary policy operations before the financial crisis.

First, the Fed is currently offering overnight reverse repurchase agreements on a daily basis at a pre-announced "offering rate," which is the maximum interest rate the Fed is willing to pay in the operation. Counterparties will compare the Fed's overnight reverse repurchase offering rate to other money market rates and determine whether to bid in the Fed's overnight reverse repurchase operation. The Fed initially took the approach of offering a rate of return (typically 5 basis points) and accepting bids from all eligible counterparties willing to accept that rate. Currently, the Fed specifies an offering rate of return and the size of each operation is limited, both in terms of the amount each individual institution can bid (currently up to \$30 billion) and the aggregate amount of the operation (currently set at \$300 billion). The Federal Reserve has been reporting the results of its daily overnight test operations, including the bid amounts submitted and accepted, as well as the high, low, and awarded bid rates. On September 30, 2014, for example, demand for the Fed's overnight reverse repurchase operation was more than \$400 billion. The results of the most recent operation may be found on the Federal Reserve Bank of New York's website at <http://www.newyorkfed.org/markets/omo/dmm/temp.cfm>. In testing overnight reverse repurchase operations, the Fed has varied the offering rate, and this has generally demonstrated that demand for the Fed's overnight reverse repurchase operations is indeed sensitive to the pattern of interest rates.

Second, the set of counterparties that are eligible to participate in the Fed's overnight reverse repurchase operations is much broader than it was in the past. The Fed conducted traditional open market operations with primary dealers; today, the institutions that are eligible to participate in the Fed's overnight reverse repurchase operations include about two dozen banks as well as a large number of money market funds under the management of 29 different firms, 22 primary dealers, and 13 government-sponsored enterprises (including 10 separate Federal Home Loan Banks). A full list of the counterparties that are eligible to participate in the Fed's reverse repurchase operations appears at http://www.newyorkfed.org/markets/expanded_counterparties.html. The eligible nonbank institutions, which are unable to earn interest on reserves, may be encouraged to engage in arbitrage activity relative to the rate the Fed offers on its overnight reverse repurchase operations because they have little incentive to lend funds in money markets at interest rates below the one they can receive directly by engaging in a reverse repurchase agreement with the Fed. For this reason, the Fed's reverse repurchase operations can provide a floor under the level of money market interest rates.

Third, unlike in the past, the Fed's overnight reverse repurchase agreements could be used in relatively large scale to increase the scarcity of reserves. When the Fed announces an overnight reverse repurchase test operation, it also announces

an aggregate offering amount—the total amount of dollars the Fed is willing to accept at the operation. The Fed’s testing of overnight reverse repurchase operations has demonstrated that these operations can set a soft floor under the level of the federal funds rate, and other short-term market interest rates, as long as market participants are confident that the aggregate capacity of the operations is large enough to meet demand. If the Fed wanted to increase the scarcity of reserves in the banking system, it could set the offering amount on its operations relatively high, and possibly also adjust the offering rate, to encourage demand for these operations. (The online Appendix available with this paper at <http://e-jep.org> describes the mechanism by which increases in overnight reverse repurchase operations result in a commensurate decline in the amount of reserve balances held by the banking system.) However, the Fed has discussed concerns associated with having a persistently large overnight reverse repurchase program, a topic to which we will return. Thus, the role that overnight reverse repurchases may play in increasing reserve scarcity over time is likely to be limited.

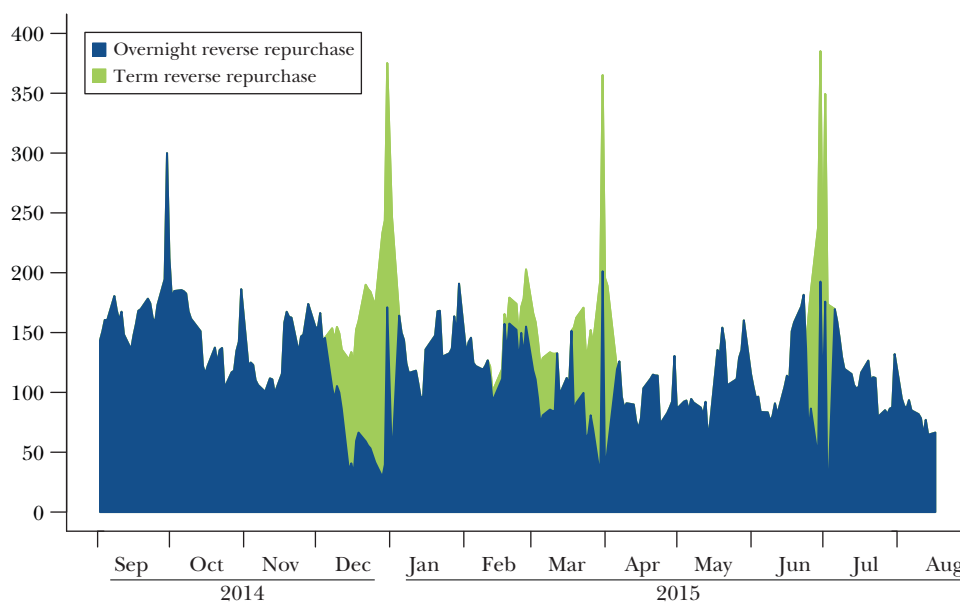
Term Reverse Repurchase Operations. In addition to overnight reverse repurchase operations, the Fed can conduct the same type of open market operation but have the second repurchasing stage occur more than one business day later; such transactions are known as “term reverse repurchase agreements.” As was the case with the overnight version of these operations, in the past the Fed has conducted relatively small-dollar amounts of term reverse repurchase agreements with primary dealers.

The Fed has been testing term reverse repurchase operations, although less regularly than the overnight operations, as shown in Figure 5. During the testing period, the Fed has offered its term operations at varying amounts, rates, and maturities, with most operations timed to cover quarter-end dates. The reason for this timing is that investment options for major cash lenders tend to dwindle at quarter-ends because some large banking institutions reduce the size of their balance sheets—that is, they tend to borrow less and accommodate less investment activity of other institutions—at that time in light of regulatory reporting requirements. About \$200 billion of term reverse repurchase agreements were outstanding on the Fed’s books at year-end 2014 and March-end 2015. Testing has also showed that term operations serve in part as a substitute for overnight operations.

Term Deposit Facility. The Federal Reserve may also choose to offer interest-bearing deposits to banks through its Term Deposit Facility. When a bank elects to place funds in this facility, the funds are moved out of reserve balances for the life of the term deposit. (The online Appendix available with this paper at <http://e-jep.org> describes the mechanism by which increases in term deposits result in a commensurate decline in the amount of reserve balances held by the banking system.) Thus, the Term Deposit Facility acts to increase reserve scarcity and it also encourages arbitrage as banks compare the yield the Fed offers on a term deposit with other investments opportunities.

The Fed has been testing the functionality of two types of term deposit operations since June 2010. In the first type, the Fed offers a given dollar amount of term

Figure 5

Total Overnight and Term Reverse Repurchase Test Operations*(billions of dollars outstanding daily)*

Source: Authors using data from Federal Reserve Bank of New York, "Temporary Open Market Operations" <https://apps.newyorkfed.org/markets/autorates/tomo-results-display?SHOWMORE=TRUE>.

deposits; banks then bid for the size of the deposit they want and specify the interest rate on the deposit. The Fed accepts bids beginning with the lowest bid rate and proceeding to higher bid rates until the total offered amount is exhausted. In this type of term deposit operation, all banks receive an interest rate identical to the rate paid to the last bank whose bid was accepted—that is, all banks receive the highest bid rate accepted. In the second type of term deposit operation, the Fed offers an interest rate and allows banks to deposit the amount of funds they desire, up to a predetermined maximum.

In its test operations, the Fed has varied some features, including the length of the term, the offering rate, and whether banks are permitted to withdraw their deposits prior to the end of the term, subject to a penalty. The option to withdraw deposits early has proven to be particularly attractive to banks in making their cash management decisions. During testing in February 2015, term deposits outstanding grew to about \$400 billion on the Fed's balance sheet. Results of all term deposit operations can be found on the Federal Reserve Board's website at http://www.federalreserve.gov/monetarypolicy/tdf_2014.htm.

Sell Federal Reserve Securities Holdings. One might expect that the Federal Reserve would choose to sell some of its securities holdings. That is, large-scale

asset purchases created the current situation of superabundant reserves, so why not engage in large-scale asset sales to reverse the process? Such sales could be seen as a way to return to a situation in which reserves are sufficiently scarce so that the Fed's traditional approach to implementing changes in the target federal funds rate may again be used, or as a way to unwind the current accommodative stance of monetary policy directly. For either reason, sales might be seen as the most obvious course of action in current circumstances.

However, these motivations for possibly selling securities are unattractive to policymakers. First, with excess reserves having accumulated over the course of several years and standing well in excess of \$2 trillion, a policy to substantially reduce the supply of reserves in the banking system would have to be enacted in a very large size and even then would take a significant amount of time to complete. For example, if the chosen pace of the Fed's large-scale asset *purchases* is any guide, it would take a number of years to sell a sufficient quantity of securities so as to cause a meaningful inward shift in the reserves supply curve. Such a tactic is not sufficiently nimble for implementing monetary policy. Also, using a heftier pace of sales might bring about unwanted effects in financial markets—for instance, the upward pressure on market interest rates that would accompany sizable sales of the Fed's holdings of securities could be hard to gauge and control.

Second, and more broadly, the monetary policies of central banks around the globe have generally been implemented in short-term financial markets. The Fed has many years of experience affecting conditions in the federal funds market, which is an overnight money market, and prefers to continue to implement its policy through this market as it raises short-term interest rates to more-normal levels while its balance sheet is large.

For these reasons, the Federal Open Market Committee has indicated that it plans to reduce its securities holdings in a gradual and predictable way primarily by altering its policy of reinvesting maturing and prepaying securities at some point after the start of the policy normalization process. In particular, the Committee has indicated that securities sales will not be part of the initial package of steps that it intends to take to begin to raise interest rates, and that it does not anticipate selling agency mortgage-backed securities as part of the policy normalization process, although limited sales might be warranted in the longer run to reduce or eliminate residual holdings. The Committee has emphasized that the timing and pace of any securities sales would be communicated to the public in advance.

Alter Reinvestments of Federal Reserve Securities Holdings. As just noted, the Federal Open Market Committee has said that it plans to alter its current policy of reinvesting maturing and prepaying securities—that is, either cease or commence phasing out its securities reinvestments—at some point after it begins increasing the target range for the federal funds rate. The timing with which the Committee will alter its reinvestments policy will depend on how economic and financial conditions and the economic outlook evolve. The pace at which this

tactic would reduce the Fed's overall holdings of securities is driven in part by the maturity dates of the Fed's holdings of Treasury and agency securities, which are known (and reported by the New York Fed at http://www.newyorkfed.org/markets/soma/sysopen_accholdings.html), and also by the pace at which agency mortgage-backed securities might be prepaid, which can only be estimated. Some examples of when prepayment of agency mortgage-backed securities would occur include when households pay off some or all of a mortgage balance early because they refinance their original mortgage with a lower available mortgage rate, pay off their mortgage when they sell a house to move, or pay down a portion of their mortgage to reduce the level of their debt.

If the Federal Open Market Committee decided to end its reinvestments, how would this affect the Fed's security holdings? As of late December 2014, the Federal Reserve held \$4.2 trillion of securities, of which about \$2.5 trillion were Treasury securities, \$1.7 trillion were agency mortgage-backed securities, and about \$39 billion were agency debt. If the Federal Open Market Committee were to end its policy of reinvesting its securities holdings in the near future, nearly \$700 billion of securities would mature or roll off of the Fed's portfolio in 2016 and 2017 taken together, comprising about \$410 billion of Treasury securities and an estimated \$290 billion of agency mortgage-backed securities (using actual holdings of securities as of December 24, 2014, and projected prepayments of agency mortgage-backed securities based on the model in Carpenter, Ihrig, Klee, Quinn, and Boote 2015, along with Blue Chip interest rate projections). Although this step would gradually shift the supply curve of reserves to the left, increasing reserve scarcity, it would take a number of years before such a shift in the supply of reserves would put upward pressure on the federal funds interest rate.

Reserve Requirements. Reserve requirements are calculated as fractions of certain deposit account levels and have traditionally helped to create demand for reserve balances. These reserve ratios are re-evaluated annually, although they have not been adjusted since 1992. In theory at least, the Fed could increase existing reserve ratios in order to require that additional reserve balances be held by banks, thereby contributing to the scarcity of excess reserve balances. The Fed may also, after consulting Congress, impose so-called emergency reserve requirements if it finds that extraordinary circumstances require such action, a step that the Fed has never before taken. Authorization for emergency reserve requirements is given in Section 204.5 of the Federal Reserve Board's Regulation D. In the past, the Federal Reserve has adjusted reserve requirements infrequently and not used them as an active tool in monetary policy implementation. The Fed has not indicated that it is considering adjusting reserve requirements at this time, either. In current circumstances, it would likely take a very substantial rise in reserve requirements to have a material effect on the federal funds interest rate.

Table 2 summarizes how each of the policy tools discussed above could be used to put upward pressure on short-term interest rates. As we discuss in the next section, the Federal Open Market Committee has announced that it plans to rely primarily on the first two channels of influence on interest rates—that is, the Fed

Table 2
The Channels through which Fed Policy Tools Could Put Upward Pressure on Interest Rates

<i>Policy tools</i>	<i>Encourage arbitrage</i>	<i>Increased scope of influence</i>	<i>Increase reserve scarcity</i>
Increase interest on excess reserves rate	✓		
Offer overnight reverse repurchase agreements	✓	✓	✓
Offer term reverse repurchase agreements	✓	✓	✓
Offer term deposits	✓		✓
Sell Fed's securities holdings			✓
Alter reinvestments of Fed's securities holdings			✓
Increase reserve requirements			✓

Source: Authors.

plans to use its policy tools to encourage arbitrage and to increase its scope of influence in short-term money markets.

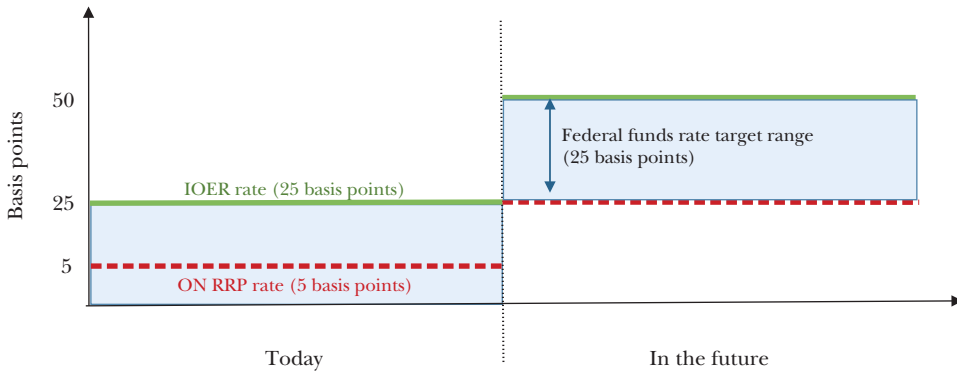
What Is the Fed's Preferred Approach for Raising the Federal Funds Interest Rate?

With the superabundant level of reserve balances in the banking system and with the Federal Open Market Committee having decided not to reverse course and sell off the assets it has purchased, the Fed cannot rely on the reserve scarcity channel to influence short-term interest rates. So what policy tools will the Fed prefer to use when it decides to raise the target range for the federal funds interest rate? The Federal Open Market Committee has formulated and issued plans regarding the approach it intends to take when it decides that the time has come to begin raising short-term interest rates, which are laid out in the “Policy Normalization Principles and Plans” that were issued following the September 2014 Federal Open Market Committee meeting (<http://www.federalreserve.gov/newsevents/press/monetary/20140917c.htm>) and augmented in the minutes of the Committee's March 2015 meeting (<http://www.federalreserve.gov/monetarypolicy/files/fomcminutes20150318.pdf>). In addition, Potter (2015) provides an explanation for how what the Fed calls policy “normalization” will be implemented.

When the Federal Open Market Committee decides that economic conditions and the outlook warrant, it will tighten the stance of monetary policy by raising the target range for the federal funds rate, a step that some have nicknamed interest rate “liftoff.” Framing monetary policy in terms of the federal funds rate has the advantage that it focuses Fed monetary policy communications on the same policy

Figure 6

The Target Range for the Federal Funds Interest Rate and the Fed's Administered Rates



Source: Authors.

Note: IOER = interest on excess reserves; ON RRP = overnight reverse repurchase agreements.

interest rate as in the past. The Committee plans to set a target range for the federal funds rate that is 25 basis points wide, as it has done since December 2008.

The primary policy tool that the Federal Open Market Committee plans to use to move the federal funds rate into its new target range is the interest rate on excess reserves; at liftoff, this interest rate will be set to the top of the new federal funds target range. As described above, increases in the interest rate on excess reserves will help to pull the federal funds rate and other short-term market interest rates into the target range via arbitrage.

The plan is for an overnight reverse repurchase facility to be used as a supplementary tool to help to push money market interest rates up from below both by encouraging arbitrage and by having an increased scope of influence in money markets: remember, the Fed can undertake its overnight reverse repurchase operations with a different set of money market participants than are eligible to earn the interest rate on excess reserves. At liftoff, the Fed will set an offering interest rate for overnight reverse repurchase agreements at the bottom of the new target range for the federal funds interest rate.

Figure 6 illustrates how this combination of tools is expected to work. The region on the left represents the position of the target range for the federal funds rate and the Fed's two overnight administered rates as they are set prior to liftoff, with a target range of 0 to 25 basis points (the shaded region), the interest rate on excess reserves rate at 25 basis points (the solid line), and the rate on the Fed's overnight reverse repurchase agreements at 5 basis points (the dotted line). For the sake of this illustration, say that the new target range is 25 to 50 basis points so that the interest rate on excess reserves and the overnight reverse repurchase rate would be increased to 50 basis points and 25 basis points, respectively. The increases

in these two administered rates will act to raise the market federal funds rate along with other short-term market interest rates.⁷

The main concern raised by the Federal Open Market Committee in using an overnight reverse repurchase agreement facility is that a large and persistent program could permanently alter patterns of borrowing and lending in repo markets and money markets as a whole—a concern the Committee has referred to as increasing the Federal Reserve’s role or size of its “footprint” in money markets. Keep in mind that the Fed’s operations in financial markets before the crisis were generally quite small and were aimed at affecting conditions in the federal funds market, a relatively small market. A large overnight reverse repurchase agreement facility could potentially expand the Federal Reserve’s role in financial intermediation and reshape the financial industry over time in ways that are difficult to anticipate in advance. In addition, in times of stress in financial markets, demand for a safe and liquid central bank asset might increase sharply, and the Fed’s counterparties could shift cash away from financial and nonfinancial corporations in the private sector and place it at the Fed instead, potentially causing or exacerbating disruptions in the availability of funds in money markets.

To mitigate these concerns, the Federal Open Market Committee plans to use its overnight reverse repurchase agreement facility only to the extent necessary to support short-term interest rates, and it will phase the facility out when it is no longer needed (for further analysis of these issues, see Frost et al. 2015). Nonetheless, balancing the need for keeping control over short-term interest rates against the risks associated with a large overnight reverse repurchase agreement facility, the Committee has determined that when policy normalization commences, the aggregate amount offered through its overnight reverse repurchase agreement facility will be temporarily large in order to help move the federal funds rate into its new target range. The Committee has also said that it expects that it will be appropriate to reduce the capacity of the facility fairly soon after it begins raising interest rates.⁸

⁷ The Fed will most likely also raise the primary credit rate when it begins raising short-term interest rates. Recall that the primary credit rate is the interest rate at which banks can borrow reserves overnight from the Fed. Since early 2010, the primary credit rate has been set at 75 basis points, 50 basis points above the top of the current range for the target federal funds rate. Given that reserves are now superabundant and will remain so for some time, banks generally will not need to borrow from the Fed and so are unlikely to be influenced by the level of the primary credit rate. In addition, the reputational costs (or “stigma”) associated with borrowing from the Fed are likely much higher than was the case prior to the financial crisis in part because the Fed is now required to release information about such borrowing to the public, albeit with a lag.

⁸ See the minutes of the Federal Open Market Committee’s March 2015 meeting for a discussion of the options the Committee considered for setting the aggregate size of the overnight reverse repurchase agreement facility in the early stages of the policy normalization process (<http://www.federalreserve.gov/monetarypolicy/files/fomcminutes20150318.pdf>). Details of the Committee’s discussion of the footprint and financial stability issues associated with an overnight reverse repurchase agreement facility are available in the minutes of the Committee’s April 2014, June 2014, and July 2014 meetings (found here, respectively: <http://www.federalreserve.gov/monetarypolicy/files/fomcminutes20140430.pdf>; <http://www.federalreserve.gov/monetarypolicy/files/fomcminutes20140618.pdf>; and <http://www.federalreserve.gov/monetarypolicy/files/fomcminutes20140730.pdf>).

The 25-basis-point spread between these two administered overnight rates at liftoff is also related to concerns about a persistently large overnight reverse repurchase agreement program. A spread of this size is expected to be narrow enough to allow sufficient control over short-term market interest rates, but wide enough to keep the overnight reverse repurchase agreement facility from becoming so attractive to financial market investors that its potential size invokes concerns about the size of the Fed's footprint in money markets or poses risks to financial stability.

The Federal Open Market Committee has said that it may use other supplementary tools if necessary, which would possibly include term reverse repurchase operations and term deposits. In addition, as noted above, the Fed is planning at some point to allow its securities holdings to decrease gradually by ceasing or reducing reinvestments of principal and interest from its securities holdings. Of course, economic and financial developments will continue to evolve, and the Fed will adjust the details of its approach to policy implementation accordingly.

Conclusion

After the Federal Reserve had used its conventional tools of open market operations to reduce the federal funds rate to near-zero in December 2008, the Fed turned to purchasing securities in the open market as a policy tool for putting downward pressure on longer-term interest rates. These purchases resulted in a superabundant level of reserve balances in the banking system. One legacy of that decision is that the traditional approach to raising the federal funds rate, which was used for many years prior to the financial crisis, will no longer work.

We have described the toolkit available to Federal Reserve policymakers and reviewed the preferred approach of the Federal Open Market Committee to raising the federal funds rate. Testing of the policy tools suggests that the proposed approach should work well. Of course, after policymakers decide that the time has come to begin raising short-term interest rates, they will be vigilant in using their available tools to adjust their approach, as needed, to ensure appropriate control over the federal funds rate and other short-term interest rates.

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