

The Evolving Role of the Fed's Balance Sheet: Effects and Challenges

By Chaitri Gulati and A. Lee Smith

The Federal Reserve's balance sheet more than doubled to nearly \$9 trillion in the wake of the COVID-19 pandemic, primarily due to large-scale asset purchases (LSAPs). Although the Federal Open Market Committee (FOMC) had previously employed LSAPs during the global financial crisis, the pace of asset purchases in March 2020 was unprecedented, as the FOMC sought to relieve severe strains in financial markets that threatened to halt the flow of credit to households and businesses. The Federal Reserve continued to purchase assets at a reduced pace through March 2022 to support the economic recovery.

More recently, with inflation surging and the labor market tight, the FOMC has started to withdraw policy accommodation and has set in motion a plan to significantly reduce the balance sheet. However, the process of balance sheet reduction is likely to be challenging, as policymakers have much less experience with adjusting the balance sheet compared with their primary policy instrument, the federal funds rate. Indeed, they have engaged in quantitative tightening (QT), or balance sheet reduction, only once before. Moreover, it is not clear exactly how much accommodation the pandemic-era asset purchases have put in place, making it difficult for policymakers to judge how fast and how far to unwind them.

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In this article, we attempt to quantify the accommodation stemming from the expansion of the Federal Reserve's balance sheet from 2020 to 2022 and discuss the challenges policymakers may face in removing it. We present evidence that the Federal Reserve's expanded balance sheet, with a large portfolio of long-duration assets, has provided a significant amount of policy accommodation in recent years, depressing long-term interest rates by about 1.6 percentage points as of early 2022. We also argue that the FOMC's plan to remove this accommodation through the passive runoff of maturing securities, rather than outright asset sales, may prove limiting. Based on the 2017 episode of QT, as only soon-to-mature Treasury securities run off the balance sheet and prepayments of the Federal Reserve's mortgage holdings slow, we project that the downward pressure the balance sheet is currently placing on longer-term interest rates will only gradually reverse. Our results highlight an inherent asymmetry between the pace at which central banks can expand and contract their balance sheets. For asset purchases to provide effective policy accommodation, central banks must credibly commit to holding assets for a sustained period; unwinding these purchases sooner than expected could undermine the effect of future LSAPs.

Section I reviews the evolution of the size and composition of the Federal Reserve's balance sheet since the FOMC first deployed LSAPs in 2008. Section II analyzes previous research to estimate the amount of accommodation arising from the 2020–22 LSAPs. Section III reviews the FOMC's recently initiated plan for significantly reducing the balance sheet and draws on the similarly structured 2017–19 balance sheet runoff to project the effects of the current QT policy.

I. The Recent Evolution of the Federal Reserve's Balance Sheet

Prior to the 2007–09 global financial crisis, the Federal Reserve's balance sheet played only a supporting role in implementing monetary policy. In this era, the Federal Reserve's asset holdings were not the primary consideration when adjusting the balance sheet. Instead, adjustments to the balance sheet were made largely to achieve the target the FOMC set for the federal funds rate, the overnight interest rate at which banks borrow and lend reserves to each other. Each day, the Open Market Trading Desk at the Federal Reserve Bank of New York, in conjunc-

tion with the Federal Reserve Board of Governors, would forecast the amount of reserves the financial system needed to maintain the target funds rate. This projected level of reserves was achieved in practice by conducting open market operations (OMOs)—regularly adjusting the amount of reserves in the banking system by buying or selling Treasury securities in the System Open Market Account (SOMA) portfolio. The focus of these operations was on achieving the desired level of reserves, a liability on the Federal Reserve’s balance sheet; consequently, these OMOs were typically small and concentrated in relatively short-maturity Treasury securities. For example, at the end of 2006, the Federal Reserve’s Treasury holdings amounted to less than 9 percent of the Treasury market, and about half of these holdings matured in less than one year. Therefore, before the financial crisis, the balance sheet primarily affected longer-term interest rates through persistent changes in the overnight federal funds rate, achieved through adjustments in reserves (Ihrig, Meade, and Weinbach 2015).

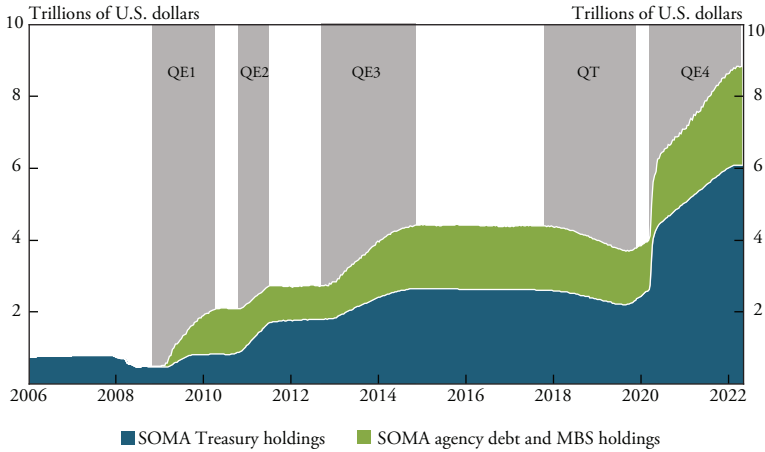
The economic and financial fallout from the global financial crisis led to a radical shift in the way the FOMC used the balance sheet to conduct monetary policy. In December 2008, the Committee set the target range for the federal funds at zero to 0.25 of a percentage point, an all-time low. With economic and financial conditions continuing to deteriorate—and with no appetite to push rates into negative territory—the FOMC turned to LSAPs to reduce longer-term interest rates more directly and stimulate the economy. These LSAPs targeted mortgage securities and longer-term Treasury securities, drastically affecting not just the size but also the composition and maturity profile of the Federal Reserve’s asset holdings relative to the pre-crisis norm.

Chart 1 shows the evolution of the Federal Reserve’s bond holdings in recent decades, with shading to denote specific asset purchase programs, often referred to as rounds of quantitative easing, or QE. The blue region denotes par values of Treasury holdings—that is, the amount the bondholder receives when the security matures—while the green region denotes par values of federal agency debt and federal agency mortgage-backed security (MBS) holdings.

Although the Federal Reserve’s balance sheet should naturally increase over time with the size of the economy to meet growth in the demand for currency and reserves, the increase in the balance sheet since

Chart 1

Evolution of the Federal Reserve's Bond Portfolio



Source: Board of Governors of the Federal Reserve System (Haver Analytics).

the start of LSAPs has far outpaced economic growth. From 2008 to 2014, the size of the Federal Reserve's balance sheet increased nearly five-fold—from roughly \$0.9 trillion to around \$4.5 trillion—after three rounds of asset purchases dubbed QE1, QE2, and QE3. Then, from 2017 through 2019, the balance sheet shrank modestly during a first-of-its-kind process dubbed QT. In the spring of 2020, the FOMC turned once more to LSAPs, as the COVID-19 pandemic again pushed the federal funds rate to the zero lower bound. However, the scale of asset purchases in response to the pandemic was unprecedented, with purchases in April 2020 alone exceeding \$1 trillion. Cumulative purchases since 2020, which we have denoted as “QE4” in Chart 1, exceeded \$4.6 trillion, more than all three previous QE programs combined.

In addition to the size, the composition of asset holdings has also changed substantially since 2008. Chart 1 shows that prior to 2008, the balance sheet comprised almost entirely Treasury securities (blue region). However, during the financial crisis, the Federal Reserve entered the then-turbulent agency debt and MBS markets to contain upward pressure on mortgage rates. In particular, the FOMC began QE1 by purchasing debt issued by the three federal agencies—the Federal National Mortgage Association (Fannie Mae), the Federal Home Loan Mortgage Corporation (Freddie Mac), and the Government National

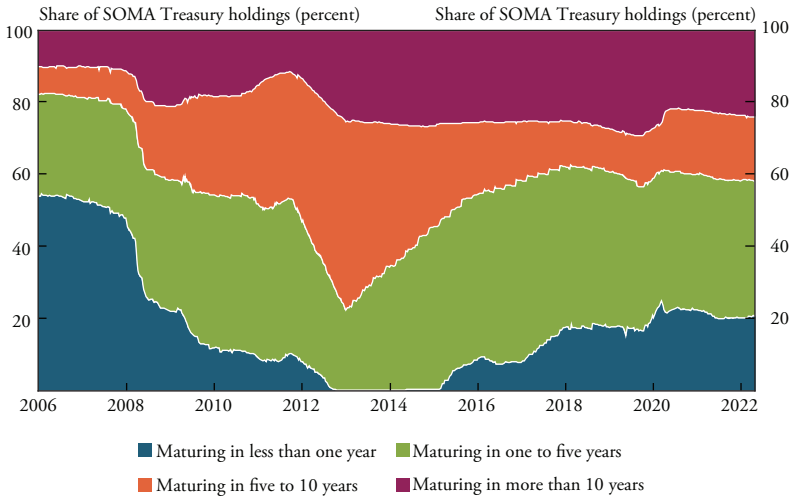
Mortgage Association (Ginnie Mae)—and the MBS guaranteed by them.¹ By the end of QE1, the Federal Reserve owned more than 20 percent of the agency MBS market. The Federal Reserve's presence in the MBS market has fluctuated since but never fully receded. At the beginning of 2020, the Federal Reserve again turned to agency MBS purchases to combat the COVID-19 crisis. By March 2022, the Federal Reserve's MBS holdings stood at more than \$2.7 trillion, which amounted to nearly 30 percent of outstanding agency MBS securities.

The maturity profile of the Federal Reserve's asset holdings has also increased since 2008, due to increased holdings of both MBS and longer-term Treasury securities. The MBS purchases not only expanded the scope of assets held by the Federal Reserve, but also helped to increase the maturity of the Federal Reserve's asset holdings: most mortgages in the United States are paid off more slowly than the bills and other short-term Treasury securities that once comprised the majority of the Fed's asset holdings. Accompanying this increase in maturity from MBS purchases, the maturity of the Federal Reserve's Treasury portfolio has also significantly lengthened in recent decades. In 2009, the FOMC expanded the QE1 purchase program to include sizeable purchases of longer-term Treasury securities; subsequent asset purchase programs have further increased the Federal Reserve's holdings of longer-term Treasury securities. Chart 2 shows that the share of Treasury securities in the Fed's Treasury portfolio maturing more than five years into the future doubled from less than 20 percent at the end of 2006 to more than 40 percent at the end of March 2022.

The average maturity of the Federal Reserve's Treasury holdings peaked after the completion of the 2011–12 maturity extension program (MEP) and has since remained elevated. The MEP differed from other asset purchase programs in that it did not aim to increase the size of the Federal Reserve's balance sheet. Instead, the MEP aimed to increase the maturity profile of the Federal Reserve's Treasury holdings while keeping the overall size of the balance sheet constant, a goal achieved by selling shorter-maturity Treasury securities and using the proceeds to purchase longer-maturity Treasury securities. Chart 3 shows that the average maturity of the Federal Reserve's Treasury holdings increased from roughly three years at the end of 2006 to a peak of more than 10 years at the end of 2012. More recently, following the completion of

Chart 2

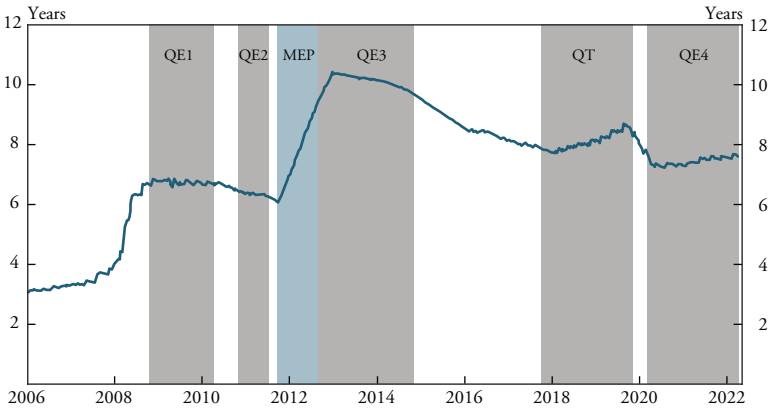
Maturity Profile of the Federal Reserve’s SOMA Treasury Holdings



Source: Board of Governors of the Federal Reserve System (Haver Analytics).

Chart 3

Weighted-Average Maturity of the Federal Reserve’s SOMA Treasury Holdings



Note: Average maturity is calculated based on the par value weighted-average maturity.
Sources: Federal Reserve Bank of New York and authors’ calculations.

the pandemic-era purchases in March 2022, the average maturity of Treasury holdings stood at 7.6 years.

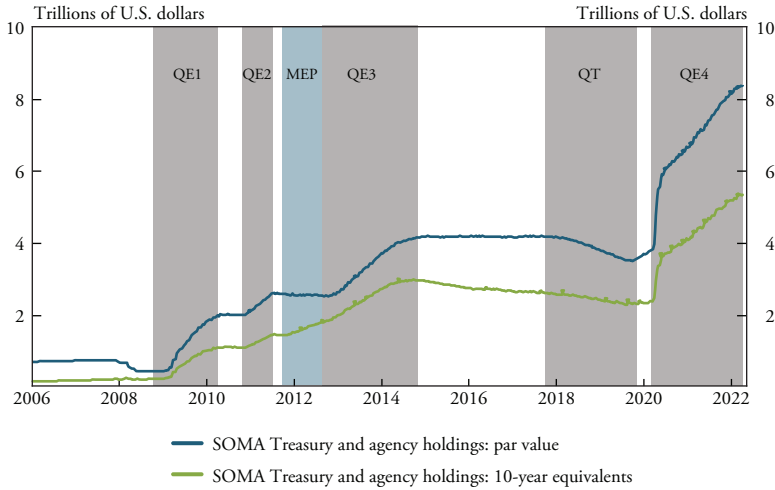
A useful way to summarize changes to both the size and maturity composition of the Federal Reserve's balance sheet is to convert the Federal Reserve's bond portfolio into 10-year equivalents. Just as it sounds, this involves scaling the (par) value of each security by its maturity relative to the maturity of a 10-year Treasury note. For example, a Treasury security maturing in five years would receive approximately half its value in 10-year equivalents, whereas a Treasury security maturing in 20 years would receive approximately double its value in terms of 10-year equivalents. Rescaling each security on the Federal Reserve's balance sheet in this way and then summing the value of the 10-year equivalent holdings provides a single measure that can simultaneously account for changes in the size and maturity structure of the balance sheet. More formally, we compute the duration of each bond—the number of years it will take a bond holder to be repaid the bond's price by way of discounted future payments—compared with the duration of a 10-year Treasury security (see Appendix A for details on this calculation).

Chart 4 compares the size of the Federal Reserve's asset holdings in par value, as is typically reported, as well as the duration-adjusted size reported in 10-year equivalents. Although each round of QE is clearly visible in both measures, the 2011–12 MEP is only noticeable after the balance sheet is converted into 10-year equivalents. Therefore, measuring the size of the Federal Reserve's balance sheet in 10-year equivalents allows us to better capture the full range of balance sheet policies and their effects on longer-term interest rates.

The duration-adjusted size of the Federal Reserve's balance sheet summarizes a central mechanism through which central bank balance sheet policies are thought to operate; namely, by changing the supply of long-duration assets in the hands of investors.² The Federal Reserve can either remove long-duration assets from the market by purchasing them and thus expanding its balance sheet, or, as the MEP neatly illustrates, by adjusting the composition of its balance sheet toward longer-duration securities without necessarily changing its size. In either case, when the Federal Reserve reduces the supply of duration in the hands of investors by purchasing long-duration assets, the price of duration is effectively bid higher. As the pricing of duration is

Chart 4

Size and Duration-Adjusted Size of the Federal Reserve's SOMA Holdings



Notes: The 10-year equivalents are calculated based on the Treasury yield curve as of July 2014. See Appendix A for more details.

Sources: Federal Reserve Bank of New York, Board of Governors of the Federal Reserve System (Haver Analytics), Bloomberg LP, and authors' calculations.

embedded in all longer-term assets, the Federal Reserve's asset purchases have the potential to increase prices across a range of assets. And since bond prices and yields move inversely, increases in the duration-adjusted size of the Fed's bond portfolio should place downward pressure on longer-term interest rates.

QT acts to reverse these effects by removing long-term assets from the Fed's balance sheet, thereby increasing the supply of long-duration assets in the hands of investors. Although the qualitative effects of these adjustments on longer-term interest rates are straightforward, the quantitative effects remain an open question.

II. Quantifying the Accommodation from the Balance Sheet

To quantify the effects of balance sheet adjustments on longer-term interest rates, we review previous studies on the relationship between the supply of duration and longer-term interest rates. Many research papers estimate this relationship using event studies, which measure how mar-

ket interest rates respond to announcements of asset purchases by the Federal Reserve. However, event studies often focus on announcements of asset purchases made during crises; as a result, these studies may capture channels that are not operative in normal times and that do not apply symmetrically to balance sheet expansions and reductions.³ For example, during periods of severe financial distress, market functioning may be impaired, leading asset purchase announcements to have outsized effects, such as during QE1 (D'Amico and King 2013). Furthermore, during crises, asset purchases may generate important liquidity effects not present in normal times. Vissing-Jorgensen (2021) argues that liquidity provision was a key channel through which the FOMC's asset purchases transmitted to Treasury and MBS markets in the spring of 2020. However, this liquidity channel of asset purchases may not be present in periods of normal market functioning when the balance sheet is reduced and that liquidity is withdrawn.

For these reasons, we restrict our attention to research that meets three criteria: (i) the research has been peer-reviewed or formally subjected to comments from other researchers, (ii) the research does not rely solely on estimates from the QE1 period nor the spring of 2020, and (iii) the analysis enables us to convert estimated effects in terms of duration-adjusted quantities (10-year equivalents) on the 10-year Treasury yield or comparable long-term Treasury rates. We impose the first criterion to ensure the estimates are of sound quality, the second criterion to ensure the estimates do not reflect the effects of asset purchases during periods of severe market dislocations, and the third criterion to ensure the estimates can be applied to the duration-adjusted size of the balance sheet.

Table 1 summarizes the eight studies that meet our criteria and accordingly inform our estimates of the effect of the balance sheet on longer-term rates. These eight studies cover a range of estimation samples and statistical techniques, ensuring our estimate of the balance sheet effect on long-term rates is not driven by any one event or estimation strategy. To facilitate comparison, we apply the same thought experiment to each study—specifically, we consider how much the 10-year Treasury yield would fall if investors were asked to hold \$100 billion less in 10-year equivalent U.S. government debt (for example, because the Federal Reserve removed duration from the market through

Table 1

Summary of Estimates of Asset Purchases on 10-Year Treasury Yield

Study	Estimation sample	Event analyzed	Par value purchases (billions of dollars)	Duration-adjusted purchases (billions of dollars, 10-year equivalents)	Estimated effect on 10-year yield (basis points / \$100 billion, 10-year equivalents)
Greenwood and Vayanos (2014)	1952–2007	QE1, QE2	\$900	\$569	-2.3
Hamilton and Wu (2012)	1990–2007	MEP	\$400	\$400	-3.5
Swanson (2011)	1961	QE2	\$600	\$400	-3.8
Krishnamurthy and Vissing-Jorgensen (2011)	2010	QE2	\$600	\$400	-4.5
Gagnon and others (2011)	1985–2008	QE1	\$1,750	\$750	-4.5
Hanson (2014)	1989–2014	QE1	\$1,750	\$750	-7.2
Li and Wei (2013)	1994–2007	QE1, QE2, MEP	\$2,750	\$1,550	-9.7
D’Amico and others (2012)	2002–2008	QE1, QE2	\$900	\$569	-14.1
Median estimate (25–75 percentile range)					-4.5 (-3.7, -7.8)

Notes: Greenwood and Vayanos (2014) and D’Amico and others (2012) study only the Treasury component of QE1 purchases. The 10-year-equivalent amounts are from Hanson (2014).

asset purchases). Answering this question for each study requires some conversions of the estimates in the respective papers (details on how we convert these estimates to the values shown in Table 1 are provided in Appendix B). The far-right column of Table 1 shows the resulting estimates (in basis points) for each study, along with the median estimate across studies.

The median estimate from our meta-analysis suggests that every \$100 billion in 10-year equivalents purchased by the Federal Reserve reduces the 10-year Treasury yield by 4.5 basis points. To arrive at a measure of the accommodation stemming from the Federal Reserve’s balance sheet, we apply this median estimate to the size of the duration-adjusted SOMA portfolio scaled relative to the size of the economy. By this measure, the Federal Reserve’s balance sheet is providing significant accommodation, depressing the 10-year Treasury by roughly 160 basis points as of the first quarter of 2022 (more details on this calculation are provided in Appendix B). Perhaps as expected, given the doubling

Box

Estimates of the Effects of Asset Purchases on Longer-Term Interest Rates

The estimates from our meta-analysis in Table 1 largely align with the estimates from other studies synthesizing existing research on the effects of asset purchases on the 10-year Treasury yield.

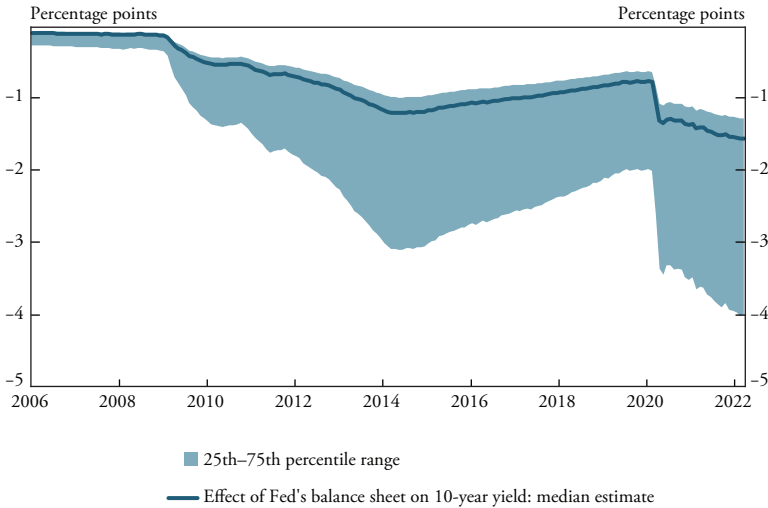
Two widely cited reviews are from Williams (2013) and Gagnon (2016), both of which compile estimates of the effects of LSAPs on the 10-year Treasury yield across a range of studies. However, unlike our analysis, the surveys in Williams (2013) and Gagnon (2016) do not account for the duration of the Fed's asset purchases. Williams (2013) instead argues that a \$600 billion (par value) asset purchase program targeting medium- and longer-term Treasury securities reduces the 10-year Treasury yield by 15 to 25 basis points. If we report the purchase amounts in the studies cited in Table 1 by par value rather than 10-year equivalents, the median estimate across the eight studies we analyze would imply that \$600 billion in purchases reduces the 10-year Treasury yield by about 18 basis points, near the midpoint of the range reported in Williams (2013).

Like Williams (2013), Gagnon (2016) does not adjust asset purchases for duration but does normalize par value purchase amounts as a share of GDP. The median estimate from Gagnon (2016) suggests that an asset purchase program amounting to 10 percent of nominal GDP reduces the 10-year Treasury yield by 50 basis points. In 2011, when QE2 and the MEP took place, two events that served as the policy scenarios that many of the estimates in Table 1 were based on, 10 percent of nominal GDP amounted to roughly \$1,580 billion in par value purchases. Therefore, the median estimate in Table 1 implies that an asset purchase program amounting to 10 percent of nominal GDP reduces the 10-year Treasury yield by 48 basis points ($= 18 \text{ basis points} \times \$1,580 \text{ billion} / \600 billion), remarkably close to the median estimate of 50 basis points reported in Gagnon (2016).

The proximity of the estimates from Table 1 with those from prior research synthesizing the effects of asset purchases suggests that our criteria for selecting which studies to include in our analysis did not meaningfully bias the estimates one way or another.

Chart 5

Estimate of Accommodation from the Federal Reserve's Balance Sheet



Note: See Appendix B for more details.

Sources: Federal Reserve Bank of New York, Board of Governors of the Federal Reserve System (Haver Analytics), Bloomberg LP, U.S. Bureau of Economic Analysis (Haver Analytics), and authors' calculations.

of the Federal Reserve's balance, about half of the 160 basis points of downward pressure on longer-term interest rates stems from asset purchases since the spring of 2020.

However, wide uncertainty surrounds this estimate. For example, Greenwood and Vayanos (2014) estimate much more modest effects from asset purchases on longer-term interest rates, while D'Amico and others (2012) estimate much larger effects. Differences across estimates reflect numerous factors, including different samples and methodology, as well as more fundamental differences in the channels through which asset purchases can influence longer-term interest rates.⁴ We attempt to acknowledge the uncertainty around our estimate by also reporting the 25th–75th percentile range of estimates from Table 1. This range suggests that the Federal Reserve's balance sheet was depressing longer-term rates by anywhere from 130 to 270 basis points as of the first quarter of 2022.

Chart 5 shows the evolution of the accommodation emanating from the balance sheet. The solid line and surrounding shaded area show the median estimate and the 25th–75th percentile range, respectively, of the

effect of the Fed's asset holdings on the 10-year Treasury yield. Since late 2008, the Federal Reserve's balance sheet has proven to be an effective means of providing policy accommodation. Given that the federal funds rate was at or near the zero lower bound for much of the last 15 years, the stimulatory effects from balance sheet expansions have played an important role in supporting the U.S. economy at times when reductions in the federal funds rate were unavailable. However, this accommodation has proven to be persistent, never fully reversing. Particularly remarkable is the fact that despite a concerted effort to shrink the balance sheet from 2017 to 2019 through QT, the accommodation emanating from past asset purchases is estimated to have only partially receded. This underscores a potential challenge in relying on the balance sheet for policy accommodation: the difficulty in removing accommodation through the balance sheet once the economy no longer requires added monetary policy support.

III. Challenges in Removing Policy Accommodation through the Balance Sheet

As the FOMC embarks on another episode of QT, it faces new and unprecedented challenges in unwinding the balance sheet. During the recovery from the global financial crisis, inflation remained low, and employment gains were frustratingly slow; therefore, the minimal withdrawal of policy accommodation through the balance sheet did not impede the pursuit of the FOMC's economic objectives. However, in the pandemic recovery, the economy is in a starkly different position. Inflation is reaching multi-decade highs, and by some measures, the labor market is historically tight. Against this backdrop, the FOMC is pursuing a more rapid withdrawal of policy accommodation through the balance sheet. Whereas the FOMC waited nearly three years after the end of QE3 in 2014 to begin QT in 2017, the FOMC only waited three months between ending net asset purchases in March 2022 and beginning to reduce the balance sheet in June 2022. Moreover, the pace of balance sheet reduction is nearly double the pace from the 2017–19 QT.

Nevertheless, the FOMC's current plan for reducing the balance sheet follows the same core strategy employed during the 2017–19 QT. In particular, the Committee is reducing the balance sheet by no longer reinvesting the proceeds from a portion of maturing securities rather

than selling assets outright. Although the FOMC signaled that it would consider MBS sales once balance sheet runoff is well underway, no plans have been announced (Board of Governors 2022a).

Some may argue that the current economic backdrop of low unemployment and high inflation calls for a more deliberate approach to QT—one that includes asset sales. Indeed, the decision to not sell assets limits the speed at which the balance sheet can shrink. However, this decision also preserves the power of asset purchases in the event of a future crisis.⁵ For asset purchases to be effective in moving long-term interest rates, market participants must believe the central bank will hold the assets it purchases for a significant period of time (Potter 2016). For example, if the central bank announces its intention to buy a large amount of long-duration assets and at the same time announces its plans to sell said assets a short period later, the effects on longer-term interest rates would likely be nil. While extreme, this example illustrates that a quicker-than-expected reduction in the balance sheet may diminish the effectiveness of future asset purchases. This logic imparts an inherent asymmetry in the pace at which the central bank's balance sheet can grow and shrink while retaining the effectiveness of LSAPs and underscores a fundamental challenge with removing accommodation from past asset purchases.

Given that the FOMC is not currently pursuing asset sales, we leverage the similarities between the FOMC's current plan for reducing the balance sheet and the 2017–19 QT episode to predict how the current balance sheet runoff will evolve. The FOMC's stated objective of QT in 2017 was to arrive at a smaller, Treasury-only portfolio (Board of Governors 2022b). To achieve this objective, the FOMC allowed principal payments from maturing securities to run off the balance sheet rather than fully reinvesting the proceeds. The FOMC also capped the pace at which these payments were allowed to run off to reduce the balance sheet “in a gradual and predictable manner.” These caps, once fully phased-in, ensured that no more than \$30 billion in Treasury securities and \$20 billion in agency MBS ran off the balance sheet each month.

The FOMC's passive approach to balance sheet runoff failed to significantly decrease the duration-adjusted size of its asset holdings. Therefore, the previous QT episode led to an incomplete withdrawal

of the accommodation stemming from past asset purchases. From October 2017 through September 2019, the par value of the balance sheet shrank by only about \$700 billion—a modest amount given the scale of the preceding asset purchase programs, which totaled more than \$3.5 trillion. Moreover, by solely relying on principal paydowns of maturing securities from 2017 to 2019, only soon-to-mature Treasury securities rolled off the balance sheet while longer-dated Treasury securities remained. As Chart 3 shows, this approach skewed the weighted-average maturity of the Treasury portfolio higher. As a result, we calculate that the duration-adjusted decline in the balance sheet from October 2017 through September 2019 totaled just \$290 billion in 10-year-equivalents. According to the median estimate from Table 1, the effect of this decrease in the duration of the SOMA portfolio would translate to an average increase in the 10-year Treasury yield of only 10 basis points from 2017 to 2019 (with an interquartile range of 8 to 17 basis points). Smith and Valcarcel (2022) arrive at a similar estimate using an entirely different empirical strategy; they estimate that QT pushed up the 10-year Treasury yield by just 8 basis points on average over this same 2017–19 period.

Moreover, the comparatively gradual runoff of MBS holdings limited the FOMC's progress toward achieving a portfolio consisting primarily of Treasury securities. Most mortgages in the United States are issued for 15- or 30-year terms; accordingly, none of the MBS purchased since 2008 were maturing from 2017 through 2019. Although MBS are frequently repaid before maturity, as when a house is sold or a mortgage is refinanced, these activities tend to slow in a rising-interest-rate environment, leading actual runoff of MBS to fall below the runoff cap once it was fully phased-in in late 2018. As a result, the comparatively slower rate of MBS runoff led to an increase in the share of agency MBS in the SOMA portfolio during balance sheet runoff, moving further away from the Treasury-only portfolio the FOMC had envisioned.

In 2022, the FOMC is pursuing a similar strategy for reducing the balance sheet, albeit with higher runoff caps. The fully phased-in runoff caps are roughly double the 2017–19 pace, increasing from \$50 billion per month to \$95 billion per month. However, as in 2017–19, only the shortest-duration Treasury securities will mature, and reinvestments above the caps will be spread across new issuance. As a result,

the average maturity of the Treasury portfolio will likely increase once again, dampening the duration-implied effects of the runoff. Moreover, projections based on current mortgage rates suggest agency MBS holdings will rarely reach the fully phased-in cap (Logan 2022). Both factors suggest that the pace of the actual runoff—both in par value and in terms of 10-year equivalents—will be slower than the notional cap of \$95 billion per month and that progress toward a primarily Treasury portfolio will be limited.

Based on the current runoff strategy, we anticipate that a significant amount of the accommodation from past asset purchases is likely to remain in place in the coming years. Recent projections from the Federal Reserve Bank of New York suggest that the Federal Reserve's bond portfolio will decline by about \$2.5 trillion in par value from June 2022 through the end of 2025.⁶ As in the previous QT episode, only soon-to-mature Treasury securities will run off the balance sheet in coming years, and the decline in terms of 10-year equivalents will therefore be significantly smaller. Based on the relative decline in 10-year equivalents versus par value from 2017 to 2019, we project that the decline of \$2.5 trillion in par value will only reduce the balance sheet by about \$1 trillion in 10-year equivalents from 2022 through 2025.⁷ Relying on the median estimate from Table 1, absent other developments, this decline in the balance sheet would be expected to increase the 10-year Treasury yield by roughly 30 basis points by the end of 2025.⁸ Given that we estimate that the balance sheet is depressing the 10-year Treasury yield by roughly 160 basis points, we anticipate that the downward pressure on longer-term interest rates stemming from the balance sheet will only partly reverse in coming years. More fully removing this accommodation will likely require a prolonged period of reinvestments from principal payments into shorter-maturity Treasury securities, thereby shrinking the duration-adjusted size of the balance sheet as a share of GDP closer to its pre-2008 share.

Conclusion

Recently, policymakers have come to rely on expansions of the balance sheet through LSAPs to provide further policy accommodation when the federal funds rate is constrained by the zero lower bound. Although LSAPs have been shown to be effective at delivering desired

accommodation, the Federal Reserve's limited experience with shrinking the balance sheet suggests that reducing this accommodation can be a slow and challenging process.

We argue that the challenges associated with balance sheet reduction are inherent to the use of the balance sheet as a policy tool. In particular, retaining the full effectiveness of future balance sheet expansions likely requires somewhat gradual reductions. In light of this intrinsic asymmetry between the pace at which the balance sheet can grow and shrink, policymakers may need to weigh future balance sheet expansions against the potential costs of putting in place persistent policy accommodation.

Appendix A

Converting the SOMA Portfolio into 10-Year Equivalents

We use Committee on Uniform Security Identification Procedures (CUSIP)-level data of the Federal Reserve's SOMA portfolio to convert the SOMA portfolio from par or face value into 10-year equivalents. These data are available Wednesday of each week from the Federal Reserve Bank of New York from July 2003 to the present.

Over this sample, the SOMA portfolio has consisted of Treasury bills, notes, and bonds; Floating Rate Notes (FRNs); Treasury Inflation Protected Securities (TIPS); inflation compensation on TIPS holdings; agency debts; agency mortgage-backed securities; and commercial mortgage-backed securities.

We convert each security from par value into 10-year equivalents based on the Treasury yield curve as of July 30, 2014. This follows Greenwood and others (2016) and prevents shifts in the Treasury yield curve from affecting the measure of 10-year equivalents week to week due solely to changes in interest rates that, in turn, affect the way future coupon payments are discounted to the present. On this day, the duration of a 10-year Treasury note is measured to be 8.9 years. Although the duration of Treasury securities can be directly calculated with the yield curve data and the detailed security-level data from the Federal Reserve Bank of New York, calculating MBS duration is considerably more complicated, as it depends on the probability that a mortgage is refinanced or paid-off early given current interest rates. We therefore follow Hanson (2014) and use a measure of MBS duration obtained from Bloomberg LP. Consistent with our Treasury duration calculations, we hold this duration measure fixed as of July 30, 2014. For each type of security, we use the following methods to convert the par or face value of the security into 10-year equivalents.

- *Treasury bills, notes, bonds, TIPS, and agency debts.* Duration is measured using the Macaulay modified duration formula based on par value, issue and maturity dates, and coupon rates with assumed biannual coupon payments (where applicable).
- *FRNs.* Duration is set to six days unless it matures before then, as the rates on these notes are reset weekly (on Tuesdays).

- *Agency mortgage-backed securities*: Bloomberg U.S. MBS Modified Duration is set to 5.1 years, its value on July 30, 2014.
- Inflation compensation on TIPS holdings and commercial MBS are excluded from the calculation.

We then scale the par or face value of each security by the ratio of its measured duration relative to 8.9 years, the duration of a 10-year Treasury note on July 30, 2014. We then sum over all securities to arrive at a measure of the SOMA portfolio in 10-year equivalents.

Appendix B

Converting Reported Duration or Asset Purchase Effects on the 10-Year Treasury Yield to Effects per \$100 Billion of 10-Year Equivalents

The meta-analysis in Section II draws on estimates of changes in the supply of long-duration assets or asset purchases on the 10-year Treasury yield from eight previously published studies. Here we detail how the previously published estimates are converted to effects on the 10-year Treasury yield per a \$100 billion reduction in the supply of 10-year equivalents, shown in the last column of Table 1.

To summarize the estimated effects of the balance sheet on the 10-year yield shown in the last column of Table 1, we first identify the event analyzed (QE1, QE2, or MEP) of each study in our sample and gather the published estimate of how the analyzed event(s) affected the 10-year Treasury yield in basis points. We then obtain the dollar amounts for these events in terms of 10-year equivalents from Hanson (2014). We take the ratio of these two items: the effect on the 10-year Treasury yield (in basis points) divided by the total amount of purchases for the analyzed event(s) in terms of 10-year equivalents (expressed in billions of U.S. dollars). Multiplying this ratio by 100 provides the implied estimate of the basis point effect on the 10-year Treasury yield per \$100 billion in 10-year equivalents. The exact inputs for these calculations are detailed in Table B-1.

We now walk through this conversion for each of the eight studies shown in Table B-1.

- *Greenwood and Vayanos (2014)*. This study analyzes the effect of changes in the supply of maturity-weighted debt relative to nominal GDP on the 10-year Treasury yield over a 1952–2007 sample. Based on the regression estimates, the authors note that a one-unit decrease in maturity-weighted debt to GDP lowers “long-term” Treasury yields by 40 basis points (p. 685, Table 2). The authors impute that the Treasury component of QE1 and QE2 purchases reduced the maturity weighted debt-to-GDP ratio by 0.32, leading us to infer a total effect of these purchases on long-term yields of about 13 basis points ($= 0.32 \times 40$).

- *Hamilton and Wu (2012)*. This study contemplates a MEP-style operation of buying \$400 billion in long-term yields funded by creating reserves which, at the zero lower bound, is roughly equivalent to selling \$400 billion in short-dated Treasury securities and using the proceeds to buy \$400 billion in longer-term Treasury securities. We assume the operation is structured to remove \$400 billion in 10-year equivalents, as was the case with the actual MEP according to Hanson (2014). Based on the pre-crisis estimates of their term structure model, Hamilton and Wu estimate this operation would lower the 10-year Treasury yield by 14 basis points (p. 32, Table 5).
- *Swanson (2011)*. This study analyzes the effects of “Operation Twist” in the early 1960s, whereby the Federal Reserve purchased longer-term Treasury securities while the Treasury shifted issuance towards shorter-term securities. Swanson argues that the size of Operation Twist purchases (\$8.8 billion) is comparable in size to QE2 (\$600 billion), relative to the size of the economy and the Treasury market at the time. Swanson estimates that Operation Twist—which can be seen as roughly similar in size to QE2—reduced the 10-year Treasury yield by roughly 15 basis points (pp. 174–175, Table 3).
- *Krishnamurthy and Vissing-Jorgensen (2011)*. This study analyzes the change in Treasury yields and other asset prices in a one-day window around the announcements by the Federal Reserve related to QE2. The authors estimate that the cumulative change around the two most relevant announcement dates related to QE2 lowered the 10-year Treasury yield by 18 basis points (p. 248, Table 5).
- *Gagnon, Raskin, Remache, and Sack (2011)*. This study analyzes the effect of changes in the net supply of 10-year equivalents relative to nominal GDP on the term-premium component of the 10-year Treasury yield over a 1985–2008 sample. Based on the regression estimates, the authors predict that the QE1 purchases would lower the 10-year Treasury yield by 38 basis points (p. 30). The authors also predict that QE 1 reduced the supply of 10-year equivalents by \$850 billion, rather than

the \$750 billion cited in Hanson (2014). To make the various estimates comparable, we use the \$750 billion figure and therefore scale down the estimated effect from 38 basis points to 34 basis points ($= 38 \text{ basis points} \times \$750 / \$850$).

- *Hanson (2014)*. This study regresses changes in MBS duration on 10-year Treasury yields and finds that a 1 standard deviation decline in MBS duration, which amounts to a \$503 billion decline in 10-year equivalents, lowers the 10-year Treasury yield by 36 basis points (p. 286, Table 4). Hanson further computes that QE1 lowered the supply of 10-year equivalents by \$750 billion, implying a total effect on the 10-year yield of 54 basis points ($= 36 \text{ basis points} \times \$750 / \$503$).
- *Li and Wei (2013)*. This study analyzes the effects of changes in the supply of long-duration assets relative to nominal GDP on Treasury yields over a pre-crisis sample of 1994–2007 using a term structure model. They then use the estimated model to infer the effects of QE1, QE2, and the MEP. The authors note that the combined effects of QE1, QE2, and the MEP removed an amount of duration that would be predicted to lower the 10-year Treasury yield by 150 basis points (pp. 28–29, Table 6).
- *D’Amico, English, Lopez-Salido, and Nelson (2012)*. This study analyzes changes in the supply of long-duration assets using detailed, security-level data to estimate a broader range of channels of how LSAPs could affect longer-term yields. They estimate that through both the supply of long-duration assets (12 basis points) and local scarcity channels (23 basis points), QE1 reduced the 10-year Treasury yield by 35 basis points (p. 441). Similar calculations for QE2 imply an estimated reduction in the 10-year Treasury yield of 45 basis points (pp. 441–442; 10 basis points from duration, 35 basis points from scarcity). The sum implies an 80-basis point reduction in long-term Treasury yields from the Treasury components of QE1 and QE2.

Given that the size of the Federal Reserve’s balance sheet should naturally increase with the size of the economy, many of the estimates in Table B-1 are based on the supply of duration relative to nominal

Table B-1:

Breakdown of Estimates of Asset Purchases on 10-Year Treasury Yield

Study	Event analyzed	Duration-adjusted purchases (billions of dollars, 10-year equivalents)	Estimated effect on 10-year yield (basis points)	Estimated effect on 10-year yield (basis points / billions of dollars, 10-year equivalents)	Calculation of estimated effect $\times 100$ (basis points / \$100 billion, 10-year equivalents)
Greenwood and Vayanos (2014)	QE1, QE 2	\$569	-13	-13/569	-2.3
Hamilton and Wu (2012)	MEP	\$400	-14	-14/400	-3.5
Swanson (2011)	QE2	\$400	-15	-15/400	-3.8
Krishnamurthy and Vissing-Jorgensen (2011)	QE2	\$400	-18	-18/400	-4.5
Gagnon and others (2011)	QE1	\$750	-34	-34/750	-4.5
Hanson (2014)	QE1	\$750	-54	-54/750	-7.2
Li and Wei (2013)	QE1, QE2, MEP	\$1,550	-150	-150/1550	-9.7
D'Amico and others (2012)	QE1, QE2	\$569	-80	-80/569	-14.1
Median estimate					-4.5

GDP. To arrive at a measure of the effect of the duration-adjusted size of the Federal Reserve's balance on the 10-year Treasury yield, as shown in Chart 5, we therefore scale our measure of the duration-adjusted size of the Federal Reserve's balance sheet by the size of the economy before applying these estimates. Intuitively, scaling the Federal Reserve's duration-adjusted balance sheet by nominal GDP is sensible: some of the studies use samples dating as far back as the 1950s, and today's economy is considerably larger. In particular, we benchmark these estimates to 2011:Q4 and then scale down the effects of \$100 billion in 10-year equivalents in future years by the ratio of nominal GDP in 2011 to nominal GDP in more recent years. We choose 2011:Q4 as a reference period because the above estimates are generally linked to the 2011 timeframe when QE2 and the MEP were ongoing.

Endnotes

¹The debt and MBS issued by these agencies became officially backstopped by the federal government once they went into conservatorship in September 2008 (Rappaport 2020).

²Vayanos and Vila (2021) and Doh (2010) provide theoretical foundations for this channel of asset purchases.

³One channel that these event studies capture that is likely relevant in normal times is the way FOMC announcements influence expectations about future adjustments in the supply of long-duration assets. Although we do not capture this channel in our approach, our estimates should eventually capture the duration effects of announced purchases once the purchases are completed.

⁴For example, D'Amico and others (2012) study not just duration effects, but also local scarcity effects of asset purchases. The scarcity channel emphasizes that investors may have difficulty replacing the particular assets purchased by the Federal Reserve, which would increase their price and, for bonds, lower their yield.

⁵Sengupta and Smith (2022) provide another rationale for moving gradually to shrink the balance sheet at least initially: the comparatively unsettled state of financial markets in 2022 relative to 2017.

⁶These are approximate values taken from the Federal Reserve Bank of New York's report prepared for the FOMC on "Open Market Operations during 2021" (Federal Reserve Bank of New York 2022).

⁷As discussed in the text, from 2017 through 2019, the par value of the Federal Reserve's asset holdings declined by about \$700 billion. However, we estimate that the balance sheet only declined by about \$290 billion in terms of 10-year equivalents. We apply this ratio of 0.41 ($= \$290 / \700) to the projections for a par value decline of \$2.5 trillion from 2022 through 2025 to arrive at a projected decline in terms of 10-year equivalents of roughly \$1 trillion.

⁸This estimate of the effects of the projected balance sheet runoff on the 10-year Treasury yield is similar though a bit smaller than those from the Crawley and others (2022).

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