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**The Fed’s “Ample-Reserves” Approach to Implementing  
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# The Fed’s “Ample-Reserves” Approach to Implementing Monetary Policy

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February 19, 2020

## Abstract

We describe the Federal Reserve’s (the Fed’s) approach to implementing monetary policy in an ample-reserves regime. We use a stylized model to explain the factors the Fed considers and the tools it uses to ensure interest rate control when the quantity of reserves is ample. Then, we take a close look at the Fed’s experience operating in this regime in the post-crisis period, both as it has raised and lowered its policy rate. Looking ahead, we highlight some considerations relevant for maintaining a level of reserves consistent with the efficient and effective implementation of monetary policy, and conclude with an overview of the benefits of an ample-reserves regime. This primer is intended to enhance discussions and understanding of the Fed’s actions and communications regarding monetary policy implementation, as many resources on this topic may be out of date given the recent evolution of the policy environment.

**Keywords:** Monetary policy implementation, reserve balances, ample-reserves regime, administered rates, interest on reserves, open market operations

**JEL:** E58, E52, E43

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## 1. Introduction

The Federal Open Market Committee’s (FOMC) primary means of achieving its dual mandate of maximum employment and stable prices is to set the target range for its policy rate—the federal funds rate—and communicate any expected changes in the near-term path of that rate.<sup>1</sup> Adjustments to the target range, when combined with careful policy communications and transparent policy strategy, transmit to other short-term interest rates and set off a chain of broader influences on financial conditions, making them more or less accommodative of economic growth. But how does the Federal Reserve (the Fed) ensure that adjustments in the target range for its policy rate affect the market-determined federal funds rate and other short-term rates? It does so through careful attention to monetary policy *implementation*.

In January 2019, the FOMC communicated its intention to continue implementing monetary policy in a regime with an ample supply of reserves.<sup>2</sup> This decision was reached following more than a decade of successful policy implementation in an environment with plentiful reserves in the banking system. In this regime, when the FOMC wants to adjust the stance of policy, it moves the target range for the federal funds rate up or down and communicates information about the range to the public. To implement a corresponding change in market rates, the Fed adjusts its administered interest rates. Together these steps affect the market-determined federal funds rate and other overnight market interest rates. In contrast to the Fed’s previous implementation regime, in which the quantity of reserves was substantially less plentiful (and thus termed “limited,” or sometimes “scarce”), the Fed is not required to

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<sup>1</sup> The Federal Reserve Act directs the Board of Governors and the FOMC to conduct monetary policy “so as to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates.” Because long-term interest rates remain moderate in a stable economy with low expected inflation, this set of goals is often referred to as the “dual mandate” of maximum employment and price stability.

<sup>2</sup> The FOMC’s announcement may be found on the Federal Reserve Board’s web site at the following link: <https://www.federalreserve.gov/newsevents/pressreleases/monetary20190130c.htm>.

actively manage, or frequently adjust, the supply of reserves to maintain interest rate control. The ample-reserves regime provides good control of the federal funds rate in a simple and efficient manner and enables effective transmission of the stance of policy to broader financial markets. Moreover, this regime has proven resilient to significant changes in the monetary and regulatory environments since the Global Financial Crisis of 2007-09.<sup>3</sup>

In this paper, we describe the Fed’s “ample reserves” approach to implementing monetary policy, review its experience operating in this regime, and highlight some operational issues it may face on the path forward. This information is intended to enhance discussions and understanding of the Fed’s actions and communications related to monetary policy implementation. In particular, the material may be used to supplement textbooks and other existing learning materials that may be out of date in their descriptions of how the Fed implements monetary policy when reserve supply is considered ample.

The rest of the paper proceeds as follows. Using a stylized demand and supply framework, we begin in section 2 by describing the roles of banks and the Fed in influencing reserves. We then describe how an “ample” quantity of reserves is determined and how the Fed controls the federal funds rate when the quantity of reserves is ample, including the basic mechanics of the tools the Fed uses in this operating regime. In section 3, we take a close look at the Fed’s experience using this regime, and discuss the technical adjustments the Fed has implemented to ensure interest rate control. Turning to section 4, we describe some operational considerations the Fed may encounter as it seeks to maintain an ample quantity of reserves over time. Finally, section 5 concludes by highlighting the benefits of the FOMC’s chosen

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<sup>3</sup> For an overview of these changes and an analysis of their effects on money markets, see Klee, Senyuz, and Yoldas (2019).

implementation regime and reminds the reader of some key takeaways about its use going forward.

## 2. Policy implementation with ample reserves

The Fed implements monetary policy with the aim of keeping the federal funds rate in the FOMC's target range.<sup>4</sup> The federal funds rate (FFR) is the interest rate at which depository institutions, or what we term “banks,” borrow reserves from and lend reserves to one another on an overnight basis to meet short-term funding needs.<sup>5</sup> To understand how the Fed implements policy, it is easiest to consider a stylized model of the demand for and supply of reserves.

### 2.1 Banks' demand for reserves

Banks may hold a portion of their cash in an account at the Fed; these funds are referred to as reserve balances, or reserves. One can think of banks' reserve accounts in much the same way as households' checking accounts. Just as individuals use the cash in their checking and other transactional accounts to facilitate their deposit and payment activities, banks use reserves in managing their liquidity needs. Unlike other liquid assets, reserve balances are immediately available throughout the day to make payments for lending, securities settlement, meeting deposit outflows, and for other intermediation activities.

There are many reasons for banks to demand reserves. Before the crisis, banks' demand was largely driven by the Fed's reserve requirements and banks' intraday payment needs. Today, a host of additional factors come into play. First, the Fed now pays interest on reserves,

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<sup>4</sup> The Fed actually seeks to keep the daily “effective” FFR in the target range. The effective FFR is the volume-weighted median rate of all overnight federal funds transactions that occurred on a given day. These data, published daily, may be found on the Federal Reserve Bank of New York's web site here: <https://apps.newyorkfed.org/markets/autorates/fed%20funds>.

<sup>5</sup> We use the term “banks” throughout to refer to depository institutions, which include commercial banks, savings banks, credit unions, thrift institutions, and most U.S. branches and agencies of foreign banks.

and so holding these balances has become more attractive. Second, in response to the financial crisis, banks have enhanced their internal liquidity risk management practices, taking into account their individual business models and liquidity preferences, and reserves are useful for this purpose. Third, banks may hold reserves to help meet several post-crisis regulatory liquidity standards created in part to enhance banks' self-sufficiency in times of financial stress, such as resolution planning and the liquidity coverage ratio. Finally, some changes in the federal funds market since the financial crisis have also boosted banks' demand for reserves. In particular, late-day trading conditions are less liquid and banks are more hesitant to tap intraday or other credit from the Fed. Taken together, the mix of factors influencing banks' demand for reserves today is complex and also likely to continue to evolve over time.<sup>6</sup>

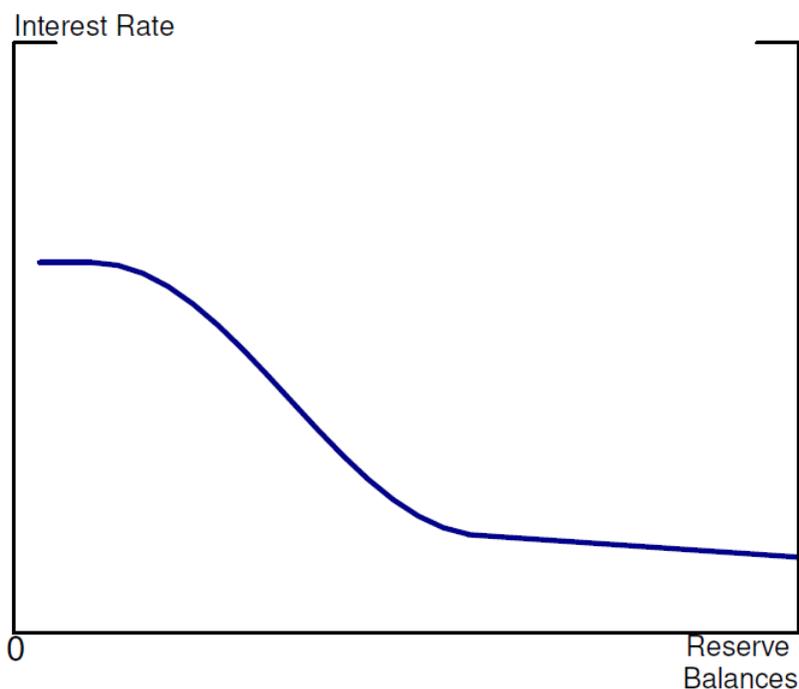
Figure 1 provides a stylized illustration of a demand curve for reserves. This downward-sloping curve has two portions. The steep portion of the curve captures the idea that the higher the opportunity cost of holding reserve balances, the lower is banks' demand. Conversely, as the cost of overnight borrowing in the federal funds market falls, banks are generally inclined to hold more reserves to provide themselves with an extra liquidity cushion. On this steep portion of the curve, banks' demand is quite sensitive to changes in reserve supply; the rate at which these funds are traded, the federal funds rate, adjusts with even modest changes in reserve supply. The demand curve also has a nearly flat, or flat, portion, located where the quantity of reserves in the banking system is significantly larger. The transition from the steep portion of the curve to the nearly flat portion illustrates that as the quantity of reserves in the banking system increases, at

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<sup>6</sup> Beginning in September 2018, the Federal Reserve has periodically conducted a *Senior Financial Officer Survey* to ask individual banks about their reserve balance management practices, including the importance of various factors in driving their reserve demand. In August 2019, banks responded that meeting routine intraday payment flows and satisfying internal liquidity stress metrics were very important factors in determining their demand for reserves. A summary of the results of each survey is published on the Federal Reserve Board's web site, available at the following link: <https://www.federalreserve.gov/data/sfos/sfos.htm>. In addition, Logan (2019a) discusses banks' demand for reserves.

some point, banks do not find much benefit from holding additional reserves other than earning the interest the Fed pays on these balances. As a result, and as we'll see below, the demand curve flattens out at a level that is close to the interest rate earned on reserve balances. On the flat portion of the curve, banks' demand is not sensitive to changes in reserve supply; the federal funds rate does not materially move when supply is adjusted either up or down.

**Figure 1**  
**Banks' Demand for Reserves**



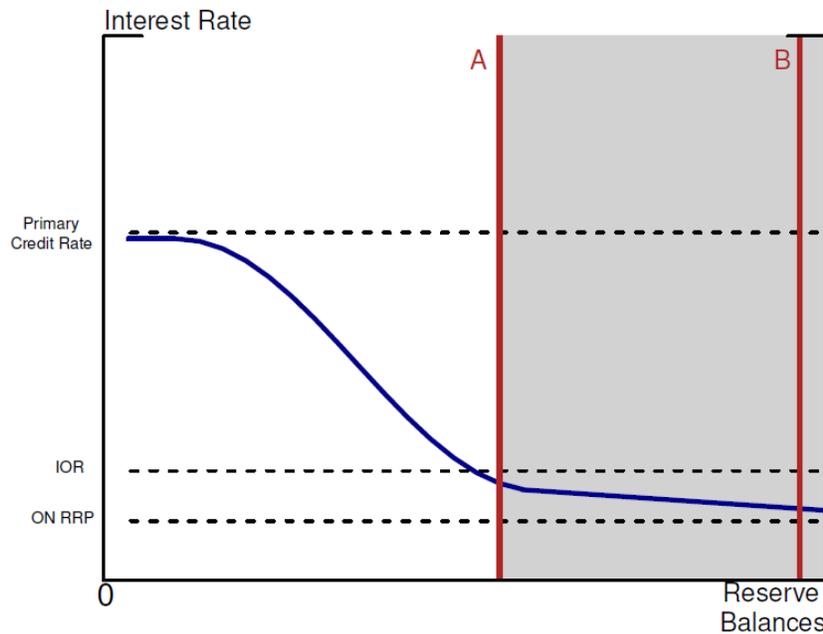
## 2.2 The Fed's supply of reserves

Many factors that affect the supply of reserves. Some influences are independent of the Fed's control, termed autonomous factors, and others are directly related to the Fed's actions, termed open market operations. Because the Fed understands how autonomous factors affect the supply of reserves, it can choose what operations to take, if any, in response. As a result, one should think of the Fed as controlling the supply of reserves in the banking system.

So what quantity of reserves must the Fed supply to be in an ample-reserves regime? The term “ample” is fundamentally tied to the location of the Fed’s supply curve relative to banks’ demand curve. In particular, to be ample, the Fed’s reserve supply must be positioned so that the equilibrium FFR does not materially change with movements in the quantity of reserves in the banking system. This condition is met when the Fed’s supply curve intersects banks’ demand curve on the portion of the demand curve that is nearly flat.

Figure 2 illustrates the Fed’s ample-reserves regime. The red supply curves are vertical because the Fed controls the level of reserves. To be in an ample reserves-regime, the quantity

**Figure 2**  
**The Fed’s Ample-Reserves Regime**



of reserves must be at least as large as the (stylized) quantity labeled “A”—reserve supply must fall in the gray shaded region. In this region, any supply curve will intersect the demand curve at its relatively flat portion, meeting the condition for being in an ample regime. While the quantity labeled “A” represents the minimum level of reserves needed to be in an ample-reserves regime,

the quantity “B” represents a super plentiful amount of reserves, and one that is also consistent with being in an ample regime.

An important takeaway from figure 2 is that the stylized gray region is very wide. An ample-reserves regime functions well with a wide range of reserve levels in the banking system, such as a quantity near, or even greater than, vertical line “B,” as well as a quantity that is significantly smaller, such as closer to vertical line “A,” or with any reserve quantity in between.

Over the past several years, the quantity of reserves supplied by the Fed has moved widely within this gray range. During the period from late 2008 to late 2014, the Fed conducted a series of large-scale purchases of longer-term securities to put downward pressure on longer-term interest rates in response to the Great Recession that severely weakened the U.S. economy. When the Fed completed these purchases, reserves stood at a peak of \$2.8 trillion, or 15 percent of U.S. nominal GDP.<sup>7</sup> At this time, the vertical supply curve was essentially near “B,” a quantity sometimes referred to as “abundant” or “super abundant.”<sup>8</sup> Then, as the economy recovered, the Fed took steps to reduce the supply of reserves. Between late 2014 and August 2019, reserves slowly declined, on balance, and at the end of this period, they stood near \$1.5 trillion, a quantity much closer to “A.” So at what approximate quantity of reserves might the Fed prefer to operate in the long run?

In January 2019, the FOMC announced its plans for implementing monetary policy over the longer run. The Committee described its choice of implementation regime this way:<sup>9</sup>

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<sup>7</sup> A summary of the Fed’s purchase programs may be found on the Federal Reserve Board’s web site at this link: [https://www.federalreserve.gov/monetarypolicy/bst\\_openmarketops.htm](https://www.federalreserve.gov/monetarypolicy/bst_openmarketops.htm). In addition, see Bernanke (2012) for a broader discussion of the Fed’s response to the crisis.

<sup>8</sup> See Yellen (2017) for a discussion of the role of reserves in the policy implementation framework, both when reserves were relatively limited and when they were characterized as abundant.

<sup>9</sup> The FOMC’s announcement may be found on the Federal Reserve Board’s web site at the following link: <https://www.federalreserve.gov/newsevents/pressreleases/monetary20190130c.htm>.

The Committee intends to continue to implement monetary policy in a regime in which an ample supply of reserves ensures that control over the level of the federal funds rate and other short-term interest rates is exercised primarily through the setting of the Federal Reserve's administered rates, and in which active management of the supply of reserves is not required.

With this announcement, the Committee communicated that it will not return to its pre-crisis implementation regime. In that limited-reserves regime, the Fed supplied an amount of reserves well to the left of vertical line “A” in figure 2; it operated on the steep portion of banks’ demand curve where even modest changes in the supply of reserves affect the equilibrium level of the FFR. In addition, characterizing the desired supply of reserves as “ample” signaled that the Committee does not want to operate in the long run with a super plentiful amount of reserves, such as one depicted as being closer to vertical line “B.” This indication is also tied to the Committee’s previously stated intention that the Fed will, in the longer run, hold no more securities than necessary to implement monetary policy efficiently and effectively.<sup>10</sup> Thus, taking the pieces together, the Committee’s announcement indicated that, going forward, the Fed will keep supplying a quantity of reserves in the gray region, and that the quantity will be closer to the vertical line labeled “A” than “B.” With this framing, we now turn to how the Fed controls the FFR when the quantity of reserves in the banking system is in the gray region.

### **2.3 Rate control tools**

When implementing monetary policy in an ample-reserves regime, the Fed primarily relies on its administered interest rates to keep the FFR within its target range. But it also

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<sup>10</sup> Holding other parts of the Fed’s balance sheet constant, an increase (decrease) in securities will increase (decrease) reserves. So a statement about “holding no more securities than necessary” is also saying the Fed plans to hold no more reserves than necessary to implement policy efficiently and effectively. Information about the Federal Reserve’s Policy Normalization Principles and Plans is summarized on the Federal Reserve Board’s web site at the following link: <https://www.federalreserve.gov/monetarypolicy/policy-normalization-discussions-communications-history.htm>.

periodically needs to adjust the quantity of reserves in the banking system, using open market operations, to maintain an ample supply. We describe each of these rate control tactics in turn.

### Administered rates

Administered rates are standing interest rates the Fed sets, or administers. Currently, the Fed predominantly relies on two such interest rates. Each rate is available to a specific set of counterparties on particular cash deposits held at the Fed. The counterparties can decide if they want to deposit their cash at the Fed and earn the relevant standing rate or lend it instead to another market participant at a negotiated rate in one of the various money markets for cash. One can think of the Fed's administered rates as reservation rates—they set a lower bar on the return a counterparty is willing to accept from others in money markets. Hence, movements in the Fed's administered rates directly help steer money market interest rates.

The Fed's key administered rate is the interest on reserves (IOR) rate, the rate that banks earn from the Fed on the funds they deposit in their reserve accounts.<sup>11</sup> When choosing whether to hold some cash in their accounts at the Fed and earn the IOR rate or invest the cash in another money market instrument, such as Treasury bills, banks mainly consider their liquidity needs and the relative returns available on alternative investments. With the payment of IOR, banks have little or no incentive to lend reserves at rates lower than IOR, which is reflected in the flattening out of banks' reserve demand curve near the IOR rate (see figure 2). In this sense, the IOR rate acts as a reservation rate in banks' intermediation activities, helping to establish a minimum, or a

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<sup>11</sup> Technically, the Fed pays interest on two different components of reserves—required reserves, tied to the Fed's reserve requirements as specified in Regulation D, and excess reserves, balances that are above the level of reserves banks are required by the Fed to hold. Under authority from Congress granted in the Financial Services Regulatory Relief Act of 2006 and the Emergency Economic Stabilization Act of 2008, the Board of Governors directed the Federal Reserve Banks to pay interest on required reserve balances and on excess balances, and these two rates are currently set equal. For simplicity, we use "IOR rate" to refer to the single rate at which the Federal Reserve Banks pay interest on all reserve balances.

floor, under the various overnight market returns that banks consider. In addition, as long as the supply of reserves remains ample, banks should compete with each other so that lending in the federal funds market occurs at rates that are never too far above the IOR rate. As a result, in an ample reserves regime, the FFR is expected to trade near the IOR rate. While it can be modestly above or below the IOR rate depending on seasonal factors and market conditions, the incentives described above combine to prevent the FFR from drifting away from the IOR rate. Because of the close linkage between the IOR rate and the FFR, the IOR rate is the Fed's primary tool of policy implementation—for keeping the FFR in its target range.

In addition to banks, various nonbank institutions actively participate in U.S. money markets, and these institutions are not eligible to earn IOR. For example, government-sponsored enterprises account for the majority of lending in the federal funds market since the financial crisis, and they often lend excess cash at rates below IOR. As a result, IOR by itself is unable to set a firm floor under the constellation of overnight money market rates. To enhance its rate control, the Fed introduced a supplementary tool, the standing overnight reverse repurchase (ON RRP) facility, to influence the interest rates at which nonbanks lend cash in money markets. The Fed began testing this form of open market operation in September 2013 and employed the facility when the FOMC first raised interest rates following the crisis in December 2015.<sup>12</sup>

The FOMC sets the facility's offering rate (ON RRP rate), the maximum interest rate the Fed is willing to pay in an ON RRP transaction.<sup>13</sup> Figure 3 illustrates a reverse repurchase

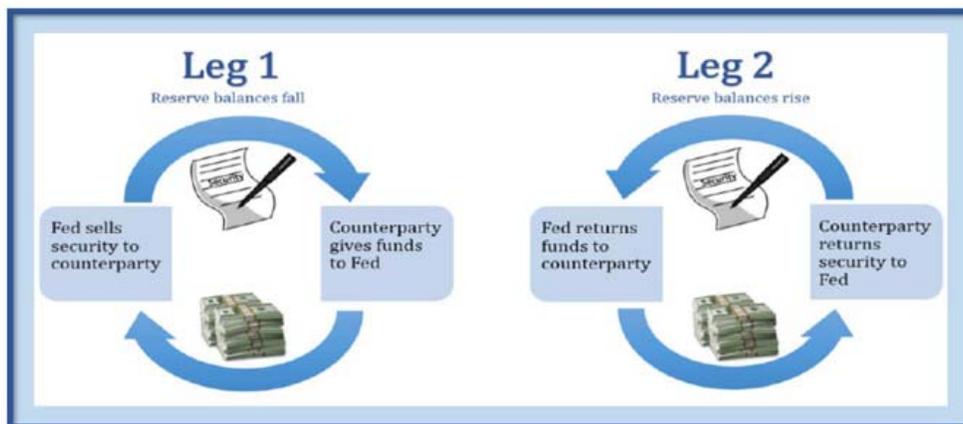
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<sup>12</sup> The Fed introduced the ON RRP facility in September 2013 and conducted test operations through late 2015. In September 2014, the FOMC indicated that it intended to use the facility as needed to help control the federal funds rate. For more information, see the Federal Reserve Board's and the Federal Reserve Bank of New York's web sites at these links, respectively: <https://www.federalreserve.gov/monetarypolicy/overnight-reverse-repurchase-agreements.htm>; [https://www.newyorkfed.org/markets/rrp\\_faq.html](https://www.newyorkfed.org/markets/rrp_faq.html).

<sup>13</sup> The interest rate a counterparty receives is the facility's offering rate except in the highly unlikely event that the amount of propositions the Fed receives exceeds the amount of securities available for the operation. In that case, the interest rate would be determined by an auction process conducted by the Federal Reserve Bank of New York, as described in the FAQs available at the following link: [https://www.newyorkfed.org/markets/rrp\\_faq.html](https://www.newyorkfed.org/markets/rrp_faq.html).

agreement (or reverse repo, or RRP) transaction between the Fed and one of its counterparties, and notes its effect on reserves. In the first leg of the transaction, the counterparty deposits its cash in the Fed's ON RRP facility and the Fed recognizes that some of its Treasury securities are temporarily sold to the counterparty. With this step, reserve supply declines by the amount of cash deposited in the Fed's facility. On the second day, or leg 2, the transaction is unwound, with the Fed returning to the counterparty their cash deposit plus interest earned, and with the interest tied to the ON RRP transaction rate. In addition, the temporary sale of the Treasury securities is unwound, and reserve supply increases. Given the nature of this transaction, take-up of the Fed's ON RRP facilities constitutes a type of open market operation.

**Figure 3**  
**Illustration of a Reverse Repo (RRP) Transaction**



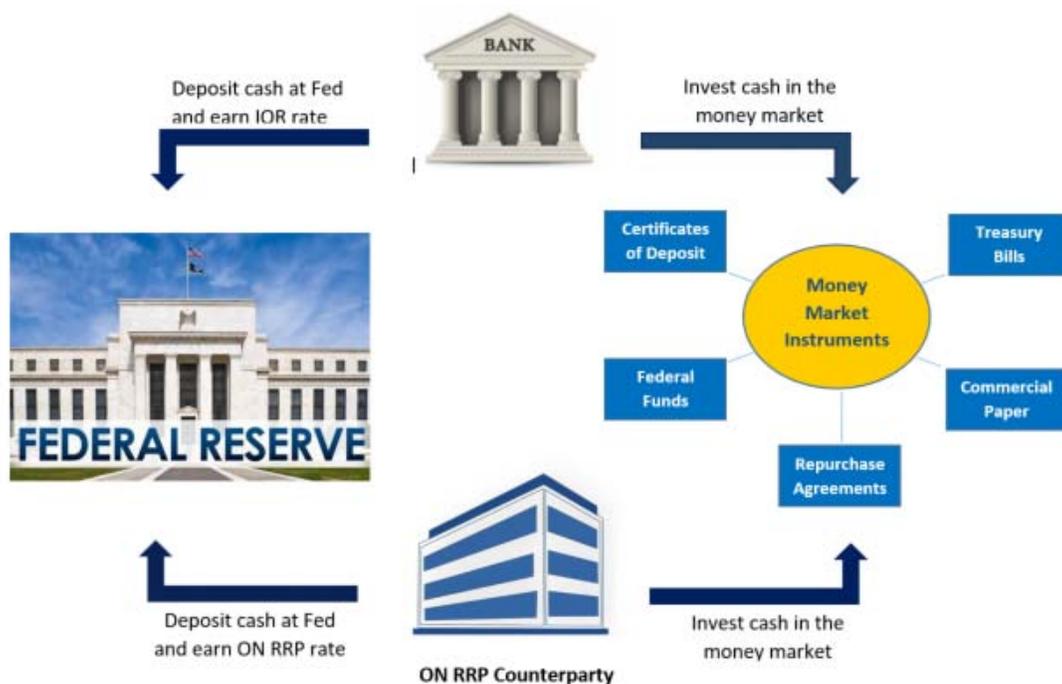
The ON RRP facility is available to about 130 counterparties. Many of these counterparties, including money market funds, government-sponsored enterprises, in addition to banks, are very active in money markets.<sup>14</sup> Because of the possibility of doing reverse repo with the Fed at its standing offering rate, these market participants have little incentive to lend cash to

<sup>14</sup> For more on how the ON RRP facility complements the use of IOR and helps control short-term interest rates, including some issues the Fed considered in its design, see Frost et al. (2015).

others at a lower rate. Thus, for these counterparties, the ON RRP facility’s offering rate plays a role similar to that of the IOR rate for banks—the ON RRP rate acts as a reservation rate in money market investment and cash management decisions, helping to put a floor under the various overnight market rates that these institutions consider, regardless of whether these counterparties actually use the Fed’s facility on any given day or not. So while it’s true that when take-up at the ON RRP facility rises, reserves decline (all else equal), the primary purpose of the facility is not to adjust reserve supply but to directly influence short-term interest rates faced by nonbanks.

Figure 4 illustrates how the Fed’s IOR and ON RRP rates act as reservation rates for the Fed’s counterparties—providing standing options for a range of money market participants when they consider investing their cash in various money market instruments or with the Fed.

**Figure 4**  
**The Fed’s Administered Rates act as Reservation Rates**



The Fed adjusts these administered rates in concert with changes in the target range for its policy rate, and its counterparties use the new levels of these reservation rates in their evaluation of where to invest cash. This dynamic allows the Fed to achieve the FOMC’s desired stance of policy.<sup>15</sup> And, importantly, this approach to interest rate control does not require the Fed to frequently adjust the quantity of reserves in the banking system. But how does the Fed ensure the quantity of reserves remains ample over time?

### Open market operations (OMOs)

Open market operations, or OMOs—purchasing or selling securities in the open market—are a long-standing tool of policy implementation. This tool is currently used in two different ways. As we noted above, for the past several years the Fed has been using an ON RRP facility designed to directly influence short-term *interest rates*. In addition, for decades, the Fed has used OMOs to alter the *quantity* of reserves it supplies—to purposefully expand or contract the amount of reserves in the banking system.<sup>16</sup> The latter type of OMOs, designed to adjust reserve quantities, is specifically used by the Fed to maintain an ample level of reserves in the banking system. As discussed above, to be in an ample-reserves regime, the Fed needs to maintain a quantity of reserves that is in the gray shaded region in figure 2, one that is at least as large as the (stylized) quantity “A.” And, in so doing, the Fed must account for the effects of autonomous factors on the supply of reserves.

As noted in section 2.2, the Fed monitors several autonomous factors. Highlighted in Table 1, these factors are liabilities of the Fed other than reserves and include currency in

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<sup>15</sup> Some erroneously refer to the Fed’s ample-reserves implementation regime as a “corridor” regime. The Fed’s ample-reserves regime is a “floor” regime with two floor, or deposit rates: one for banks (the IOR rate) and one primarily for nonbanks (the ON RRP rate). The fact that the Fed may set the IOR rate a bit above the ON RRP rate does not reflect an intention to create a rate corridor.

<sup>16</sup> For more information on how various OMOs affect reserves, see Ihrig, Mize, and Weinbach (2017).

circulation, the Treasury’s cash account, or General Account, at the Fed (the TGA), and outstanding reverse repo agreements (the latter includes the Fed’s foreign repurchase pool and balances at the ON RRP facility). Box 1 describes each of these non-reserve liabilities and their purpose. Here we describe how these factors intersect policy implementation.

**Table 1**  
**The Fed’s Liabilities: Autonomous Factors Highlighted**

Fed Liability Item	Amount* (\$ billions)
Currency in circulation	1,748
Reserve Balances	1,695
U.S. Treasury, General Account (TGA)	404
Reverse repurchase agreements	224
Other liabilities	73

\* As of February 12, 2020.

Source: Federal Reserve Board, H.4.1 statistical release.

The levels of the Fed’s non-reserve liabilities move over time, exhibiting both long-run trend growth as well as short-run fluctuations. For example, currency in circulation has grown on average about 6 percent a year, and the public’s demand often temporarily expands around holidays. Each of these influences causes reserves to decline, all else equal. In addition, Treasury’s account at the Fed fluctuates, sometimes substantially, including around corporate and personal tax payment dates; the movements cause aggregate reserves to fluctuate in response, in the opposite direction. In general, reserves decline dollar-for-dollar when the Fed’s non-reserve liabilities increase, and vice versa. The effects on reserves from changes in the

autonomous factors reflect the fact that the activities associated with each of the Fed’s non-reserve liabilities clear through reserve accounts at the Fed.<sup>17</sup>

Does the Fed need to respond to the effects of changes in autonomous factors on reserves? The answer is, sometimes. When currency or another non-reserve liability grows, the Fed has to decide if it wants to offset the decline in reserves by purchasing securities in the open market. The Fed will conduct a permanent OMO (buy securities and hold them to maturity) if it thinks the drain in reserves is permanent; it will conduct a temporary OMO (a repurchase agreement or repo) if it thinks the drain is temporary.<sup>18</sup> Either of these actions will immediately expand the supply of reserves in the banking system, shifting any supply curve in figure 2 rightward within the gray region. Whether the Fed judges it needs to undertake one of these actions or not depends on the location of the original supply curve and the size of the effect on reserve supply relative to the quantity associated with the vertical line “A” in figure 2.

### **The discount window and other tools**

The Fed also continues to administer several interest rates that it charges to banks for loans extended through its long-standing lending programs known collectively as the discount window. The Fed typically adjusts these rates in sync with its other administered rates. The main lending program is for primary credit—overnight loans extended to banks in generally sound financial condition. The primary credit rate is typically set above the general level of

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<sup>17</sup> For example, when a bank requests currency for its customers, an armored truck comes to a regional Federal Reserve Bank, picks up the cash that was ordered, and delivers it to the requesting bank. The Fed decreases the ordering bank’s reserve account to take payment for the cash. (These steps are similar to those that occur when you go to your bank or an ATM for cash: When you withdraw cash, your bank takes payment by debiting your bank account.)

<sup>18</sup> A repo (or RP) operation is the opposite of the RRP transaction shown in figure 3. When the Fed conducts a repo, it lends cash to the market, temporarily purchases a security from an eligible counterparty, and agrees to sell the security back when the term of the contract ends, receiving the lent cash back plus interest when the transaction unwinds. Each year, the Federal Reserve Bank of New York publishes an annual report of open market operations conducted during the previous year, available at the following link: [https://www.newyorkfed.org/markets/annual\\_reports](https://www.newyorkfed.org/markets/annual_reports).

short-term interest rates. This rate is depicted in figure 2 as the intercept of the demand curve on the y-axis because banks should be unwilling to buy reserves at market rates that are much, if any, above the rate they can pay to borrow from the Fed. In that sense, the discount window provides a backup source of funding for banks, with pricing that is intended to discourage frequent borrowing while still providing a ceiling on short-term market rates. However, for many years, banks have demonstrated reluctance to use the discount window out of concern that borrowing from the central bank sends negative signals about their financial condition, a dynamic typically referred to as the stigma associated with the use of the discount window. The Fed also maintains other policy implementation tools, ones that are less frequently relied upon.<sup>19</sup>

### **3. How has policy implementation worked with ample reserves?**

The Fed has accumulated a lot of experience implementing policy with a sizable level of reserves. Here we take a look at the Fed's experience using an ample-reserves regime, including how the Fed has adjusted its tools to maintain the FFR in the FOMC's target range.

#### **3.1 Transmission of the policy rate to other interest rates**

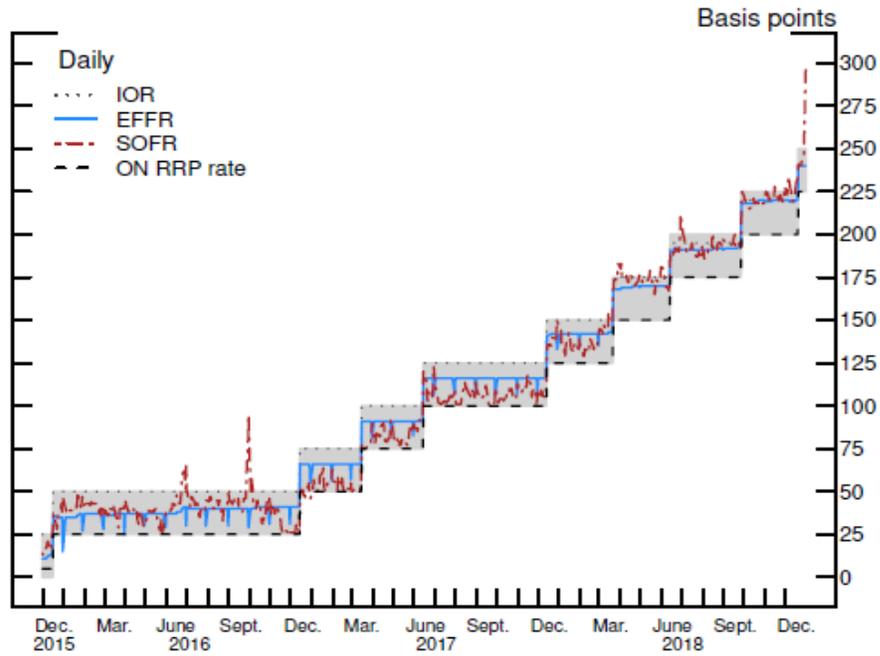
Figure 5 illustrates the movements in the Fed's administered rates and selected overnight money market rates over the most recent period of ups (panel A) and downs (panel B) in the target range, shown by the gray shaded regions. The IOR and ON RRP rates are shown by the dotted and dashed black lines, respectively. The blue solid line shows the (effective) federal funds rate, and the red dash-dotted line shows the secured overnight financing rate, or SOFR, which is a broad measure of the cost of borrowing cash overnight when collateralized by Treasury securities. Panel A begins with the first step in the Fed's process of normalizing the stance of monetary policy after the Great Recession. Specifically, in December 2015, after seven

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<sup>19</sup> A summary of all of the Fed's policy tools can be found on the Federal Reserve Board's website. <https://www.federalreserve.gov/monetarypolicy/policytools.htm>.

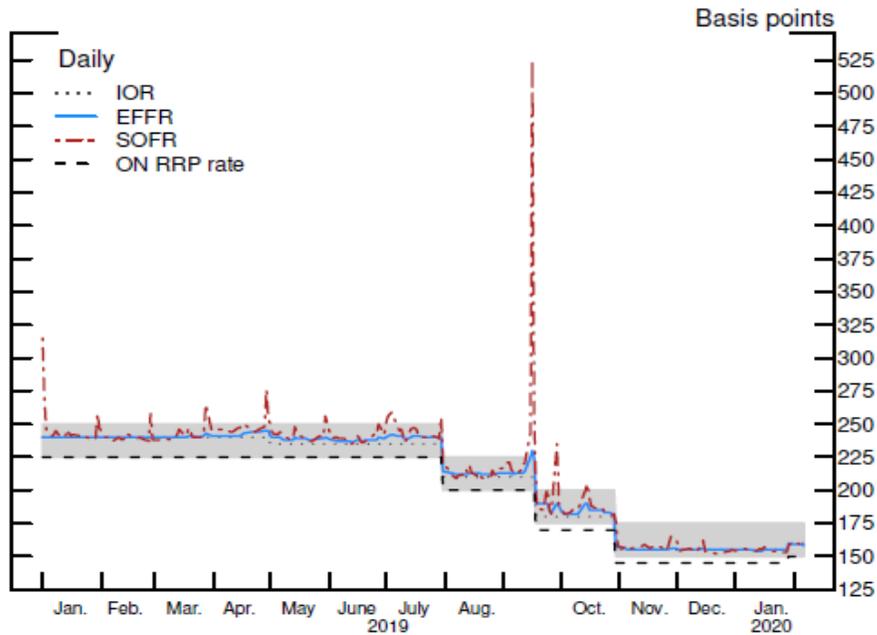
## Figure 5 Policy Rate Pass-through to Selected Overnight Money Market Rates

Panel A: Pass through of policy rate hikes



Source: Federal Reserve Bank of New York.

Panel B: Pass through of policy rate cuts



Source: Federal Reserve Bank of New York.

years of keeping the fed funds rate near zero (in a range of 0 to  $\frac{1}{4}$  percent), the FOMC increased its target range for the federal funds rate by  $\frac{1}{4}$  percent (25 basis points), to a range of  $\frac{1}{4}$  to  $\frac{1}{2}$  percent. At that time, the Fed's key administered rates, the IOR and ON RRP rates, were set at the top (0.50 percent) and bottom (0.25 percent) of the target range, respectively.<sup>20</sup> Immediately after the Fed increased both administered rates, a constellation of short-term market interest rates moved up simultaneously. Since then, the FOMC increased the target range for the federal funds rate eight more times through the end of 2018. Then, as shown in panel B, the FOMC reduced the target range three times in 2019 to cushion the economy from possible headwinds to economic growth. With each of the FOMC's decisions to move the target range up or down, the Fed adjusted its administered rates accordingly, and the federal funds rate and other short-term market rates followed suit.<sup>21</sup>

One can see that the changes in the FFR and other short-term interest rates also passed through to longer-term interest rates. For example, figure 6 plots three such rates. The rate shown in solid green is the net yield on government money funds held by institutional investors, which reflects the weighted-average return on the underlying assets held, less fees charged, by the fund. Also shown are rates on 3-month Treasury bills (the purple dashed line) and AA-rated commercial paper of financial companies (the red dash-dotted line). Each of these rates also moved with the changes in the FOMC's target range. In fact, these rates moved up and down a bit in anticipation of the Fed's policy rate changes as term interest rates reflect not only prevailing overnight interest rates but also market participants' expectations for the level of

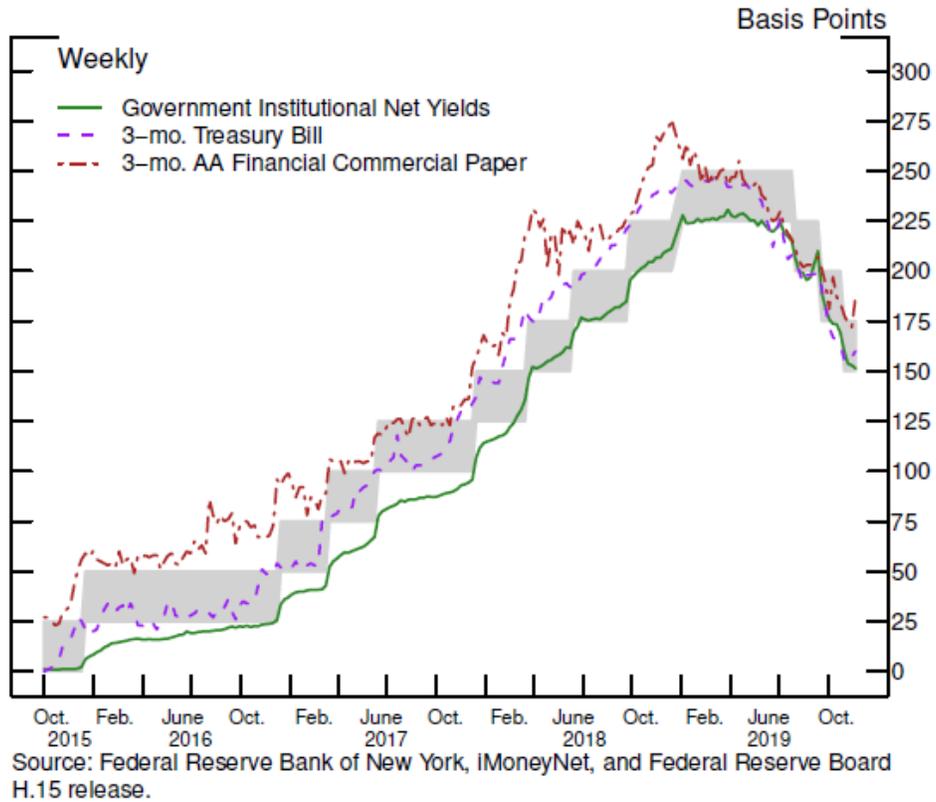
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<sup>20</sup> For a full discussion of how the Fed designed its tools to work at liftoff, see Ihrig, Meade, and Weinbach (2015).

<sup>21</sup> During the period shown, there were two days only when the daily effective FFR printed outside of the target range. On December 31, 2015, the effective FFR printed five basis points below the bottom of the target range and on September 17, 2019, it printed five basis point above the top of the target range.

overnight rates in the future.<sup>22</sup> When market participants expect the Fed to tighten or ease the stance of policy, term rates can rise or fall to some extent ahead of the FOMC’s actual decision.

**Figure 6**  
**Policy Rate Pass-through to Selected Longer-term Interest Rates**



Overall, the FOMC’s adjustments to the stance of policy have transmitted to a relatively broad set of market interest rates and influenced financial conditions, as well as consumers’ and businesses’ economic decisions. These adjustments ultimately created conditions that have helped prolong the post-crisis economic expansion by fostering the achievement of both legs of the FOMC’s dual mandate.

<sup>22</sup> For a more detailed account of how the first three post-crisis rate hikes were transmitted to other interest rates, see Anderson, Ihrig, Styczynski, and Weinbach (2017).

### **3.2 Technical adjustments within the implementation regime**

As we just discussed, the FOMC has been successful in steering the federal funds rate up and down to reflect the desired stance of monetary policy, and those changes have transmitted to broader financial conditions. Part of the Fed's success in maintaining the FFR within the target range has been due to its flexibility in adjusting the parameters of its implementation tools as needed to support interest rate control. These actions are purely technical measures to support the effective implementation of monetary policy; such actions do not represent a change in the stance of monetary policy. In this subsection, we discuss two broad categories of technical adjustments that the Fed has made in response to evolving financial market conditions and as it has gained more experience with the current operating regime.

#### **Technical adjustments to the Fed's administered rates**

A close look at either panel in figure 5 reveals that the position of the IOR rate (the dotted black line) relative to the top of the FOMC's target range (the top of the shaded region) has not remained fixed. At times, such as when pressures in short-term funding markets have emerged, the Fed has made technical adjustments to the setting of the IOR rate to help keep the FFR trading within the target range. For example, in the spring of 2018, upward pressure on money market rates, including the effective FFR, materialized. The pressure seemed to stem from a large increase in the net supply of Treasury bills, which pushed the yields on those securities higher and, with increased repo financing activity on the part of the bill holders, put some upward pressure on repo rates. As a result, a constellation of short-term money market interest rates moved higher, the effective FFR increased within the target range, and money funds allocated their cash investments into higher-yielding Treasury bills and private repo instead of into the Fed's ON RRP facility. To ensure that the effective FFR remained well within the target

range, the Fed made a small downward technical adjustment to the IOR rate, reducing it by 5 basis points, to a level that was 5 basis points below the top of the target range. This change was accomplished by implementing a 20-basis-point increase in the IOR rate at a time when the FOMC raised the target range by 25 basis points.

The Fed made a few more technical adjustments to the IOR rate between 2018 and 2020. In 2018 and 2019, the Fed again lowered the IOR rate relative to the top of the target range. And in September 2019, the Fed also simultaneously lowered the ON RRP rate, setting it 5 basis points below the bottom of the target range, keeping a spread between the IOR and the ON RRP rates of 10 basis points. These small technical adjustments exerted downward pressure on the federal funds rate and other money market rates and fostered trading in the federal funds market at rates well within the target range. The Fed has also made adjustments in the other direction. In January 2020, the Fed unwound its previous step, adjusting the IOR and ON RRP rates each higher by 5 basis points, to keep the FFR trading well within the target range. These technical adjustments, all made within the ample-reserves regime, are used for policy implementation purposes only.<sup>23</sup>

### **Technical adjustments to the supply of reserves**

Although active management of the supply of reserves is not, by design, a feature of an ample-reserves regime, there are times when the Desk may take steps, in accordance with the direction it receives from the FOMC, to adjust the supply of reserves in order to support interest rate control. This step was taken in mid-September 2019 when strains in funding markets

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<sup>23</sup> The Fed publishes an Implementation Note after every FOMC meeting and any time implementation adjustments are made, available on the Federal Reserve Board's web site (with other FOMC meeting documents) at the following link: <https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm>.

emerged as quarterly corporate tax payments and the settlement of Treasury securities coincided and resulted in a large amount of cash being drained from money markets.<sup>24</sup> In fact, reserve balances fell by more than \$100 billion over just two days. Although the drain in reserves associated with seasonal tax payments was expected to put some upward pressure on money market rates, the increases in rates that materialized were exceptionally large by historical standards. As shown in panel B of figure 5, the SOFR (red dash-dotted line) spiked and the effective FFR (blue solid line) moved 5 basis points above the target range. The moves in each rate were much larger than those observed over the past few years. (Box 2 presents an analysis of the relationship between changes in the quantity of reserves and the FFR and provides estimates of rate sensitivity at various reserve levels.) In response to these market developments, and consistent with the directive from the FOMC to maintain the FFR in the FOMC’s target range, the Desk undertook OMOs to temporarily purchase securities to add reserves. Specifically, the Desk conducted repos to provide immediate liquidity to the market and help alleviate the funding strains, ensuring the FFR resumed trading within the target range.

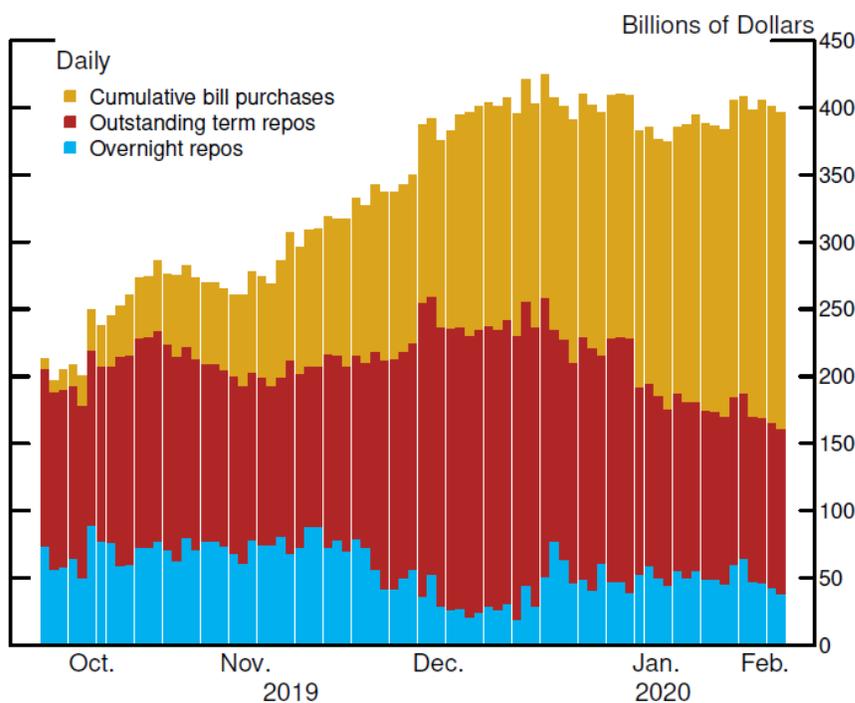
In addition, the FOMC judged that the prevailing level of reserve supply at that time may have been a bit too low to be consistent with operating in an ample-reserves regime. Accordingly, in early October 2019, the FOMC directed the Desk to maintain over time reserve balances at least as large as the level that had prevailed in “early September,” a time when there were no evident pressures in money markets, and instructed the Desk how to go about increasing reserve supply. Consistent with those instructions, the Desk announced further overnight and term repos (temporary OMOs) as well as reserve management purchases in the form of outright

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<sup>24</sup> See Anbil, Anderson, and Senyuz (forthcoming 2020) for an overview of money market events in September 2019, including a more detailed discussion of the factors that contributed to the strains that emerged in the repo market.

purchases (permanent OMOs) of Treasury bills at a pace of about \$60 billion per month at least into the second quarter of 2020. The Committee explicitly noted that these bill purchases were purely a technical measure to increase reserve levels and support the effectiveness of monetary policy implementation.<sup>25</sup> Figure 7 shows the composition of these reserve management OMOs, which totaled several hundred billion dollars as of February 2020.

**Figure 7**  
**The Fed’s Reserve Management OMOs in 2019-2020**



Source: Federal Reserve Bank of New York and Federal Reserve Board staff calculations.

Looking ahead, once reserve balances are judged to be sufficiently high, the need for sizable Treasury bill purchases will diminish, and the Fed will likely scale back or phase out its repo operations.<sup>26</sup> At that time, the Fed will be in position to conduct OMOs over time solely to

<sup>25</sup> See the FOMC’s October 2019 “Statement Regarding Monetary Policy Implementation,” available at this link: <https://www.federalreserve.gov/monetarypolicy/files/monetary20191011a1.pdf>. Logan (2019b) reviews money market developments over the year and also discusses these particular open market operations.

<sup>26</sup> For a discussion of FOMC participants’ views on this issue, see the minutes to the January 2020 FOMC minutes, available at the following link: <https://www.federalreserve.gov/newsevents/pressreleases/monetary20200219a.htm>.

accommodate trend growth in autonomous factors to maintain an ample level of reserves, a discussion we take up in the next section.

## 4. Maintaining ample reserves

Looking ahead, the Fed will seek to stay in an ample-reserves regime by supplying a quantity of reserves that is consistently ample, avoiding the need to actively manage the supply of reserves. To do so, the Fed will continue to be vigilant in monitoring various factors that could potentially affect the level or variability of reserves, continue to gain more information about banks' evolving demand for reserves, and remain ready to respond if the need arises. Here we discuss some considerations that might arise in maintaining an ample reserves-regime. Note that our discussion of these issues is intended to be illustrative, not exhaustive.

### 4.1 Evolution of autonomous factors

As we discussed in section 2.3, autonomous factors include currency, the Treasury's General Account (TGA), reverse repos, and other Fed liabilities that are directly linked, operationally, with the supply of reserves. As the level of these factors increase or decrease, they drain or add reserves, shifting the Fed's supply curve left or right, respectively.

Equation 1 shows how the Fed's supply of reserves,  $R$ , evolves over time:

$$R_t = R_{t-1} - \Delta AF_t + OMOs_t \quad (1)$$

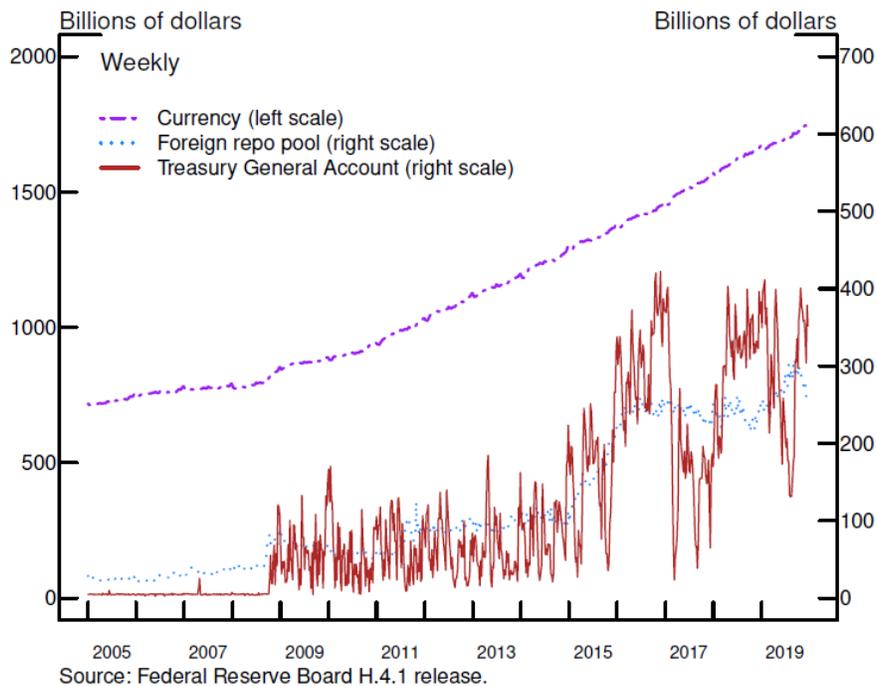
The equation captures the fact that today's level of reserves will be equal to yesterday's quantity in the absence of any changes in autonomous factors ( $AF$ ) or OMOs.<sup>27</sup> But, as shown in Figure

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<sup>27</sup> In this equation, " $OMOs$ " are defined as the aggregate net addition to reserves from these operations (any reverse repos would be accounted for with a negative sign).

8, autonomous factors exhibit substantial fluctuations in the short run and also grow over time. Moreover, the degree of variation in these factors can change over time; each of the factors exhibits more variability now than prior to the crisis. This pattern is particularly true for the TGA, the most volatile factor (the solid red line). Taken together, over the past few years, the weekly swings in the factors suggest that, at the extreme, they can jointly change by about \$200 billion from one week to the next.

**Figure 8**  
**Selected Fed Non-Reserve Liabilities**



The Fed needs to consider these short-run movements in autonomous factors in ensuring its supply of reserves remains ample. In particular, the variability of the autonomous factors influences the Fed’s judgment about the practical location of the vertical line “A” in figure 2—the minimum quantity of reserves that constitutes being in an ample-reserves regime. So what is

the Fed’s desired minimum level of reserves? When asked about this topic, Chair Powell replied with a detailed response that is linked to our discussion.<sup>28</sup>

*“... in terms of the actually desired reserve level, we know that reserves will continue to move up and down over the course of the calendar year in a wide range depending on volatility in non-reserve liabilities, particularly the Treasury General Account, or TGA. In particular, reserve levels will need to be at a level high enough to remain ample even when the TGA peaks during the April tax season. Effectively, what that means is that we need reserves at all times to be no lower than they were in early September [2019]—and, I would say, around \$1½ trillion, subject to learning more. ... So, most of the time, reserves will be moving in a range substantially higher than that but not going below \$1½ trillion.”*

In other words, in setting the quantity “A,” the Fed explicitly accounts for the short-run variability in autonomous factors. The Fed sets “A” large enough to stay consistently in an ample reserves-regime, even when autonomous factors occasionally cause a very large drain in reserves. And, given that the behavior of the autonomous factors could evolve over time, the Fed’s view of the location of “A” could change going forward.

In addition to daily fluctuations in autonomous factors, the Fed also needs to consider their long-run growth in ensuring its supply of reserves remains ample, that is, at least as large as a given quantity “A.” As shown in figure 8, currency (the purple dash-dotted line), trends up over time. As noted above, currency has expanded an average of about 6 percent per year, and with more than \$1.5 trillion of currency in circulation, such growth amounts to a large nominal increase each year.<sup>29</sup> The TGA has also grown over the past decade, and the size of this account

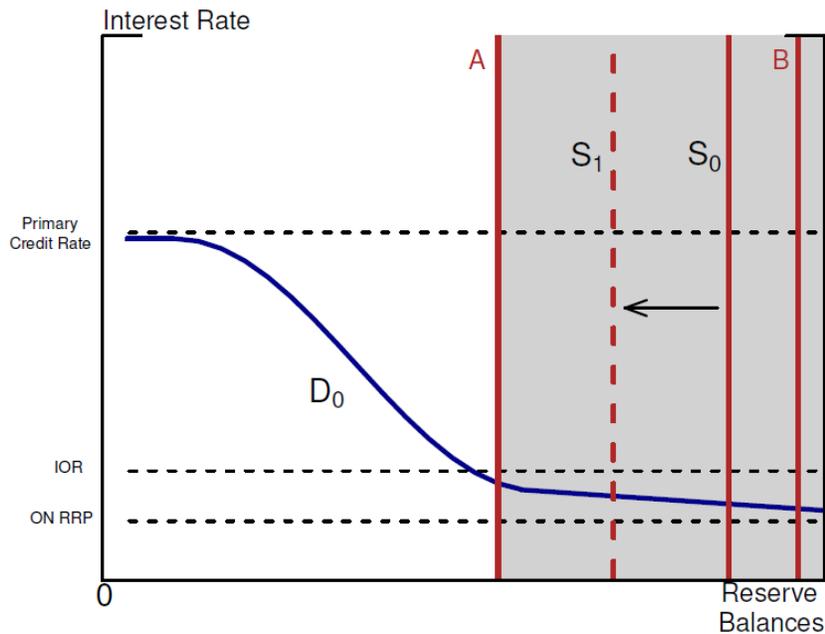
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<sup>28</sup> See the transcript of Chair Powell’s January 2020 press conference, available on the Federal Reserve Board’s web site at the following link: <https://www.federalreserve.gov/mediacenter/files/FOMCpresconf20200129.pdf>.

<sup>29</sup> For example, currency in circulation has nearly doubled over the past decade, expanding from about \$985 billion at the end of 2010 to about \$1.7 trillion in February 2020. This means that the Fed’s balance sheet would have expanded by more than \$700 billion over that period regardless of any other factors. Data on currency in circulation are available on the Federal Reserve Board’s web site at the following link: <https://www.federalreserve.gov/releases/h6/>.

could continue to expand as the nominal value of payment flows managed by the Treasury increases over time. Overall, the long-term growth of these autonomous factors will slowly, but permanently, drain reserves. This reserve-draining effect is illustrated in figure 9, with the leftward shift in the supply curve, from  $S_0$  to  $S_1$ .

**Figure 9**  
**Reserve Supply is Drained by an Expansion of Autonomous Factors**



To offset the reserve-draining effect of trend growth in its non-reserve liabilities, the Fed will, over time, need to regularly conduct permanent OMOs (reserve management purchases) to inject reserves into the banking system and shift the supply curve back to the right. For example, if the Fed estimates that its non-reserve liabilities will grow by \$10 billion a month, it would need to purchase \$10 billion of Treasury securities each month to offset the reserve-draining effects of this growth. These OMOs will be necessary over time to keep the quantity of reserves ample.

## 4.2 Other factors

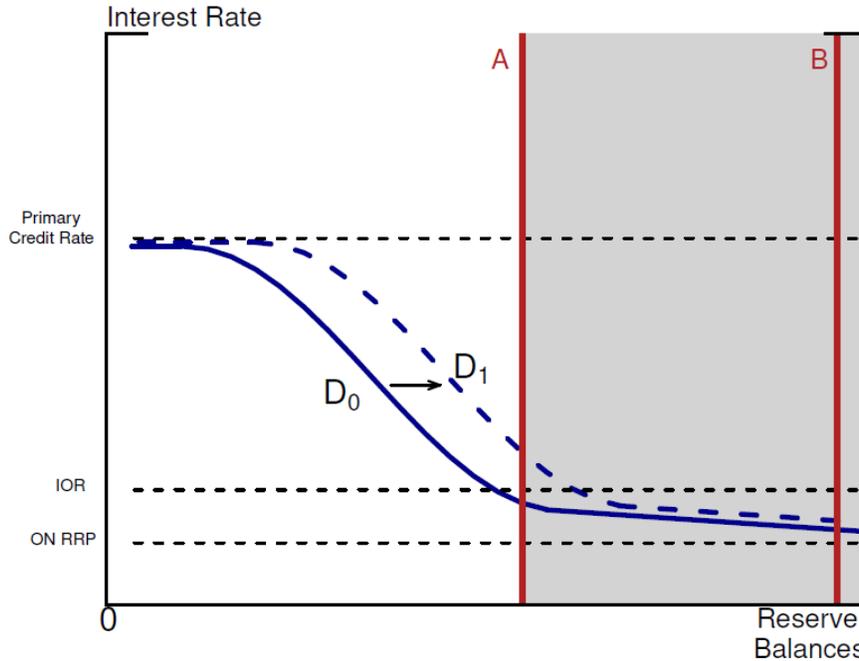
Unlike the autonomous factors that are known to affect the supply of reserves each day, other, less certain, factors may change the supply of or demand for reserves over time. And, of course, still other factors may one day need to be taken into consideration that are not yet conceived today. Here we provide a couple of examples of such potential factors for illustrative purposes. Given the uncertainty with which various factors may materialize, as well as their ultimate influence on the federal funds and other money markets, the Fed will need to stay vigilant in monitoring conditions in money markets going forward.

We start by thinking about factors that could affect the demand for reserves. First, consider a development that significantly reduces banks' demand for reserves. For example, a technological change could enable banks to speed the processing of payments and economize on cash, or the Fed could introduce a change to its existing policies or tools that lead banks to have a greater preference for investing in non-reserve liquid assets. In this situation, the Fed's existing supply of reserves would still be ample. Next, consider the opposite case, a development that results in a marked increase in banks' demand for reserves. For example, banks' preference for holding reserves could shift higher as a result of new or persistently heightened perceptions of liquidity risks. In this situation, the Fed could need to take action to ensure the quantity of reserves it supplies remains ample.

Figure 10 illustrates a rightward shift in the demand curve, from  $D_0$  to  $D_1$ . In this scenario, the vertical line "A" would move to the right along with the outward shift of the demand curve. Would the Fed need to adjust its supply curve? The answer is that it depends. If supply was sufficiently to the right of "A" when that point shifts, the Fed's current implementation regime would still work fine. If instead reserve supply was close to "A" when

that point shifts, the Fed would likely need to add some reserves to the banking system, by conducting OMOs in the form of permanent purchases of securities, to remain in an ample-reserves regime relative to the new position of “A.”

**Figure 10**  
**Increase in Demand for Reserves in an Ample-Reserves Regime**



One can also conceive of considerations that could affect the Fed’s long-run supply of reserves. One such consideration is the long-run implications of the current, low interest rate environment on reserve supply. For some time now in the United States and in other advanced economies around the world, macroeconomic variables such as average inflation, output growth, and short- and longer-term interest rates have been persistently low relative to their longer-term historical norms.<sup>30</sup> As a result, the Fed and many other central banks have been operating in

<sup>30</sup> Many factors are contributing to the current macroeconomic environment—well-anchored inflation expectations in the context of improved monetary policy, aging demographics, increased globalization, slower productivity

economic environments in which the policy rate is set relatively low. If growth of the U.S. economy were to significantly slow, the FOMC would likely lower the policy rate, as usual, to provide stimulus to economy activity. However, there is less room for the FOMC to provide stimulus to the economy by lowering the policy rate if the federal funds rate is already relatively low. To provide additional policy accommodation in such circumstances, the FOMC would most likely need to employ large-scale asset purchases, as it did during the financial crisis and subsequent severe recession. Regardless of its starting point, purchases of this size would shift the supply curve well to the right, closer to vertical line “B” in figure 2. On balance in this situation, the current regime would seamlessly continue to work, providing the Fed a means of stable interest rate control as the FOMC provided needed economic stimulus to the economy.

## 5. Concluding remarks

The Fed is one of many central banks around the world that is implementing monetary policy with plentiful reserves. In this primer, we provided a stylized framework to describe how a central bank implements policy in such a regime, including the specific tools the Fed uses to ensure interest rate control with ample reserves. We reviewed the effectiveness of the regime over the past decade and discussed some operational considerations relevant for maintaining an ample supply of reserves going forward.

Our discussion highlighted some of the Fed’s key motivations for choosing to operate in an ample-reserves regime in the long run. First, as described in section 2, an ample-reserves regime is simple and efficient to operate. While the Fed needs to manage reserve supply in any implementation regime, the ample-reserves regime eliminates the need for the Fed to intervene in

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growth, greater demand for safe assets, and weaker links between unemployment and inflation. And these factors seem likely to persist. For more discussion of this issue, see Chair Powell’s speech on “Challenges for Monetary Policy,” available at the following link: <https://www.federalreserve.gov/newsevents/speech/powell20190823a.htm>.

markets on a daily basis, which is an operationally attractive feature. Second, as shown in section 3, the regime is effective. The Fed's administered rates have enabled successful control of the federal funds rate and its transmission to other short-term interest rates as well as to broader financial conditions, all of which support the FOMC's achievement of its dual mandate. Third, as highlighted in section 3 and discussed in section 4, the regime has proven resilient to a variety of changes in the economic, financial, and regulatory environments, and is expected to stay so going forward.

Finally, we emphasized that operating in an ample-reserves regime going forward, the Fed will periodically need to add reserves to the banking system to accommodate ongoing growth in its non-reserve liabilities, and also highlighted the importance of monitoring for developments that could necessitate a shift in the Fed's assessment of the minimal quantity of reserves needed to stay in an ample-reserves regime. Overall, the Fed will need to be vigilant in monitoring conditions that influence banks' evolving reserve demand, the autonomous factors that affect reserve supply, and other dynamics that might shift reserve demand or supply as the economy and financial markets continue to evolve.

## **Box 1** **The Fed's Non-reserve Liabilities**

Many of the Fed's liabilities arise from its statutory responsibilities, such as supplying currency to the public and serving as the U.S. Treasury's fiscal agent. Each liability has social benefits and plays an important role as a safe and liquid asset for the public, the banking system, the U.S. government, or other institutions. Here we briefly describe each of the Fed's primary non-reserve liabilities.<sup>31</sup> A key point is that, taken together, the Fed's non-reserve liabilities tend to increase over time. This is because the Fed's largest liability, currency, and to which we first turn, exhibits trend growth.

***Federal Reserve notes.*** Federal Reserve notes outstanding—also known as (paper) currency in circulation, or simply currency, shown as the green region in the chart—have traditionally been the largest liability item on the Fed's balance sheet. The public's demand for currency tends to increase with the nominal size of the economy because households and businesses have sought, collectively, to hold more cash as the volume of economic transactions grows. In addition, with heavy usage of U.S. currency overseas, changes in global economic growth, as well as in financial and geopolitical stability, can also materially affect the rate of U.S. currency growth. Over the past decade, the amount of notes in circulation has almost doubled, from about \$900 billion in late 2009 to almost \$1.8 trillion by early 2020.

***Treasury General Account (TGA).*** The U.S. Treasury holds cash balances at the Fed in the TGA, shown by the blue region in the chart. Treasury's payments activity flows through this account—the account is used to collect tax payments and to receive the proceeds of Treasury's securities sales, and it is used to pay the federal government's bills, including interest and principal on maturing Treasury securities. Prior to 2008, the Treasury targeted a steady, low balance of \$5 billion in the TGA on most days, and it used separate, private accounts at commercial banks to manage the bulk of its cash flows outside of the TGA. Since 2008, the Treasury has used the TGA as its primary account for managing its cash flows. In May 2015, the Treasury announced its intention to hold in the TGA a level of cash generally sufficient to cover

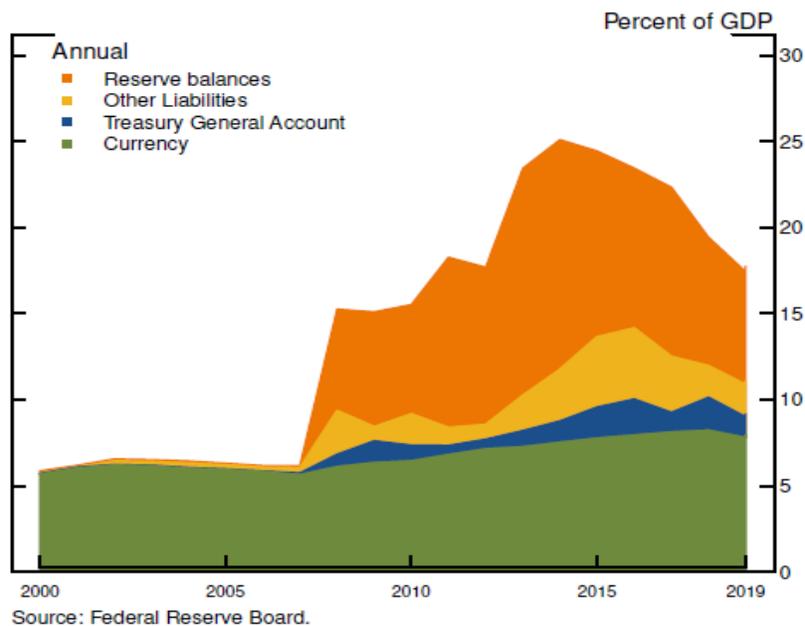
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<sup>31</sup> Data on the Fed's assets and liabilities are published weekly on the Board's H.4.1 statistical release, available at the following link: <https://www.federalreserve.gov/releases/h41/>.

one week of outflows, subject to a minimum balance of roughly \$150 billion.<sup>32</sup> The rationale for this decision was to protect the resilience of government payments and to avoid potential concerns about the safety of U.S. government debt that could be damaging for the global financial system. As of the end of 2019, the TGA stood above \$300 billion.

**Foreign Repo Pool.** The Fed conducts overnight reverse repo with foreign official accounts, also known as the foreign repo pool and included in the yellow region of the chart, in order to provide an investment option for foreign official institutions. The daily amount invested in the foreign repo pool has also increased in recent years. The Fed has long offered this custodial service to foreign central banks, foreign governments, and international official institutions to facilitate immediate access to dollar liquidity to support their operational needs, to clear and settle securities in their accounts, or to address any unexpected dollar shortages. The foreign repo pool has grown from an average level of around \$30 billion before the crisis to a current average of about \$250 billion, equivalent to a little more than 1 percent of GDP, reflecting in part foreign central banks' preference to maintain more substantial dollar liquidity buffers since the crisis.

**Figure 1.1**  
**The Fed's Liabilities as a Share of Nominal GDP**



<sup>32</sup> Treasury's press release containing this announcement may be found on its web site at the following link: <https://www.treasury.gov/press-center/press-releases/Pages/jl0249.aspx>.

***Other deposits.*** Other deposits, also included in the yellow region of the chart, consist of balances held at the Fed by international and multilateral organizations as well as government-sponsored enterprises. This liability item also includes the accounts of Designated Financial Market Utilities (DFMUs) which provide the infrastructure for transferring, clearing, and settling payments, securities, and other transactions among financial institutions. Other deposits have risen from less than \$1 billion before the crisis to about [\$80 billion] at the end of 2019, owing mainly to the establishment of accounts for DFMUs that have been designated as systemically important by the Financial Stability Oversight Council (FSOC).

***Overnight reverse repo (ON RRP) facility.*** When the Fed's eligible counterparties choose to take up ON RRPs at the Fed's facility, the cash they deposit is logged as an increase in the Fed's reverse repo liabilities; this item is also included in the yellow region of the chart. Over the past half-decade, the outstanding amount of ON RRPs has ranged from \$0 to more than \$350 billion, largely depending on the relative positions of comparable money market interest rates and other conditions in money markets.

## Box 2

### The Relationship between the Federal Funds Rate and the Level of Reserves

Theoretical models on the relationship between overnight interest rates and the level of aggregate reserve balances generally predict that as reserve balances decline, the level of overnight interest rates as well as their responsiveness to changes in the level of reserves increase; that is, the demand curve for reserves steepens.<sup>33</sup>

Figure 2.1 plots the level of the spread between the effective federal funds rate (EFFR) and the interest on reserves (IOR) rate, the purple dashed line, and the level of reserves, the green solid line, from April 2018 to September 2019. (This sample ends just prior to the volatility observed in money markets followed by the Fed’s repo operations to increase reserves.) Starting in March 2018, a substantial increase in Treasury bill issuance pushed the yields on these securities as well as the constellation of money market rates higher. As a result, as shown in the figure, the EFFR started to increase in the target range relative to the IOR rate, increasing the spread between the two. During this time, reserve balances had also been declining gradually with the ongoing normalization of the Fed’s balance sheet and growth in the Fed’s non-reserve liabilities. The combination of the declining level of reserves and the increasing rate spread led some to speculate about a causal link between the two series—that a shrinking level of reserves could cause the EFFR to trade up relative to the IOR rate.

To measure the sensitivity of the federal funds rate to the level of reserves we estimate the simple regression below:

$$\Delta(FFR_t - IOR_t) = \beta\Delta(Reserves_t) + \varepsilon_t \quad (1.1)$$

Our endogenous variable is the spread of the FFR to IOR rate to account for the effects of the FOMC’s changes in the target range as well as the effects of technical adjustments to the IOR rate.<sup>34</sup> We drop month-end days from the sample to exclude the effects of regulatory reporting days when many money market borrowers scale down their positions to meet regulatory or

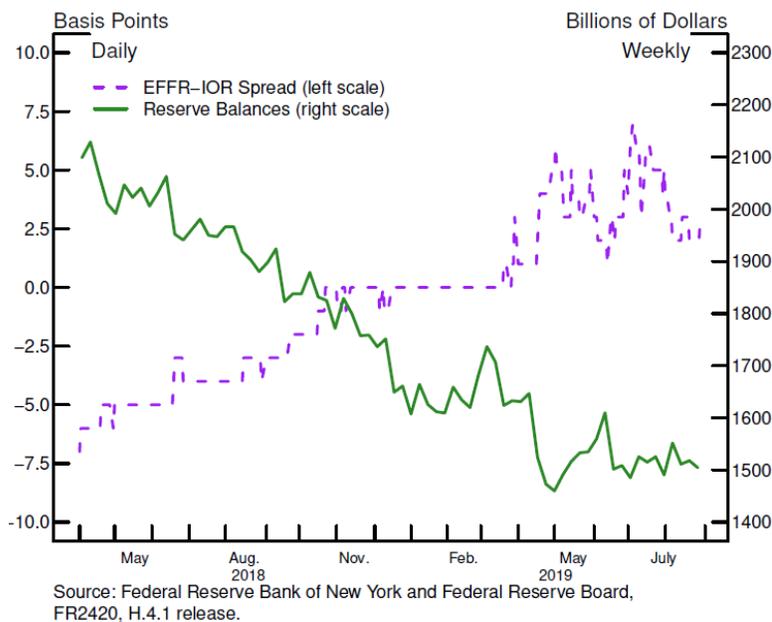
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<sup>33</sup> These models date back to the classic paper by Poole (1968). More recent examples that incorporate aspects of current money markets structure include Schulhofer-Wohl and Clouse (2018) and Afonso, Armenter, Lester (2018). In addition, Potter (2018) provides a discussion of the dynamics between reserve levels and short-term rates.

<sup>34</sup> We use the volume-weighted average federal funds (VWA FF) rate, instead of the effective federal funds rate (EFFR), which is the volume-weighted median, since the volume-weighted mean rate has more variation than the median and captures all movements in the distribution. The correlation of 5-day changes between the volume-weighted mean and median rate is close to 1 and results are qualitatively similar when the EFFR is used.

internal targets. Note that equation (1.1) is specified in differences, rather than in levels, since the two series were trending during the time period considered.

**Figure 2.1**  
**EFFR-IOR Spread and Reserve Balances**  
**(April 2018 to September 2019)**

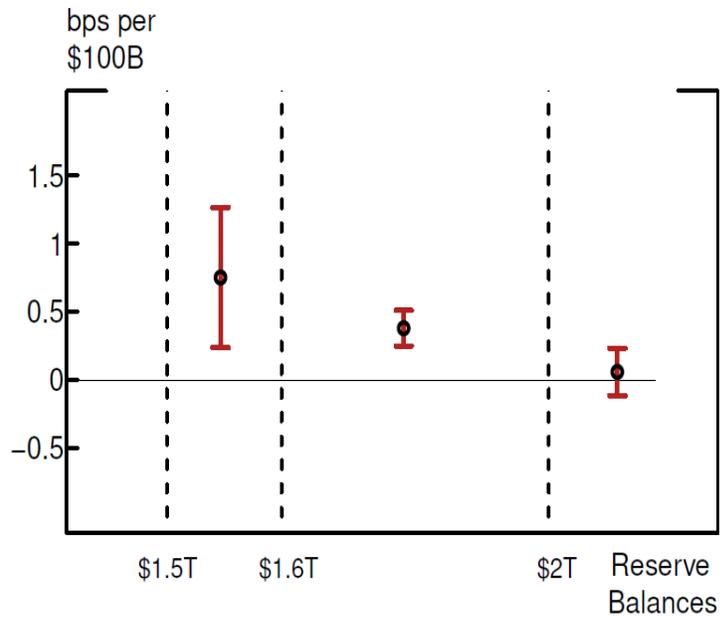


When we regress daily changes in the FFR-IOR spread on changes in reserve balances, we estimate the slope of the reserve demand curve, denoted by  $\beta$ . We allow this slope to vary with levels of reserves to identify points at which the demand curve becomes steeper—more interest sensitive—as reserves decline. This is achieved by using a “threshold model” in which the threshold variable—the level of reserves—is used to estimate the slope at different regions of the reserve demand curve.

Figure 2.2 shows point estimates of the slope coefficient,  $\beta$  (the black circles), and 95 percent confidence bands (the red brackets) at different reserve levels using the thresholds determined by the model. Moving from the right to the left in the figure, the slope coefficient is not significant for reserves levels above \$2 trillion, but it becomes negative and statistically significant when reserves fall below \$2 trillion. The model identifies two thresholds, one at a reserves level of \$2 trillion and another at a level of \$1.6 trillion. The FFR shows slight sensitivity to changes in reserves for reserves levels between \$1.6 and \$2 trillion—the FFR is expected to increase one-half a basis point per \$100 billion decline in reserves. The slope

coefficient increases to just under 1 basis point when reserves were between \$1.5 trillion and \$1.6 trillion. Reserves became consistently below \$2 trillion in the third quarter of 2018, and reached levels around \$1.6 trillion in early 2019.

**Figure 2.2**  
**Sensitivity of the Federal Funds Rate to the Level of Reserves**



Source: Authors' calculations.

Note: Black dashed lines show the estimated thresholds for reserve levels. Red brackets show the 95 percent confidence bands around the point estimates, shown by the black circles.

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