

Changes in Fed Tools: Classroom Implications

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In this paper, I show how the tools that have been used by the Fed since the Great Recession have changed the way we need to talk about monetary policy in the classroom. In the new regime of abundant reserves, open-market operations have different effects than before. A daily model of the reserves market may be helpful in guiding students to understand the mechanism by which the Fed operates. However, the danger of that model is that students may focus too much on the daily mechanics and not pay enough attention to the longer-run implications of Fed policy decisions. I illustrate how to combine both short-run and long-run models of Fed policy actions.

Keywords: monetary policy, Federal Reserve

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I. Introduction

During the Great Recession in the late 2000s, the Federal Reserve changed its approach to monetary policy, driving short-term interest rates to around zero and using a variety of other tools to influence the economy. In the subsequent recovery, the Fed dropped some of the extraordinary measures it used, but kept one major change in place—the payment of interest on reserves, with a large balance sheet causing short-term interest rates in the economy to be driven by the interest rate on reserve balances paid by the Fed. Because of that change, open-market operations, which used to be the Fed’s main tool for making changes in the economy, no longer worked as they did before, and became a less-important tool.

Because initially instructors and textbook writers were not sure if the Fed would make these changes permanent or not, they were slow to adapt.¹ As a result, many instructors and textbooks still focus on how monetary policy was conducted prior to 2008 as their main model.² But now that 17 years have passed since the Fed changed its tools, it is time for instructors and textbook authors to refine their description of the tools used by the Fed.³

In a regime of abundant reserves, the Fed’s main tool for changing interest rates is to change the interest rate on reserve balances held by banks at the Fed. Because of that, open-market operations, which had formerly been the Fed’s main operating tool, have less importance. However, open-market operations still need to be discussed, as expansionary open-market operations were used by the Fed during both the Great Recession and the pandemic, though they were called Quanti-

¹As someone who teaches course in money and banking, and intermediate macroeconomics, as well as co-author with Andy Abel and Ben Bernanke of a leading textbook in intermediate macroeconomics, I was thinking about how to modify teaching materials along the way, but it wasn’t until the 11th edition of Abel, Bernanke and Croushore (2024), that we added the reserves-market diagram described in this paper.

²Ihrig and Wolla (2022) and Ihrig and Wolla (2023) point to this failure.

³That being said, there are proposals in government circles to force the Fed to return to the old model, so we still do not know how permanent the changes will be.

tative Easing. And they have been used in the aftermath of both the Great Recession and the pandemic, as the Fed reduced the size of its balance sheet using Quantitative Tightening. But now instructors and textbooks need to discuss how open-market operations work in financial markets but how they do not, on their own, affect short-term interest rates.

From my view as both an instructor and textbook author, I worry that students will focus too much on the short-term reserves market, which is after all, a daily analysis, and not enough on the long-term analysis that is more fundamental. That is, students need guidance about what model should be their focus. One reason that our textbook resisted using the reserves-market model for ten editions is that it didn't seem relevant because it described only what was happening that day, and short-term macroeconomic shocks are just noise. But we relented in the 11th edition because of student and instructor questions about how the Fed implements policy in the short run, and how to show the non-impact on interest rates of open-market operations.

In this paper, I walk through the historical development of the short-term reserves-market diagram and show how to relate it to more a complete general-equilibrium model. Tying the short-term model to the long-term one provides a more complete picture, but one that students might struggle with, to understand how to relate the two models. I wrote this paper to help bridge that gap.

II. Historical Developments

Early models of the Federal Reserve's operating procedures were based on money demand and supply. The Fed used a model to forecast money demand and determined the money supply to hit its targets for inflation and output. In some formulations, the Fed had an intermediate target, such as the money supply, and used an operating target in the short run, such as the monetary base or a short-term interest rate, as Mishkin (1995) notes. Indeed, historically, the Fed moved from operating on interest rates before 1979, to targeting monetary aggregates

from 1979 to the early 1990s, then returned to targeting interest rates since then. But in many models, there is a certainty equivalence between targeting monetary aggregates and targeting interest rates; though in a stochastic model the optimal choice of instrument depends on parameters of the model if the Fed wants to minimize the variance of output⁴.

Fed Chair Greenspan's strategy for reducing inflation after he entered office in 1987 was to gradually reduce the growth rate of the money supply. The Fed's target for the M2 growth rate was reduced slowly almost every year from 1983 to 1993, as Table 1 shows.

TABLE 1—FED M2 GROWTH TARGETS

Year	M2 Growth Target
1980	6 to 9%
1981	6 to 9%
1982	6 to 9%
1983	7 to 10%
1984	6 to 9%
1985	6 to 9%
1986	6 to 9%
1987	5.5 to 8.5%
1988	4 to 8%
1989	3 to 7%
1990	3 to 7%
1991	2.5 to 6.5%
1992	2.5 to 6.5%
1993	1 to 5%
1994	1 to 5%
...	
2000	1 to 5%

Sources: Monetary Policy Report, February and July each year.

In the 1990s, the relationship between the monetary aggregates and macroeconomic variables of interest, such as inflation and output, changed in unpredictable

⁴See Poole (1970).

ways. The Fed's procedure of forecasting money demand growth to determine the optimal growth rate of the money supply was no longer viable. As Fed Chair Greenspan noted, "the relationship between money and the economy may be undergoing a significant transformation."⁵

Through the 1990s, as money growth became less related to output and inflation, the Fed's policy actions were based on interest rates, but they still formally targeted the monetary aggregates each year. That ended in mid-2000, with the Fed noting in Greenspan (2000), "At its June meeting, the FOMC did not establish ranges for growth of money and debt in 2000 and 2001. The legal requirement to establish and to announce such ranges had expired, and owing to uncertainties about the behavior of the velocities of debt and money, these ranges for many years have not provided useful benchmarks for the conduct of monetary policy. Nevertheless, the FOMC believes that the behavior of money and credit will continue to have value for gauging economic and financial conditions, and this report discusses recent developments in money and credit in some detail." (p. 2)

After the Fed abandoned money-growth targets, policymaking became more discretionary, and interest rates became more of the focus of policy. The Fed was influenced by proposals for rules, such as the Taylor rule, and there was discussion of the equilibrium real interest rate. Of course, the danger, as in previous periods when the Fed focused on interest rates, was that the equilibrium real interest rate might change and policymakers wouldn't recognize it.

Within the Fed, implementing monetary policy on a daily basis required the people working at the Open Market Desk to consider how the federal funds interest rate might be affected each day. Its daily goal was to keep the fed funds rate as close as possible to the target. In periods when the Fed had a target for money growth, the directive to the Open Market Desk was often that a given fed funds

⁵See Greenspan (1993), p. 14. He also noted that "In the last few years, the broader aggregates in turn have become much less reliable guides for the conduct of policy." (p. 16) and "...the monetary aggregates do not appear to be giving reliable indications of economic developments and price pressures." p. 22

rate would be consistent with hitting the target range for the monetary aggregates. Of course, in the standard textbook setup, the Fed could set interest rates or the money supply but not both. Implicit in the use of a fed funds target was a complete economic model that related interest rates to the money supply.

III. Reserves-Market Diagram Before 2003

Before 2003, the daily reserves market operated as shown in Figure 1.⁶ In the figure, you can see that the target for the federal-funds interest rate is denoted ffr^* , while the discount rate for loans from the Fed to banks is d . The demand curve (D) for reserves is downward sloping, as the lower the fed funds rate on a given day, the more reserves banks will demand; reserve requirements were met by averaging reserves over a two-week maintenance period. In those days, the fed funds target rate was above the discount rate. However, the Fed discouraged borrowing from the discount window, so the opportunity for an arbitrage profit for banks by borrowing at the discount rate and lending at the fed funds rate was limited. That is why the supply curve (S) is only slightly sloped upwards. If banks borrowed for arbitrage purposes, the Fed imposed costs on them, including increased scrutiny of the bank's operations. So, the amount of discount borrowing was small, and the difference between nonborrowed reserves (NBR^*) and total reserves (R^*) was small.

In this regime, the Fed would analyze the reserves market every morning to determine the need to change the supply of non-borrowed reserves every day. For example, Figure 2 shows a situation in which the market would have a fed funds rate above target if the Fed did not take action in the markets that day. By adding reserves through open-market operations, the Fed expects to hit its target. Generally, the Fed engaged in open-market operations each morning, but events could occur later in the day that would cause the fed funds rate to differ from its target, or the demand curve could end up in a different place than the

⁶See the description in Muegel (1985).

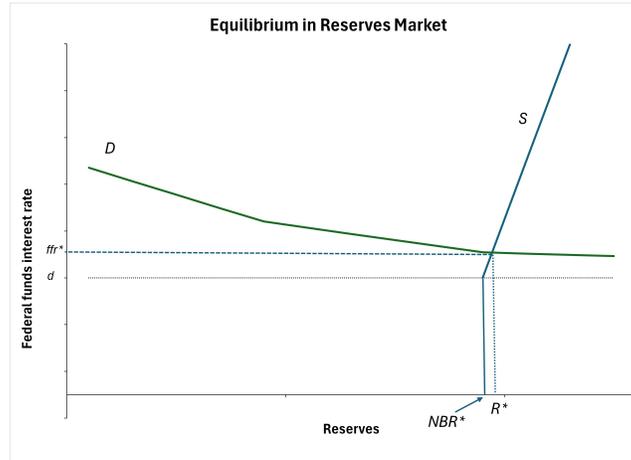


FIGURE 1. EQUILIBRIUM IN RESERVES MARKET BEFORE 2003

Fed expected that morning.

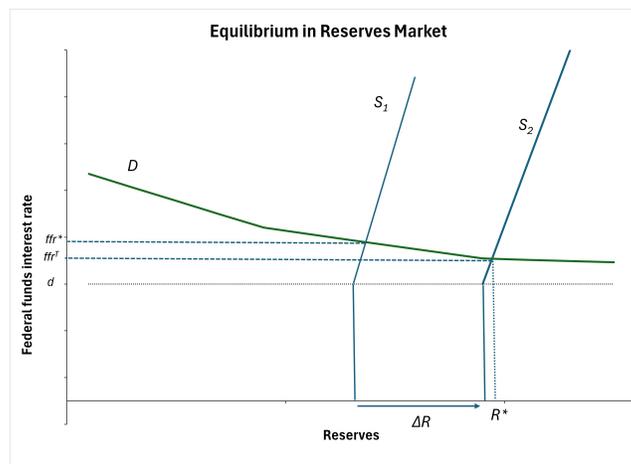


FIGURE 2. ADD NEED IN RESERVES MARKET BEFORE 2003

In the early 2000s, shocks to money demand led to volatility in the fed funds rate, as in Figure 3. Reserves were scarce. Bank reserves held at the Fed from 1975 to 2003 peaked in 1988 at \$39 billion, then declined because of the existence of sweep accounts, which helped banks avoid reserve requirements, leading to smaller and smaller levels of reserves. The volatility in the fed funds rate led the

Fed to consider methods to modify the reserves market.

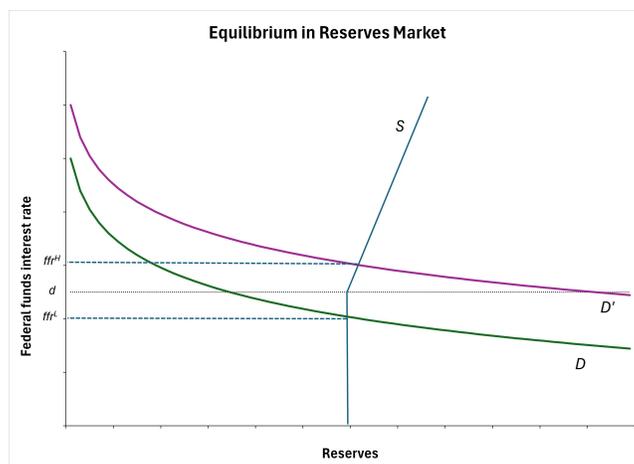


FIGURE 3. VOLATILITY OF FED FUNDS RATE IN RESERVES MARKET BEFORE 2003

IV. Reserves-Market Diagram From 2003 to 2008

To combat the volatility in the fed funds market, the Fed changed the operation of the discount window in 2003. The discount rate was raised above the target for the federal-funds rate, and the Fed switched from discouraging discount loans to encouraging them, with the idea that the discount rate would put an upper bound on the fed funds rate. Banks in good condition could borrow any amount against good collateral. Thus, they could arbitrage away any differences between the fed funds rate and the discount rate, thus putting an upper limit on the fed funds rate equal to the discount rate.⁷ The effect of this new setup for the discount window puts a horizontal kink in the supply curve, as shown in Figure 4.

In this new setup, the Fed plans to hit its target for the fed funds rate on a daily basis. But reserves remain scarce, with bank reserves held at the Fed varying from \$6.5 billion to \$16.8 billion between 2003 and late 2007. A surge in demand causes the fed funds rate to equal the discount rate, so the volatility of the fed

⁷The costs of arbitrage might allow the fed funds rate to be slightly higher than the discount rate (technically, the primary credit discount rate) but the fed funds rate could never be very much higher, so in what follows I ignore that small possible discrepancy.

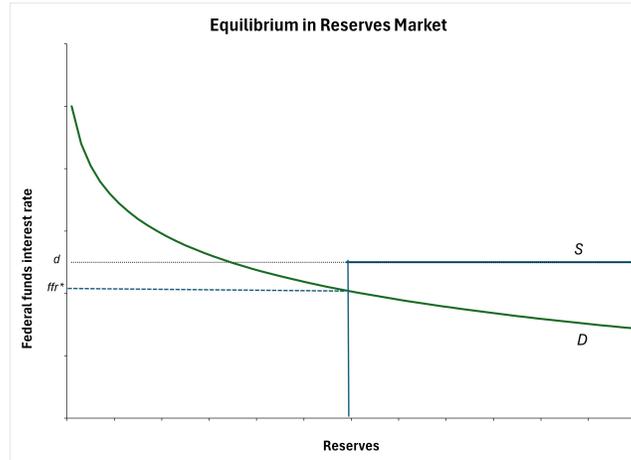


FIGURE 4. EQUILIBRIUM IN RESERVES MARKET 2003 TO 2008

funds rate is limited, as shown in Figure 5.

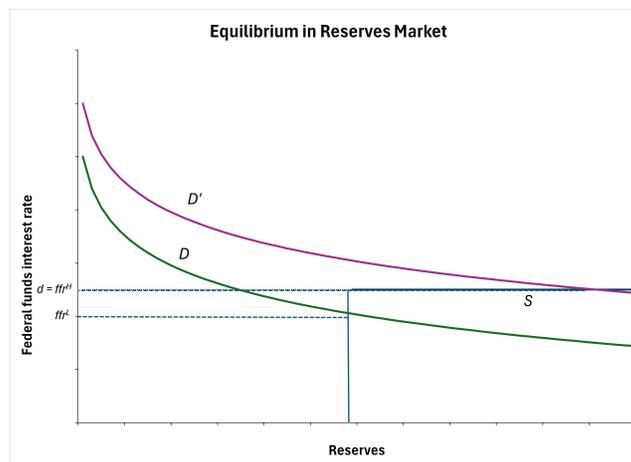


FIGURE 5. VARIANCE IN FED FUNDS RATE 2003 TO 2008

V. Reserves-Market Diagram after Great Recession

When financial problems surfaced in the U.S. economy in late 2007, the Fed began cutting interest rates, by lowering its target and increasing the monetary base, as shown in Figure 6.

As the recession worsened and turned into a full-blown financial crisis in 2008, the

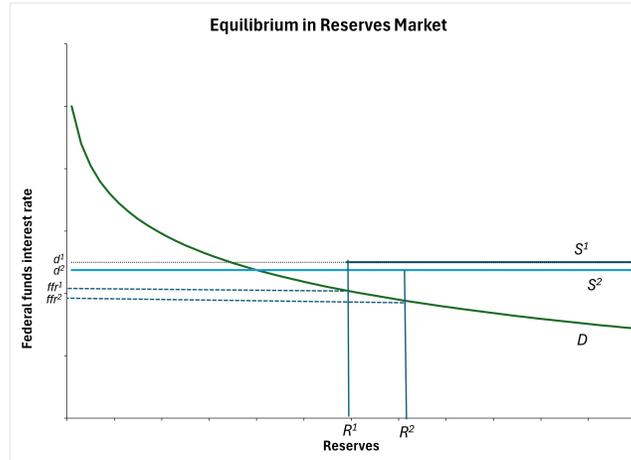


FIGURE 6. LOWERING THE FED FUNDS RATE 2003 TO 2008

Fed used huge volumes of open-market operations, moved the target fed funds rate close to zero, and moved to a system of abundant reserves, as shown in Figure 7.

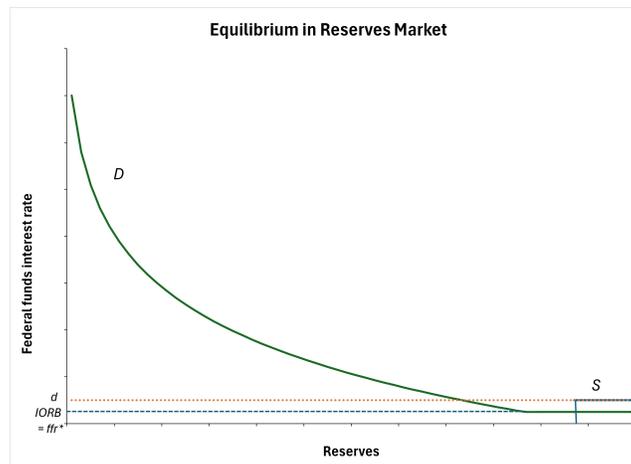


FIGURE 7. FED FUNDS RATE NEAR ZERO IN GREAT RECESSION

The Fed also developed other tools to use in the financial crisis, including forward guidance and an alphabet soup of lending programs in financial markets. But my focus in this paper is just on the changes in the reserves market. As Figure 8

shows, the Fed drove the fed funds rate near zero in late 2008 and kept it at that low level for seven years, until finally raising the rate in late 2015.

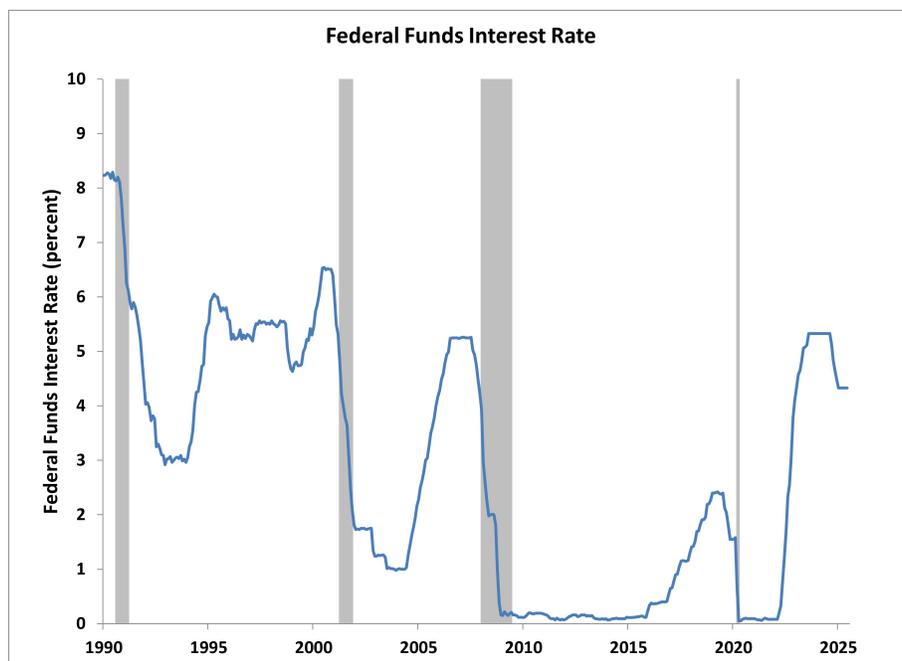


FIGURE 8. THE FEDERAL FUNDS INTEREST RATE SINCE 1990

As the recovery from the financial crisis was slower than expected, and with the fed funds rate near zero, the Fed tried to stimulate the economy further by using quantitative easing (called Large Scale Asset Purchases by the Fed), buying large quantities of bonds (both Treasury securities and mortgage-backed securities) in the open market. Figure 9 shows the change in the Fed's asset holdings over time. They ranged from under \$900 billion before 2008, to over \$2 trillion by the end of 2008, to nearly \$3 trillion in 2011, then finally peaking at \$4.5 trillion in early 2015. The increased asset levels had no effect on the fed funds rate, which was maintained near zero with a constant interest rate on reserve balances, but operated on the financial markets through effects on the supply of securities of different types, especially through reducing long-term interest rates when the Fed bought long-term bonds through the Maturity Extension Program (commonly

called Operation Twist).

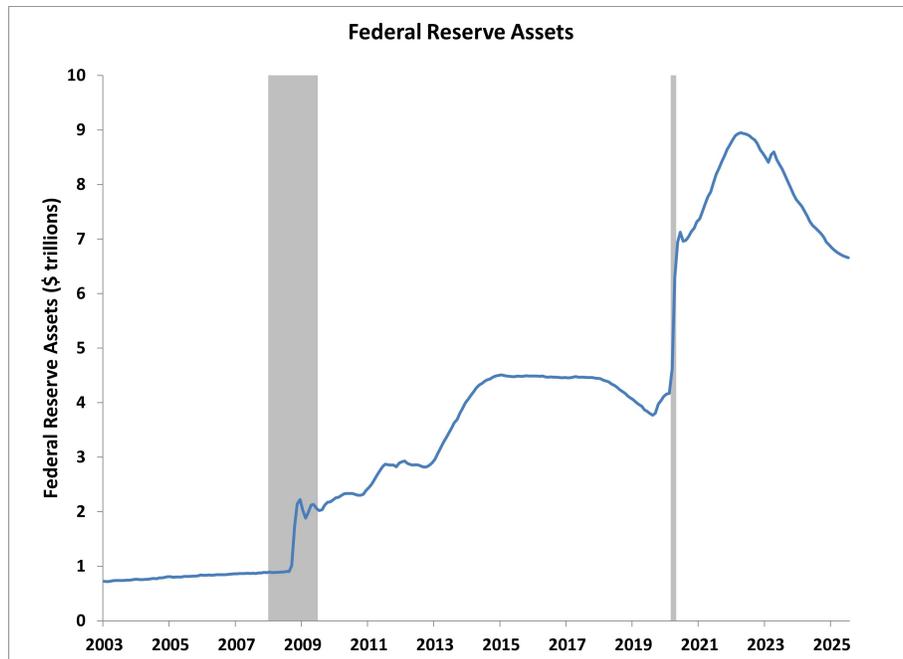


FIGURE 9. THE FEDERAL RESERVE'S ASSET HOLDINGS SINCE 2003

In late 2015, the Fed began raising interest rates, slowly. They maintained the size of their asset holdings at about \$4.5 trillion until 2018, as Figure 9 shows. Interest rates were raised by increasing the interest rate on reserve balances, as Figure 10 shows.

In the regime of abundant reserves, when the Fed shifts the supply curve to the right by open-market purchases, or to the left by open-market sales, there is no impact on the fed funds rate, which remains equal to the interest rate on reserve balances. To change the fed funds rate, the Fed changes the interest rate on reserve balances, usually changing the discount rate at the same time. Because in this regime, the discount rate is not terribly relevant, an alternative, simpler version of the reserve-market diagram can be drawn, in which the demand curve flattens out at low levels of reserves, and the supply curve has no kink in it, as

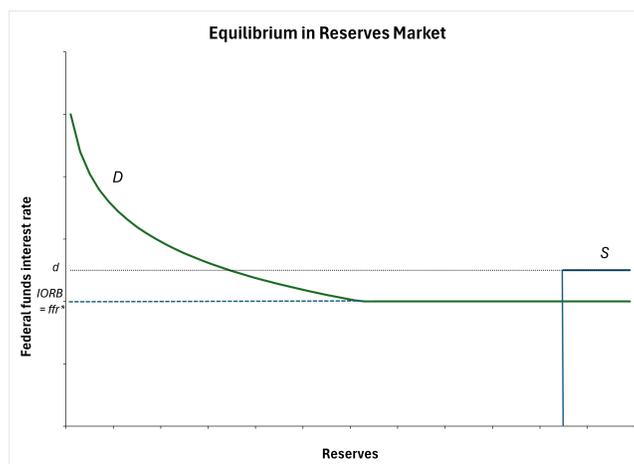


FIGURE 10. THE RESERVES MARKET WITH ABUNDANT RESERVES

shown in Figure 11.⁸

A disadvantage of the regime of abundant reserves is that the Fed gains no understanding of the elasticity of the demand for reserves because it is always operating on the flat part of the demand curve. For that reason, the Fed’s long-term goal in the late 2010s and today is to move from a regime of “abundant reserves” to a regime of “ample reserves.” The idea was to shrink the Fed’s balance sheet gradually (through allowing securities to mature, rather than selling them outright in the market), so that the supply curve is near the kink in the demand curve, as shown in Figure 12.⁹ With the supply of reserves near that spot, small variations in demand and supply might lead to small deviations of the fed funds rate from its target, which allows the Fed to learn about the slope of the demand curve, without the fed funds rate from deviating substantially from its target.

A vital policy issue is how close the Fed should get to the point at which the demand curve slopes downward or is flat. Afonso et al. (2023a) show that uncertainty because of shocks to demand, the vertical portion of the reserve supply

⁸Technically, we are plotting non-borrowed reserves on the horizontal axis, rather than total reserves, but there are no discount loans for non-operational purposes in this case.

⁹See Afonso et al. (2024)

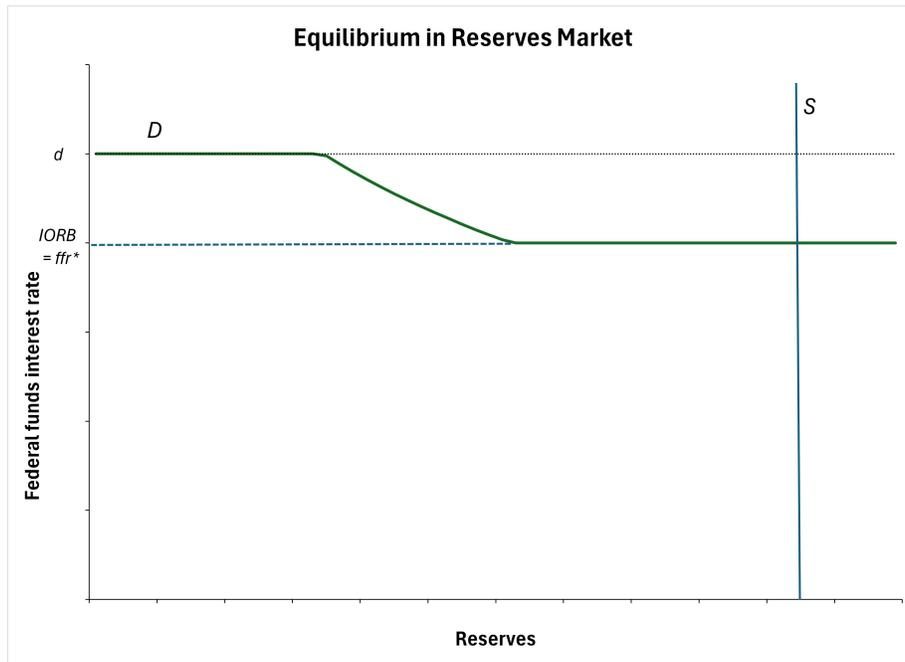


FIGURE 11. ABUNDANT RESERVES

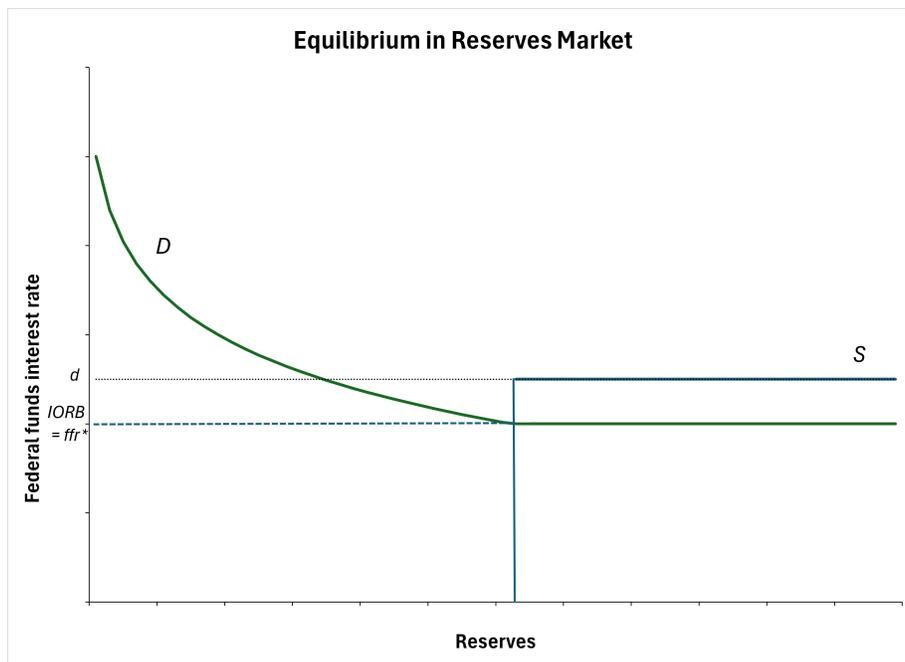


FIGURE 12. EQUILIBRIUM IN AN AMPLE RESERVES REGIME

curve should be further to the right than if the location of the demand curve were certain.

VI. Reserve Market Complications

In the discussion above, I have intentionally simplified the reserves market. There are, in fact, some institutional features that make the market a bit more complicated. However, undergraduate instructors may prefer to ignore these aspects because they are complicated and do not change the main message.

The first feature of the reserves market that complicates the situation is that there are some non-bank participants in the reserves market. Federal Home Loan Banks (FHLBs) can both hold reserves at the Fed and lend them to banks, but they cannot earn interest on their reserve holdings. So, beginning in 2008, they often offered loans to banks at interest rates below the Fed's target for the fed funds rate. Because of that, the fed funds rate started to be below the Fed's target and below the interest rate on reserve balances. Banks were able to borrow reserves from the FHLBs, then hold the reserves at the Fed, earning the interest rate on reserve balances, and earn an arbitrage profit.¹⁰ In equilibrium, of course, the fed funds rate would not fall too far below the interest rate on reserve balances, but by an amount equal to the costs of arbitrage. So, many instructors may not find this complication worth bringing up in class.

To limit the scope of the problem, the Fed uses overnight repurchase agreements to have more control over the fed funds rate. Under the overnight reverse-repurchase (ONRRP) facility, which began in December 2015, institutions that cannot earn interest on reserves can instead enter a repurchase agreement with the Fed. This effectively puts a lower bound on the fed funds rate because institutions with reserves to lend would rather earn the ONRRP rate than the fed funds rate, if the latter were lower.¹¹

¹⁰Doing so was especially attractive to U.S. branches of foreign banks, who have become the predominant borrowers in the fed funds market. See Afonso et al. (2023b) for details.

¹¹See Afonso et al. (2022a) and Afonso et al. (2022b) for details.

VII. Long-Run Model

Students benefit from understanding the basic idea of the reserves-market model, so they can see how open-market operations no longer affect short-term interest rates, and how instead the interest rate on reserve balances drives those rates. But the danger from an instructional point of view is that they may not understand the relationship between this short-term model of daily fed funds rate determination and the longer-run picture, which requires a more-complete macro model.

Such a model might suggest that there exists a neutral real short-term interest rate r^* , which changes when shocks occur. For example, expansionary fiscal policy might cause r^* to increase. In a typical model, if the short-term real interest rate is below r^* , monetary policy is expansionary. Models of this type include many common models, such as the static IS-LM framework, or dynamic, stochastic general-equilibrium (DSGE) models. Different models may lead to differing measures of r^* , as documented by Gust et al. (2015).

If the macroeconomic model that underlies the determination of r^* is presented, students can begin to understand not just the daily mechanics of how the Fed changes interest rates, but the mechanisms behind how monetary policy affects the economy in general equilibrium. Unfortunately, both students and policymakers sometimes fail to put both the pieces together. Fed policymakers particularly failed in 2021, leading to a surge in inflation in Spring of that year, which the Fed was much too slow to react to.

As an example, use the textbook IS-LM-FE model from Abel, Bernanke and Croushore (2024). Shocks to money demand shift the LM curve, as shown in Figure 13, leading to changes in equilibrium output and the real interest rate. But because the intersection of the IS and FE curves does not change, neither does r^* . In the face of such shocks, an interest-rate target is appropriate.

But other shocks may change r^* . For example, a shock to the IS curve, such as

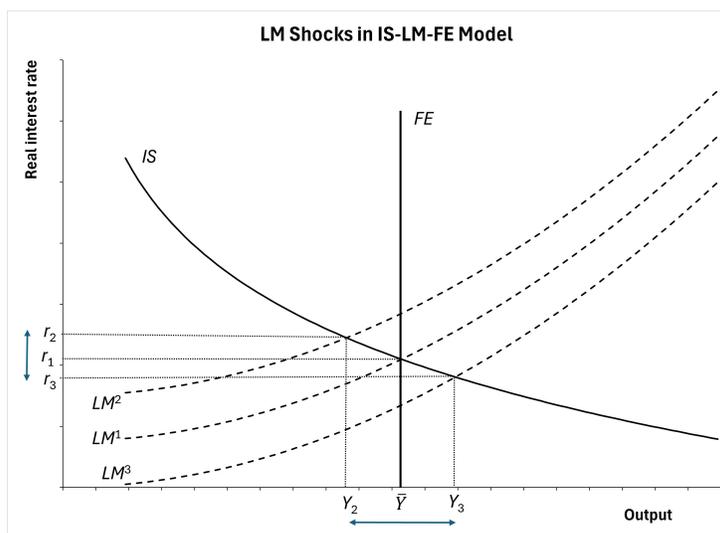


FIGURE 13. INTEREST-RATE TARGETING WITH LM SHOCK; FROM ABEL-BERNANKE-CROUSHORE *Macroeconomics* FIGURE 14.5

one emanating from fiscal policy or household sentiment, or changes in incentives for business investment, causes the intersection of the IS and FE curves to change. This means r^* is now different. Failure by policymakers to update their measure of r^* then leads to inappropriate policy actions, as shown in Figure 14.

This possibility has led some textbook authors to develop an alternative model containing an interest-rate target, as shown by the LR curve in Figure 15. But the key is to recognize in that figure that shocks to the IS or FE curves force the LR curve to shift in general equilibrium.

VIII. Combining Short-Run Model and Long-Run Model

To put the short-run and long-run models together requires a fully specified macroeconomic model tied to data. It has also led to productive research on measuring r^* , and the optimal response of monetary policy to shocks when r^* is unknown.¹²

¹²See the memos from Fed staff in preparation for the October 27-28, 2015 FOMC meeting at: <https://www.federalreserve.gov/monetarypolicy/2015-fomc-memos.htm>. The memos include Gust et al. (2015), Chung et al. (2015), Lopez-Salido et al. (2015), and Yi and Zhang (2015).

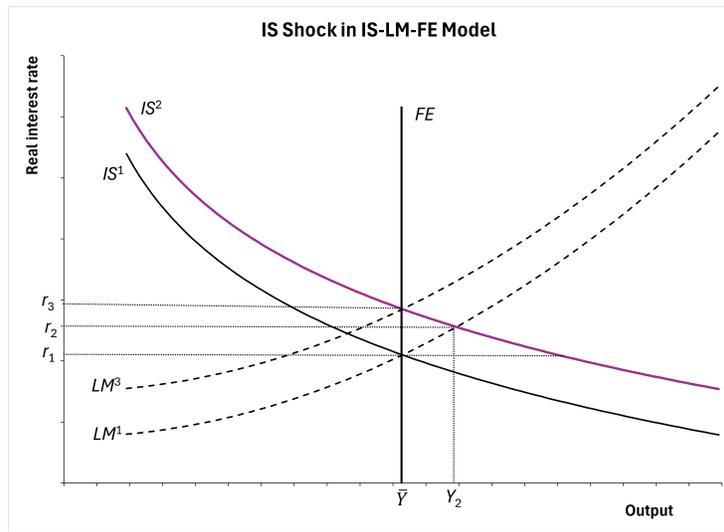


FIGURE 14. INTEREST-RATE TARGETING WITH *IS* SHOCK; FROM ABEL-BERNANKE-CROUSHORE *Macroeconomics* FIGURE 14.6

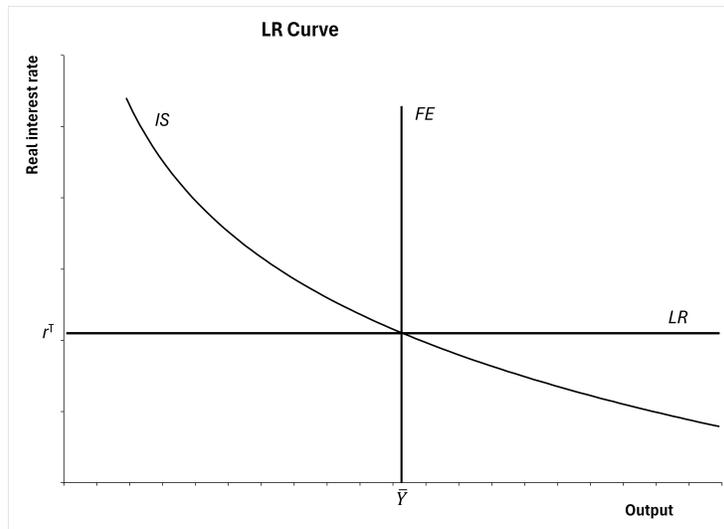


FIGURE 15. INTEREST-RATE TARGETING WITH *LR* CURVE; FROM ABEL-BERNANKE-CROUSHORE *Macroeconomics* FIGURE 14.7

The benefit of tying both short-run and long-run models together is that it has led to theoretical and empirical research on r^* , including a variety of attempts to measure r^* in real time. For example, the Federal Reserve Bank of New York has developed a number of measures and a web page devoted to the topic, with an example measure of r^* for the U.S. shown in Figure 16.¹³

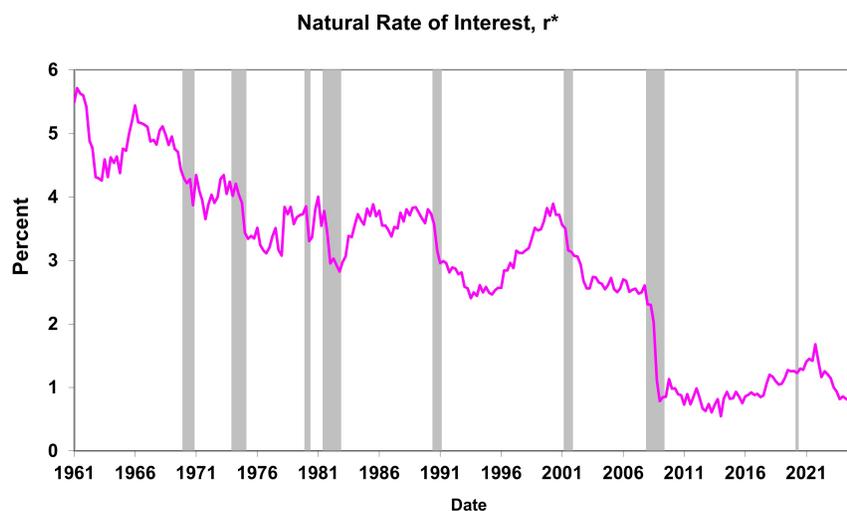


FIGURE 16. HOLSTON-LAUBACH-WILLIAMS r^*

IX. Summary and Conclusions

In this paper, I have shown the historical development of the reserves market and how it can be used to explain the short-term determination of the fed funds rate. In order for instructors to explain the current situation in the reserves market, they need to understand the differences between the regimes of scarce, abundant, and ample reserves. But a longer-run model is needed for students to understand how to properly adjust interest-rate targets in response to shocks. The danger is that otherwise students might miss the long-run forest (of interest-rate

¹³See the New York Fed's web page at: www.newyorkfed.org/research/policy/rstar.

determination) for the short-run trees of daily mechanics in the reserves market.

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