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Issues in the Use of the Balance Sheet Tool[1]

A. Introduction and Summary

Balance sheet policy (BSP) is one of the tools that the Committee could use to provide monetary policy stimulus in situations when its primary tool, the federal funds rate, is at or near its effective lower bound (ELB). This memo reviews a variety of options for implementing BSP, and for each of these options we evaluate benefits and costs, the most important of which are summarized below.

First, we review the evidence regarding the effects of the BSPs put in place by the Federal Reserve in the wake of the Global Financial Crisis—quantitative easing (QE1, QE2, and QE3) and the maturity-extension program (MEP)—and find that the benefits have been substantial, while the costs either did not materialize (e.g., outbreak in inflation) or materialized to a degree smaller than initially feared (e.g., financial stability issues). On the benefits side: a significant QE pass-through to higher-quality private assets, an increase in bank lending and risk tolerance, a faster recovery of the labor market, and a modestly higher inflation rate than in the absence of QE. On the costs side: communication challenges arising from the novelty of the tool and the use of multiple tools, some degree of non-productive risk-taking behavior by investors, and some political risks related to the volatility of remittances. Regarding the evolution of the efficacy of QE, some evidence has emerged that the marginal benefits of QE did not diminish despite varying economic and financial conditions. However, it is hard to know how these findings would apply in environments that are very different from those we have observed so far, for example, in situations in which longer-term interest rates are much lower. A related but separate issue is the lack of BSP space when longer-term Treasury rates get closer to their ELB, which could make QE less effective, similarly to any other policy that works through a reduction in interest rates.

Second, we discuss the use of flow-based asset purchase programs instead of fixed-size programs. The state-contingent nature of flow-based programs implies an automatic-stabilizing function—that is, more stimulus when the economy deteriorates, and vice versa. This feature may be associated with higher uncertainty about the program size and length, which can delay and/or diminish its full effect, and it also implies a higher risk of ending up with a very large balance sheet. However, aligning the state contingencies of flow-based programs and forward guidance (FG) about the policy rate

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may minimize the risk that the two instruments work at cross-purposes and thus may increase their credibility, which could help contain the size of flow-based programs.

Third, we consider using BSP to target interest rates along the yield curve, rather than the balance sheet size, by committing to adjust the balance sheet as necessary to place ceilings on interest rates—also known as yield curve control. We focus on the use of ceilings rather than strict targets, as they do not necessitate responding to declining yields by tightening policy when economic conditions worsen. Such policies could be particularly effective in reducing interest rate volatility in addition to helping maintain a particular level of rates, but at the cost of balance sheet control. Ceilings could be used on the short end of the yield curve, where they might reinforce FG, or for longer-term rates, which might be more relevant for the economic decisions of households and businesses.

Fourth, we discuss using BSP involving assets other than Treasury securities. These BSPs include the purchases of mortgage-backed securities (MBS) by the Federal Reserve as well as corporate bond purchase programs and "funding for lending" programs conducted by foreign central banks. Such policies can be more effective in easing conditions in the targeted markets, but raise concerns about the Federal Reserve engaging in credit allocation.

Finally, because each of these BSPs influences asset prices and the real economy through somewhat different channels, their relative effectiveness and thus optimal configuration will depend on the shocks affecting the economy. Consequently, it would be valuable for the Committee to keep a variety of tools and employ the ones that best fit the situation that it faces. We discuss some of these situations later in the memo.

B. Assessment of the benefits and costs of balance sheet policies since the crisis

The memo "Monetary Policy and Economic Performance since the Financial Crisis" of the Framework Review[2] discussed three commonly cited transmission channels of BSP: the signaling channel, the duration-risk channel, and the portfolio balance channel (also known as supply/scarcity channel).[3] In this section, we discuss recent findings related to the efficacy of these channels and additional aspects of BSP.

[2] Dario Caldara, Etienne Gagnon, Enrique Martinez-Garcia, and Christopher J. Neely: "Monetary Policy and Economic Performance since the Financial Crisis," memo sent to the Committee on July 12, 2019.
[3] The signaling channel works through changes in the expected future path of the policy rate. The duration-risk channel affects term premiums by changing the amount of aggregate duration risk held by private investors. The portfolio balance channel works by changing the available supply of the targeted assets and tends to affect more the yields of those assets and their close substitutes.

Benefits of balance sheet policies and impact on the real economy

BSPs were intended to provide monetary policy accommodation by reducing private borrowing costs, attenuating financial constraints, and stimulating bank lending and investments.

Recent studies find QE pass-through to be large and significant for stock returns, investment-grade corporate yields, real 30-year MBS yields, and real 30-year fixed-rate mortgage (FRM) rates.[4] The pass-through appears to occur gradually, reaching its peak after a few months from the start of the policy intervention.[5] In particular, the evidence suggests that QE supply effects on corporate bond prices are much larger by the end of the purchase program than upon its announcement, and that the maximal response of stock prices, equity implied volatility, and credit spreads to QE announcements occurs several weeks after the announcement. However, QE pass-through to lower-quality corporate bonds and non-agency mortgage loans is weaker and seemingly not very effective in compressing spreads, as lower-quality private yields tend to be less sensitive than government yields to changes in government bond supply induced by QE.[6]

Recent research also provides evidence on QE increasing bank lending and risk tolerance. Several studies find that QE1 and QE3 affected relatively more the lending behavior of banks with higher initial holdings of MBS. In particular, their lending increased by more than in banks with little MBS exposure, and they were more likely to re-shuffle their lending activities towards riskier loans and easier lending standards.[7] Regarding the composition of lending, there is evidence on QE1 translating into increased mortgage lending and refinancing, but a slowdown in commercial and industrial (C&I) lending;[8] QE3 increased not only home purchase mortgage originations, but also C&I lending.[9]

[4] See Gilchrist and Zakrajsek (2013), Gilchrist et al. (2015), Mamaysky (2018), and D'Amico and Kaminska (2019). In particular, the first two studies document an almost complete pass-through of QE shocks to real private borrowing costs. In earlier studies that find little pass-through, the empirical approaches do not seem very robust. The appendix discusses differences in the empirical approaches and explains why we focus on more recent evidence.
[5] These results are consistent with the theory of Greenwood et al. (2018) showing that, in partially-segmented asset markets, prices in a related market not directly targeted by the supply shock (e.g., the corporate bond market in reaction to supply shocks in the government bond market) initially underreact; but, as investors gradually rebalance their portfolios, prices change by more in the longer run.
[6] See, for example, D'Amico and Kaminska (2019) and Di Maggio et al (forthcoming).
[7] See Rodnyansky and Darmouni (2017), Chakraborty et al. (forthcoming), and Kurtzman et al. (2018).
[8] See Chakraborty et al. (forthcoming) and Luck and Zimmerman (forthcoming).
[9] Chakraborty et al. (forthcoming) find a crowding-out effect on C&I lending after both QE1 and QE3 while Luck and Zimmerman (forthcoming) find a positive effect on C&I lending after QE3. However, the dataset in Luck and Zimmerman (forthcoming) is more comprehensive (it also includes smaller and/or non-syndicated loans and it is at quarterly frequency) and arguably encompasses the dataset used in Chakraborty et al. (forthcoming).

In addition, Bernanke and Reinhart (2004), based on theories dating back to Friedman and Schwartz (1963) and Tobin (1969), suggest that the creation of reserves in the banking system as a result of central bank asset purchases can lead to portfolio substitution effects and thereby play a crucial role in the transmission of QE. The creation of reserves by the central bank implies that banks need to hold a larger amount of reserves than was previously regarded as sufficient, and will therefore seek to increase investments in securities and loans (Friedman and Schwartz, 1963). Kandrac and Schlusche (2017) test such a reserve-induced transmission channel and find that reserve creation induced by QE led to an acceleration in lending activity and increased risk taking within banks' loan portfolios.

Turning to non-financial firms' financing and investment decisions, Foley-Fischer et al. (2016) find that, around the MEP's announcement, stock prices of firms more dependent on longer-term debt rose by more. As a result, these firms issued more long-term debt during the MEP, and expanded their employment and investment. These results suggest that the MEP may have relaxed financial constraints for some firms by reducing bond market risk premiums and inducing gap-filling behavior in issuance.

Finally, we review a few recent studies focused on the macroeconomic effects of QE. Luck and Zimmerman (forthcoming) find that QE3 led to a sizable increase in employment at the county level through the bank-lending channel, while there were no significant effects on employment from QE1. Using FRB/US simulations, the estimated effects of unconventional monetary policy in speeding up the labor market recovery and the return of inflation to 2 percent after a recession are modest.[10] Other studies, such as Eberly et al. (2019) find that, in the absence of QE, unemployment would have been about one percentage point higher from 2014 to 2018.[11] Similar results are found by Wu and Xia (2016) for the period from July 2009 to December 2013.

Costs of balance sheet policies

BSPs are also associated with certain costs. Some of the costs initially feared did not materialize, notably an outbreak of inflation and a surge in financial stability risks. In this section, we provide an overview of costs that can still be potentially relevant in the future, such as challenges in communications, non-productive risk-taking behavior by investors, risks associated with elevated scarcity of securities being purchased, and fiscal

[10] Engen et al. (2015) estimate that the forward guidance and BSPs combined had a peak unemployment effect of 1¼ percentage points. Chung et al. (2019) find that the FOMC's ability to contain the initial raise in unemployment and fall in inflation after a significant recessionary shock is limited because there are significant lags in the transmission of unconventional monetary policy. Some of these studies model the post-crisis slump as largely unanticipated, which dampens the effects of BSP.
[11] Gertler and Karadi (2013) and Baumeister and Benati (2013) find even larger effects. For instance, according to Gertler and Karadi's calibrations, QE1 reduced the magnitude of GDP contraction by 3.5 percentage points, while QE2 increased GDP by 1 percentage point.

risks. The experience with BSPs that policymakers, investors, and researchers have gained over the last decade should mitigate some of these costs going forward, such as communication challenges, but they will still represent potential challenges.

First, the introduction of new policy instruments, such as BSPs, requires additional communication to inform the public about their nature and potential effectiveness. Such challenges can be compounded by the simultaneous use of multiple tools, for instance FG and BSP, as their effects can be interconnected. That said, effective communications about multiple instruments and their complementarity can reinforce the credibility of the central bank's commitment to future policy accommodation.

The exit from BSPs involves additional challenges. Policymakers have to decide on and communicate about multiple aspects of the normalization strategy, for example: the end date of asset purchases, the extent to which principal payments should be reinvested, passive runoffs versus active sales, and in the case of the former, whether and how to cap the runoffs. Following the experience of the Taper Tantrum, it became clear that if communication is done gradually and over a longer period of time, investors' expectations about the size and composition of the portfolio can adjust slowly and therefore be reflected in asset prices incrementally. Overall, it should be noted that as policymakers and investors have now much more experience with the normalization process, the complexities considered here may be less severe in the future.

Second, although a central objective of BSPs is to encourage investors to rebalance their portfolios toward riskier assets, prolonged BSPs could alter asset prices in ways that induce non-productive risk-taking behaviors, for example by increasing the incentives for maturity and liquidity transformation or imprudent "reach for yield" by institutional investors. This could be the case if investors needed to maintain short-term nominal returns due to principal-agent issues or for accounting purposes (Stein, 2013). However, Kuttner (2018), in reviewing the evidence on excessive risk-taking by financial and non-financial firms, concludes that while some reaching-for-yield may have occurred, it certainly did not pose serious concern.

Third, QE may mute or impair market functioning. Although QE1 significantly improved liquidity in the markets in which purchases occurred during the height of the financial crisis, BSPs could impair market functioning if the purchases were too large relative to the overall market or too concentrated in certain maturity sectors, thereby crowding out a particular class of market participants (e.g., money market funds at

shorter maturities and pension funds and insurance companies at longer maturities).[12] For example, Kandrac (2018) finds that the Federal Reserve's MBS purchases after 2011 led to a deterioration in measures of liquidity and market functioning, particularly at the beginning of purchase programs, although these effects were fairly short-lived. D'Amico et al. (2018) find that the scarcity of Treasury securities resulted in some price distortions in the Treasury repo market, which are often related to elevated fails to deliver. In addition, certain intermediaries, such as banks, have business models that depend in part on exploiting maturity mismatches.

Finally, QE has fiscal implications as it affects asset prices and, hence, public financing costs as well as government revenues and expenditures. Clearly, over the last ten years, the lower interest rates generated by QE have reduced the costs of issuing public debt and have facilitated its maturity extension. However, Cavallo et al. (2018) highlight that the Federal Reserve may face political economy concerns related to the volatility of remittances to the U.S. Treasury during the transition to the long-run balance-sheet size, including the possibility of recording a deferred asset. While the likelihood of the Federal Reserve recording losses and temporarily ceasing remittances has been relatively small over the past ten years, this may not be the case if BSPs were in place in the future.

Does QE have diminishing returns?

Most previous research assessing whether QE has diminishing returns in financial markets has not controlled at the time of the BSP announcements for expectations about the future size of the balance sheet.[13] That failure has led some researchers to conclude that QE programs have become less effective over time, but it is actually the magnitude of the asset supply surprise—not necessarily the yield sensitivity—that has diminished.[14] Further, the recent experience with the normalization process—or quantitative tightening (QT)—has allowed researchers to study the effect of the Federal Reserve's BSP on Treasury yields across diverse macroeconomic and monetary-policy cycles.

Studies that take into account expectations about future purchases continue to find that the marginal effects of asset purchases on financial and macroeconomic variables have not decreased over time. Cahill et al. (2013) and D'Amico and Seida (2019) carefully measure the surprise components of QE announcements using results from the Survey of Primary Dealers (SPD). Based on a range of estimates, Cahill et al. (2013) find that the responses of Treasury yields to a given amount of QE surprise do not appear

[12] See, for example, D'Amico and King (2013) and Gagnon et al. (2011) for the Treasury market, and Hancock and Passmore (2011) and Krishnamurthy and Vissing-Jorgensen (2011) for the agency MBS market.
[13] See, for example, Krishnamurthy and Vissing-Jorgenson (2011, 2013).
[14] The Treasury yield sensitivity is obtained by dividing the yield reaction by the size of the supply surprise.

to have declined across consecutive fixed-size QE programs. D'Amico and Seida (2019) conclude that the Treasury yield sensitivity to a supply shock during QT announcements is at least as large as the yield sensitivity to a supply shock during QE announcements, implying the supply/scarcity channel's strength at impact did not diminish across economic and monetary-policy cycles. Given that the yield sensitivity does not seem to diminish across states, the main driver of the observed differences in the announcement impacts of QE programs is the size of the supply surprise resulting from the announcements. Relatedly, Hesse et al. (2018) find that, once anticipation about asset purchases are accounted for, the effects of asset purchase programs on macroeconomic variables did not notably diminish as new rounds of asset purchases were added.

Nevertheless, there may be reasons to be concerned about diminishing effects of the duration-risk channel. Both Greenwood and Vayanos (2014) and King (forthcoming) show that when interest rate volatility is greater than zero, changes in the aggregate duration risk held by investors affect risk premiums. In their models, the risk premium reflects the product of the quantity of risk, which equals the interest rate volatility, and the market price of that risk, which equals the average duration of investors' portfolios. As shown in King (forthcoming), the duration-risk channel becomes less effective at the ELB because the ELB lowers the volatility of interest rates.[15] It is therefore conceivable that as longer-term yields decline to lower levels amid extended ELB episodes, the effects of the duration-risk channel will diminish.

Finally, some studies note that the macroeconomic effects of BSP may interact with the state of the financial sector. For example, the macroeconomic effects of BSP in Gertler and Karadi (2013) depend on collateral constraints limiting the lending ability of financial intermediaries; QE would have larger effects when these constraints are more binding.[16] In contrast, in Brunnermeier and Koby (2018), more restrictive capital constraints imply a faster drop in bank profitability caused by policy rate cuts, and QE, by removing long-term bonds from bank balance sheets, has the potential to magnify this effect. However, even in normal times, there are frictions and distortions that may give rise to effective BSP. For example, Schabert (2015) demonstrate that, even in the presence of collateral constraints that occur if only a fraction of assets is eligible for open market operations (repos and outright purchases), BSP can still improve welfare.[17]

[15] While the ELB lowers the volatility of nominal short-term rates, it is theoretically possible that it increases the volatility of real short-term rates through movements in inflation. However, the effect on inflation tends to be small in empirically realistic models so that the volatility of real short-term rates is lower too. Hence, the duration-risk channel's effects on real term premiums are smaller at the ELB.
[16] This is also true in Curdia and Woodford (2011) and He and Krishnamurthy (2013), although these studies emphasize the role of different financial market imperfections.
[17] In this model, there are also other frictions such as sticky prices and cash-in-advance constraints.

Taken together, these findings suggest that the strength of some QE channels (e.g., the supply/scarcity channel) does not seem sensitive to the state of the economy and corresponding levels of interest rates, while the strength of other channels (e.g., the duration-risk channel) does. It also seems that the efficacy of the state-sensitive channels may vary in potentially offsetting ways across states of the economy. Consequently, it is hard to know how QE programs' overall effect varies across states of the economy. Moreover, most of this evidence derives from sample periods in which longer-term rates never fell below two percent, and thus may not be directly applicable to environments with very low longer-term rates. Finally, as noted above, when longer-term Treasury rates get closer to their ELB, a lack of BSP space might mean that QE becomes less effective, similarly to any other policy that works through a reduction in interest rates.

C. Benefits and costs of flow-based programs relative to fixed-size programs

While the Federal Reserve's first two rounds of QE were conducted as "fixed-size" programs, with the total amounts of purchases specified upon announcement of the program, purchases under QE3 were "flow-based"—or "open-ended." That is, instead of announcing the total target amount of asset purchases, policymakers announced a specific pace of monthly purchases that would continue until a certain threshold (e.g., a substantial improvement in the outlook for the labor market) is crossed.

The advantage of flow-based programs is that they are state-contingent, allowing for program adjustments in response to positive or negative shocks to the economy. Such programs can be formulated using a rule-based framework that provides prescriptions for BSP conditional on economic conditions.[18] Under a flow-based program, if the economy experiences negative shocks, the statements the Committee has made linking the program to the economy should result in economic agents quickly updating their expectations for the length and therefore the amount of asset purchases, which, in turn, should lead to quick adjustments in financial conditions. While investors might expect an extension of a fixed-size program in the presence of negative shocks, there is more uncertainty about whether and when such extensions occur. The higher uncertainty may prevent asset prices from fully reflecting new expectations about the BSP so that there would be less automatic stimulus. Similarly, if the economy improves faster than expected, economic agents, under a flow-based program, would automatically revise down their expectations regarding the size of the asset purchase program. Further, there are credibility issues linked to trying to adjust a fixed-size program as, for instance, investors may start

[18] An example of rule-based BSP could be a rule under which the monthly pace of purchases of a flow-based program (similar to QE3) depends on the forecast of the output gap and inflation as in a Taylor rule for the federal funds rate; or alternatively, an even simpler rule in which the monthly pace of purchases stays constant and only the length of the program in terms of months is changed based on economic conditions. Gagnon and Sack (2018) suggest that a rule-based QE should focus on the Federal Reserve's holdings of longer-term assets and exhibit a considerable degree of inertia.

questioning whether future asset purchases will be completed as announced. Overall, flow-based programs can be linked to more confidence about policymakers' ability to make timely adjustments and, hence, circumvent the credibility issues inherent to fixed-size programs.

If a fixed-size BSP is accompanied by state-contingent FG about the policy rate, and policymakers are hesitant to renege on their commitment to the fixed-size program, a situation may arise in which the two instruments work at cross-purposes. For example, improving economic conditions may lead to a situation in which the state contingencies of FG are met so that policymakers may want to raise the federal funds rate before the fixed-size BSP is completed. In contrast, aligning the state contingencies of flow-based programs and FG about the policy rate may minimize the risk that the two instruments work at cross-purposes and increase their credibility, which could help contain the size of flow-based programs.

The main disadvantage of flow-based programs is the difficulty faced by investors in gauging the total size and persistence of asset purchases—that is, for how long a given pace of purchases will persist in response to shocks to the economy—as this information is relevant for the transmission mechanism of asset purchases. In contrast, in the case of a fixed-size program, economic agents are informed upon announcement about the size and length of the program and therefore have to form expectations only about the extent of the transmission to asset prices and the corresponding macroeconomic effect. The higher investor uncertainty surrounding the size and length of a flow-based program can delay and/or diminish its full effect on financial markets and the macroeconomy.

In addition, flow-based programs are subject to a possible inherent "ratcheting-up effect." If the economic recovery is slow and therefore, by construction, asset purchases continue for a long time, the Federal Reserve's balance sheet may grow to undesirable sizes.[19] A related concern is that the Federal Reserve could end up holding a large share of outstanding government securities, which might be detrimental to market functioning. However, the Federal Reserve's past flow-based asset purchase program has not been associated with undue disruptions to market functioning. Moreover, it is unlikely that the share of outstanding public debt held by the Federal Reserve would grow to very high levels as, during economic downturns, Treasury debt issuance rises sharply, creating room for the Federal Reserve to expand its balance sheet through purchases of government securities without necessarily crowding out private investors.

[19] In addition, the FOMC communicated, during its flow-based asset purchase program, its commitment to evaluating the efficacy of the program by stating that "In determining the size, pace, and composition of its asset purchases, the Committee will continue to take appropriate account of the likely efficacy and costs of such purchases."

D. Targeting quantities vs. targeting prices: Defining balance sheet policies through purchase amounts vs. yield curve targeting

An alternative to policies that expand the balance sheet by a particular amount or at a particular pace would be for the Committee to choose a goal for interest rates on Treasury securities and adjust the balance sheet size as necessary to achieve that goal. Setting policy in this way would allow the Committee to better control segments of the yield curve to provide the desired amount of monetary policy accommodation. Such policies could be focused on the shorter-end of the yield curve, to reinforce any forward guidance, or focused on the longer-end of the yield curve, which might be more relevant for the economic decisions of households and businesses (this issue is discussed in more detail below). Policies regarding yields could be defined either in terms of targets for those yields, in which case yields are not allowed to be either above or below the target, or ceilings, in which case only deviations above the ceiling matter. The discussion below focuses on the use of ceilings, which do not necessitate responding to declining yields by tightening policy when economic conditions worsen.[20] However, most of the arguments would apply to the use of interest rate targets as well.

Setting policy in terms of interest rates also has the potential to reduce interest rate volatility, especially the likelihood that rates might rise suddenly, and greater certainty about interest rates may in turn contribute to more accommodative financial conditions, allowing households and businesses to make spending plans with more confidence (Bowman et al., 2010). To achieve the benefits of reduced interest rate volatility, the Committee needs to be willing to tolerate the possibility that it may have to purchase securities amid improving economic conditions and rising yields. Investor expectations about the economic recovery and the responsiveness of monetary policy are likely to matter for the size of the purchases needed to maintain the ceilings. If the economy is improving, then investors will increasingly expect policy tightening and yields would rise toward the ceiling. It is likely that the Committee would want to be confident in the durability of the recovery before removing policy accommodation, so it is plausible that the ceiling would become binding and that substantial purchases could be required at some point amid the economic recovery. It is also important to remember that if the purchases result in the Federal Reserve acquiring a significant portion of outstanding securities, then many of the costs noted in Section B "Costs of balance sheet policies" would apply here as well.

Establishing ceilings on particular interest rates will clearly affect the prices of securities with maturities covered by the ceilings. However, the ceilings are also likely to

[20] Policymakers may consider policies under which yield targets would move in response to changes in conditions. However, allowing the targets to move too often would reduce one of the many benefits of such policies, which is increased certainty about the level of yields.

affect the prices of nearby securities. That could occur if the ceilings are seen as providing a signal about the path for monetary policy and change investor expectations. It could also affect prices of other securities in the event that the ceilings become binding and the Federal Reserve purchases securities, as investors rebalance their portfolios and use the money obtained from selling securities to the Federal Reserve to purchase other securities that would be close substitutes, such as those with similar risk or duration. In particular, investors might purchase securities with maturities just a bit longer than those covered by the ceilings.

The Committee will also have to decide how solid the ceilings are. The Committee could announce that the ceilings are firm and that the balance sheet would be expanded as needed to maintain that ceiling. Such a ceiling policy for a particular segment of the yield curve could be implemented by announcing that the Federal Reserve would be willing to purchase Treasury securities with maturities covered by the ceilings at a price such that the yield would be equal to the desired ceiling. Firm ceilings would provide the greatest benefit in terms of reducing interest rate volatility and concerns about sudden increases in rates. However, that benefit comes at the cost of a greater loss of control over the balance sheet size. Alternatively, the Committee could establish softer ceilings in which yields above the ceilings trigger purchases of securities with maturities covered by the ceilings at a particular pace until yields move below the ceiling. Softer ceilings allow the Committee great ability to manage how quickly the balance sheet expands, but may not necessarily result in a smaller overall balance sheet nor would they be as likely to compress interest rate volatility.

Ceilings on shorter-term rates

Ceilings on shorter-term rates, such as those in the two to three year range, would interact importantly with any FG about the federal funds rate provided by the Committee. As discussed in the memo "Issues Regarding the Use of the Policy Rate Tool," FG has been effective in reducing expectations about interest rates. Nevertheless, ceilings could be used to reinforce FG by signaling that the Federal Reserve is willing to use its balance sheet to ensure that rates remain below a certain level. Because interest rate ceilings would need to reference the maturities of the securities subject to the ceilings, it would be straightforward to coordinate FG and ceilings if the FG was framed in terms of calendar time. This could be done by aligning the maturities of securities covered by the ceilings with the information covered in the FG. If FG is framed in other terms, such as macroeconomic thresholds, then aligning FG and interest rate ceilings would be more challenging. In this case, the Committee could indicate that the same economic conditions referenced in the FG would also cause changes to the ceilings; it is likely that in this case there would be some maturities for which yields would surge notably once the referenced macroeconomic outcomes are reached. Regardless of the approach used, it

would be necessary to coordinate the exit or use "escape clauses" for FG and for the lifting of ceilings, as the end of one would likely cast doubt on the commitment to the other.

The Committee would also have to determine how close to set the ceilings on Treasury yields relative to the policy path implied by any FG. Setting the ceilings close to the policy path implied by FG would emphasize the commitment to that guidance. Reinforcing that commitment would help reduce interest rate uncertainty, lower risk premiums, and be more supportive of the accommodation provided by the FG. However, setting ceilings close to the implied policy path would increase the likelihood that the Federal Reserve would have to purchase substantial amounts of Treasury securities to maintain the ceilings. If instead the Committee chose to set the ceilings somewhat above the level of rates implied by the FG, it would reduce the likelihood of substantial purchases but also the extent to which the ceilings reinforced the FG's credibility. Indeed, as noted in the memo "Issues Regarding the Use of the Policy Rate Tool," FG has generally been quite credible and has reduced both the level of interest rates and uncertainty about rates. In that case, ceilings well above the level of rates implied by FG may not be helpful at all, and might actually reduce the credibility of the FG.

Limiting the use of ceilings to shorter-term rates would facilitate the unwinding of any balance sheet expansion incurred while maintaining the ceilings, because any securities acquired would have a short maturity. These securities would naturally mature and roll off the balance sheet relatively quickly after the Committee has decided to tighten policy.[21] Because the accommodation induced by ceilings on shorter-term rates can be reversed fairly quickly, these ceilings might be most useful in situations where the Committee believes that it might want to return to a neutral stance of monetary policy in the near future, such as in moderate, but not extreme, downturns.

Ceiling on longer-term rates

Rather than targeting shorter-term rates, the Committee may prefer to target longer-term rates, perhaps around ten years, as these are more important for economic decisions of households and businesses. Moreover, setting a ceiling on the level of longer-term rates would also reduce the risk that these rates would rise suddenly and sharply; that in turn would further support the ability of households and businesses to make longer-term spending plans with more confidence and could deliver a stronger

[21] It would always be possible for the Committee to abandon the ceilings and raise rates if conditions change. Doing so would result in mark-to-market losses on the securities it held. Such losses would likely be less if the Committee were targeting shorter-term rates than longer-term rates. The realization of those mark-to-market losses would depend on the Committee's decisions about the size of the Federal Reserve's balance sheet and whether the Committee would want to sell assets to reach the desired size.

boost than targeting shorter-rates. Counterfactual simulations by Eberly et al. (2019) suggest that a BSP that, following the financial crisis, had pinned the 10-year yield to two percent for five years would have resulted in the unemployment rate decreasing faster.[22] They also report that such policies would have notably increased the size of the Federal Reserve's balance sheet.

A ceiling on longer-term rates would be less tightly connected to FG and likely more challenging to maintain through communications about near-term policy or the near-term economic outlook. This reduced connection to FG and the greater sensitivity of longer-term rates to the longer-term economic outlook, which is less affected by monetary policy, might make it more difficult to maintain a ceiling on longer-term rates without notable asset purchases. Consequently, ceilings on longer rates could entail more uncertainty about the evolution and the ultimate size of the Federal Reserve's balance sheet.

It is important to note that interest rate ceilings provide accommodation through a somewhat different transmission mechanism from QE programs. Interest rate ceilings provide greater certainty about the maximum levels of yields on securities covered by the ceilings and a more effective reduction in the risk of a sudden increase in those yields. On the other hand, under fixed-size QE there is no uncertainty about the total amount of longer-term assets that will be purchased. Thus, the lower uncertainty in this regard could trigger larger portfolio rebalancing upon the announcement of the program and lead to faster declines in yields along the entire yield curve. Moreover, if the removal of duration risk from the market is an important channel by which BSPs are transmitted, then programs involving purchases of very long-term securities, such as 30-year bonds, could have a larger impact on longer-term rates while having a smaller impact on the Federal Reserve's balance sheet.

Securities accumulated while maintaining a ceiling on longer-term rates would be of longer maturities. Thus, if the Committee subsequently wants to tighten policy, it might need to rely on exit strategies similar to those used for previous QE programs rather than waiting for securities to roll off naturally. If the Committee determines that it needs to reduce the size of the balance sheet quickly through sales of securities, doing so would likely result in losses.

Examples of yield curve policies

Central banks have had polices for managing the yield curve. The Federal Reserve maintained a ceiling on the yield on long-term Treasury bonds of 2½ percent

[22] Their simulations technically focused on a policy of reducing the slope of the yield curve out to 10 years, but since the overnight rate was already at the ELB, that policy is very similar to imposing a ceiling on the 10-year rate.

from 1942 to 1951 and maintained a ceiling of ⅜ percent on the short-term (three-month) Treasury bill rate from 1942 to 1947 (there were also ceilings on intermediate rates). These ceilings were put in place during World War II to support the ability of the U.S. Treasury to fund the war effort and manage the interest burden afterward.[23] The ceiling on the Treasury bill rate was lifted to provide the Federal Reserve some ability to tighten policy in the face of rising inflation. The ceiling on longer-term bonds was lifted in conjunction with the 1951 Federal Reserve-Treasury Accord, which restored Federal Reserve control over monetary policy.

These ceilings were not binding when they were first established. However, the ceiling on the three-month bill quickly became binding and remained so until it was lifted. The Federal Reserve had to purchase a significant portion of outstanding bills in order to maintain the ceiling and by 1947, owned nearly the entire stock of such securities (Chaurushiya and Kuttner, 2003). Long-term interest rates generally remained low in this period and purchases were not often needed to maintain the ceiling on longer-term rates. The purchases that did occur represented only a modest fraction of outstanding.

While the Federal Reserve was successful in maintaining the ceilings on Treasury yields, the effect on private securities was more mixed (Chaurushiya and Kuttner, 2003). Yields on private money market securities rose despite the ceiling on Treasury bill rates with the rate on prime commercial paper increasing 25 basis points during the second half of 1946. The spread between the rate on longer-term AAA-rated corporate bonds and long-term Treasury securities widened some in 1947, around the time when the ceiling on the bill rate ended and amid purchases of Treasuries by the Federal Reserve to defend the ceiling on long-term rates. However, the spread narrowed subsequently and remained low even in the months just prior to the Accord, when the Federal Reserve was again engaging in purchases to maintain the ceiling on longer-term rates. While these historical episodes are suggestive that Federal Reserve actions to place ceilings on yields in the Treasury market in the 1950s were generally transmitted to private markets, it is not certain whether transmission would be more or less today given increases in opportunities for arbitrage, market interconnectedness, and market depth.

The Bank of Japan (BOJ) provides a recent example of targeting longer-term rates, through its "yield curve control" regime. Since September 2016, the BOJ has committed to keep the yield on 10-year Japanese government bonds (JGBs) around 0 percent. The BOJ initially defended an informal band of 10 basis points on either side of its yield target. In July 2018, in response to concerns that a decline in private transactions had impaired market functioning, the BOJ expanded that band to 20 basis

[23] The ceilings not only kept the rates low and held down government financing costs, but they also supported current demand by giving investors confidence that rates would not rise later in the war and result in mark-to-market losses on their securities holdings.

points in either direction. Over this period, the BOJ saw a rapid expansion of its balance sheet, even though it has gradually reduced the annual pace of its long-term bond purchases from ¥80 trillion to less than ¥30 trillion. Around this fairly steady rate of purchases, the 10-year yield target has required very little active adjustment of the BOJ's balance sheet. For instance, on a few occasions when the yield rose to near the top of the informal band, the BOJ announced that it stood ready to buy unlimited amounts of 10-year bonds at a rate just above the top of the band. In the event, no sellers emerged, so the BOJ's defense of its target did not require any extra bond purchases. In recent months, as the 10-year yield moved somewhat below the bottom of the informal band, the BOJ reduced its monthly bond purchases but did not conduct any special operations to raise the yield. The BOJ's ability to control the 10-year yield is facilitated by the fact that it holds about 50 percent of outstanding Japanese government bonds (JGBs), up from about a 10 percent share when it began large-scale purchases in 2013. That dominance, however, has reduced active trading and liquidity in the JGB market.

The BOJ's experience suggests that a central bank can target a longer-term bond yield without big fluctuations in its balance sheet around a trend of expansion. However, there are a couple of open questions. The BOJ has not yet changed the level of its yield curve target, so it is unclear how disruptive such a change could be. For instance, if market participants begin to expect that the yield target will be raised, there could be substantial selling of JGBs that would require increased BOJ purchases to maintain the targeted level until it is raised. Similar issues could be presented by the BOJ's eventual exit from targeting 10-year yields.

E. Policies targeted at increasing lending to households and firms

The discussion thus far has focused on policies targeting the Treasury market. The general assumption here is that by pushing down interest rates in that market, the Committee will reduce private borrowing costs generally. However, it may be more effective to provide accommodation that more directly targets households or businesses. This section discusses some options for doing so, including purchases of MBS, which were part of previous Federal Reserve QEs; corporate bond purchases, for which the Federal Reserve has no authority but which have been implemented by some foreign central banks; and lending programs for banks that aim to reduce their cost of funding and encourage them to pass those reduced costs on to their own customers.

Programs that target particular economic agents or transactions—home buyers/owners, corporations, or banks and bank borrowers—present an inherent political risk for the Committee since they could be interpreted as engaging in credit allocation favoring certain sectors of the economy. In addition, some of these programs would add credit risk to the Federal Reserve's balance sheet. However, in the midst of a recession

that has pushed interest rates to the ELB, policies seen as supporting "main street" may be viewed positively.

Purchases of non-Treasury securities

There is compelling evidence that the MBS purchases conducted during QE1 and QE3 influenced MBS yields and mortgage rates.[24] For example, those rates fell by more than 120 basis points over the six months following the announcement of QE1. Beyond the interest rate effects, Di Maggio at al. (forthcoming) analyze how QE programs affect aggregate debt issuance and consumption through the mortgage market, and thus quantify the importance of QE-induced refinancing activity for the real economy. They find that MBS purchases lead to (i) an increase in refinancing activities, (ii) lower interest rate payments for refinancing households, (iii) a boom in home equity extraction, and (iv) higher aggregate consumption. The authors also provide evidence that the transmission of MBS purchases to the real economy depends crucially on the composition of the assets purchased and the health of the banking sector. For example, QE programs that did not involve mortgage purchases (QE2 and MEP) or occurred when the banking sector was healthier (QE3) are associated with smaller effects on mortgage rates and similar effects across conforming and jumbo segments.[25] This is because healthier banks during QE3 were able to reallocate capital across those segments of the mortgage market.

Other central banks have gone further and purchased private securities. Analysis of these programs has found them to be an effective form of accommodation for the institutions targeted by the programs. For example, D'Amico and Kaminska (2019) consider the corporate bond purchases conducted by the Bank of England (BOE) during the "Corporate Bond Purchase Scheme" (or credit easing, CE), which was launched at the same time as a new round of QE, following the EU referendum result in 2016. They find that corporate bond prices responded substantially more to corporate bond purchases than to government bond purchases with similar maturities. This, in turn, leads CE to be more effective than QE in reducing credit spreads, especially for higher-rated bonds. The authors also find that, differently from QE, CE seems to stimulate new issuance of corporate bonds quite rapidly.[26] This aspect of their findings is consistent with the

[24] See, for example, Fuster and Willen (2010), Hancock and Passmore (2011), Krishnamurthy and Vissing-Jorgenson (2011 and 2013), Boyarchenko et al. (2015), and Di Maggio et al. (forthcoming).
[25] While Di Maggio et al. (forthcoming) estimate that, following QE1, conforming mortgage rates fell by 120 basis points and jumbo mortgage rates fell by 55 basis points. Following QE2 and MEP, mortgage rates fell by 36 and 47 basis points, respectively, and without any differential effects across the two mortgage segments.
[26] D'Amico and Kaminska (2019) find that QE does not seem to stimulate new issuance of corporate bonds over the programs' entire duration.

evidence reported in recent studies of the ECB's "Corporate Sector Purchase Program" (see, Abidi and Miquel-Flores, 2018; Todorov, 2018; and Zaghini, 2019).

Use of central bank lending authority

Another way that central banks have used their balance sheet to provide monetary policy stimulus is through the use of their lending authority, for instance by providing low-cost, stable funding to banks.[27] Reductions in bank funding costs should lead to declines in the rates that banks charge on their loans; Illes et al. (2019) find evidence that, at least in Europe, this has indeed been the case. Lower loan rates should in turn support credit availability and economic activity.

One approach to using the lending authority is to reduce bank funding costs generally. An example of this is the ECB's "Long-Term Refinancing Operations" (LTROs) between 2008 and 2012 in which the ECB provided banks with low-cost loans that had maturities of up to three years. Jossova et al. (2018) find that Portuguese banks that took advantage of the improved funding stability provided by the LTROs were more likely to sustain lending relationships with existing borrowers and to extend credit to new borrowers. Providing the long-term funding stability found to be beneficial by Jossova et. al. (2018) would be difficult for the Federal Reserve due to limits on the maturity of discount window loans. However, an effectively similar program could be established if the Federal Reserve were to announce an extended series of auctions—similar to those conducted under the Term Auction Facility—in which a large amount of discount window credit was offered and the minimum bid rate was set at a level below the rate prevailing on wholesale funding liabilities of banks.[28]

A second approach that other central banks have used is "funding-for-lending" style programs under which central bank loans are extended to banks at rates that are lower if the banks' lending to household and firms increases more. Such programs are structured to incentivize banks to lend. One such lending program was established by the BOE in 2016, the "Term Funding Scheme." A study of the effects of this lending program suggests it was successful in reducing rates on some residential mortgages (Nardi and Nwankwo, 2018). Assessments of the impacts of an earlier BOE lending program, the "Funding for Lending Scheme," have been more mixed. The ECB

[27] The Federal Reserve made extensive use of its lending authority, both under regular and emergency authorities, during the financial crisis. Those programs were geared toward responding to market dysfunction rather than policy accommodation, although alleviating market stress certainly helps promote economic activity. The mechanics of lending to provide policy accommodation would be similar to lending to alleviate market stress, but the policy considerations would be somewhat different.
[28] The Federal Reserve could also lower the primary credit rate to very low levels. This is likely to be less effective as the stigma associated with borrowing from primary credit is considerable so that the pass-through of changes in this rate to general bank funding costs is likely to be small. The auction, and market rate associated with an auction, should mitigate stigma.

introduced "Targeted Longer-term Refinancing Operations" facilities that provided funding of up to four years to banks at terms that were favorable relative to market rates, conditional on sufficient nonfinancial loan growth at the participating banks. Recent research suggests that these facilities served to reduce borrowing costs and had a positive effect on loan growth (Bennetton and Fantino, 2018 and Desislava and Garcia-Posada, 2019). The BOJ also established a funding-for lending-scheme, the "Growth-Supporting Funding Facility," but there has not yet been much research on the effectiveness of this program.

The Federal Reserve could establish a funding-for-lending program using its discount window lending authority. To align the program with a sustained increase in lending, the program would have to last for several years; since discount window loans have a maximum maturity of four months, banks would need to be allowed to roll over loans extended under the program so long as they remained in good standing. The program could incentivize lending by making participation subject to a fee that decreased depending on the extent to which the bank increased its lending over some horizon.

While such programs appear to have been helpful abroad, it is less certain whether they would be similarly beneficial in the United States. One reason is that many banks, including most of the largest institutions, already have access to other stable sources of low-cost funding, such as from the Federal Home Loan Banks (FHLBs), which reduces the benefit of such a program being offered by the Federal Reserve.[29]

A second reason that programs focused on promoting bank lending are less likely to be beneficial in the United States is that such programs tend to help most in the event that typical bank funding markets are disrupted, such that spreads are elevated or available maturities are unusually short. That has been the case in Europe following the financial crisis and an extended period in which the level of non-performing loans has been elevated. By contrast, in the United States, the recovery of the banking system was much stronger. That reflects both a stronger macroeconomic recovery and a robust effort by bank supervisors and regulators to encourage banks to write-down non-performing loans and to promote the health of the banking system.[30] Moreover, results from the stress tests indicate that the banking system is likely to remain reasonably healthy even in the event of a severe economic downturn. Consequently, bank funding markets are unlikely to deteriorate significantly. If there were a situation in which bank funding markets in the United States were disrupted, then actions by the Federal Reserve to

[29] However, the discount window is available to a few more institutions than are FHLB advances and can accept a wider range of collateral.
[30] Some research, such as Acharya et al (2019), has argued that some extraordinary policies by the ECB resulted in increased "zombie lending" to poorly performing firms in the Euro-area although other research, such as Bottero et al (2019), has found no such dynamic. Regardless, the low levels of non-performing loans at U.S. banks should alleviate concerns about this issue in the United States.

improve functioning in those markets would be valuable; however, it is not clear that it would be necessary for any support provided by the Federal Reserve to be conditional on the banks providing additional loans to businesses and households.

F. Balance sheet policies through the lens of the "Poole model"

This memo has considered various ways of using BSP to provide additional stimulus, including the choice between fixed-size and flow-based asset purchase programs, targeting the quantity of purchases versus targeting specific interest rates, and policies aimed at increasing lending to households and firms. As noted since the seminal work of Poole (1970), the optimal combination of policies depends on (i) the shocks expected to hit the economy; (ii) the sensitivity of medium- and longer-term rates to different policy tools; and (iii) the uncertainty around these sensitivities.[31] In general, higher interest rate sensitivities to a specific policy tool would lead to a larger and more frequent use of that tool in response to a certain shock, while higher uncertainty about those same sensitivities could lead to either a smaller use of that tool or a use of that tool in combination with other tools to diversify risks.[32]

The optimal configurations of BSP will depend on the economic and financial shocks the economy is facing. For instance, if the economy is suffering from a sequence of adverse and persistent demand shocks, flow-based programs, where the expected ultimate size adjusts quickly and automatically to the changing state of the economy, might be more advantageous than fixed-size programs. In addition, if these demand shocks originate in specific sectors, such as housing, then the composition of the flow-based program could be tilted toward securities in related markets, such as MBS, the purchases of which seem more effective in reducing mortgage rates and rates on credit sensitive products. By contrast, if these adverse shocks are not expected to persist long, ceilings on short-term rates combined with FG could be effective in lowering rates over shorter horizons without using significant balance sheet capacity.

Alternatively, if interest rate volatility is generally elevated and the demand shock hitting the economy is most likely a one-time shock, it might be preferable to use a fixed-size program concentrated in longer-duration securities. Such programs quickly raise expectations regarding scarcity of certain securities and are also quite effective in

[31] Here, we are working under the assumption that once shorter- or longer-term interest rates decline as a result of BSP, their decline affects the economy through the same basic transmission mechanism as the federal funds rate.

[32] For example, Brainard (1967) and Williams (2013), who focus on uncertainty over the effects of monetary policy, find that higher uncertainty should lead to caution and smaller policy responses. In particular, in Williams (2013), under uncertainty the optimal strategy is to use the instrument with the least uncertainty (policy rate) to its fullest extent before turning to other instruments (BSP) associated with greater uncertainty. In Brainard (1967), if the two tools are complements, then the central bank should use both tools, even if one has less powerful and more uncertain effects, to diversify risk. However, uncertainty about future macro fundamentals may justify a stronger policy response, from a risk-management perspective (Evans et al., 2015).

removing duration-risk from the market and thus trigger faster and larger portfolio rebalancing. Finally, if the shock is due to a decline in consumer or business confidence, establishing ceilings on longer-term rates that are more relevant for investment and consumption decisions than short-term rates may be particularly beneficial. Ceilings may be especially effective in reducing interest rate uncertainty and realized volatility, in addition to managing the level of rates, and so may be particularly beneficial in supporting consumption and investment plans.

Appendix: Details about empirical evidence used in Sections B and E

While there is mounting evidence that QE has significantly reduced yields of targeted "default-free" securities, the literature on QE pass-through to riskier assets is still growing and characterized by some disagreement. Arguably, most of the disagreement arises from the difference in approaches used in earlier research versus more recent studies. Much of the earlier research is characterized by three features: (i) the use of an event-study approach focused on short event windows, (ii) the use of aggregate corporate and stock price indices, and (iii) QE shocks proxied by policy-induced changes in Treasury yields rather than in Treasury quantities. The first feature can lead to an understatement of portfolio rebalancing effects in riskier and less liquid markets where capital might move more slowly (Greenwood et al., 2018). The second feature limits the ability to identify substitution effects across assets, as only security-level data allow to build buckets of substitute securities. The third feature can alter the persistence of the QE-induced shock and limit the ability to identify the channels of the pass-through, as QE-induced changes in Treasury yields, unlike amounts purchased, can be due to a variety of channels. In contrast, more recent research has been focusing on measuring QE effects on riskier asset classes using (i) longer time windows, (ii) granular security-level data, and (iii) QE shocks proxied by amounts purchased.

- Gilchrist et al. (2015) isolate the unexpected component of the policy announcement before analyzing its impact on private borrowing costs within one- or two-day event windows. In their study, the closest proxy of a BSP shock is a change in the 10-year nominal Treasury yield within a narrow window around unconventional monetary policy announcements that is orthogonal to a change in the 2-year nominal Treasury yield within the same window. They show that a large share of this shock is due to a decline in the term premium.
- Gilchrist and Zakrajsek (2013), who analyze the impact of QE-announcements on market-based indicators of corporate credit risk, exploit the fact that the volatility of policy shocks increases on policy announcement days (Rigobon and Sack, 2004) to correct for the simultaneity bias that affects standard event-study analysis.
- D'Amico and Kaminska (2019) group individual quantities of government bonds purchased by the BOE in different sets of substitute purchases for each investment-grade (IG) corporate bond. For instance, the bucket of gilt substitutes is built around each IG corporate bond by considering all gilts with remaining maturity within 2.5 years of a certain corporate bond if its maturity is below 10 years, and all gilts with remaining maturity within 5 years of the same corporate bond if its maturity is above 10 years. This is key to determine how localized QE supply effects are on corporate prices, and therefore the extent of the substitution mechanism, which is crucial to understand the pass-through.
- Evidence suggesting that the Treasury yield sensitivity to asset purchases is symmetric over purchases and sales is provided in Cahill et al. (2013). They

exploit the fact that both asset purchases and sales took place during the Federal Reserve's maturity extension programs and use that information to compare their respective effects. They find that the effects of asset sales and purchases arising through the scarcity/supply channel are similar. Furthermore, Rogers et al. (2014) provide evidence that announcements that signaled an earlier-than-expected end to QE3, such as then-Chairman Bernanke's testimony to Congress in May 2013, produced effects on financial variables that are similar, though in the opposite direction, to those produced by announcements of asset purchases. Although this evidence suggests symmetric effects, more analysis is necessary to arrive at firmer conclusions regarding the effects of asset sales.

- Di Maggio et al. (forthcoming) use rich borrower-linked mortgage-market data and an identification strategy based on market segmentation between QE-eligible conforming mortgages and QE-ineligible jumbo mortgages. They estimate that QE-eligible mortgage rates fell by 120 basis points, 40 basis points more than QE-ineligible mortgage rates, refinancing increased by $100 billion (56%) over the first 6 months of QE1, increasing the consumption of refinancing households by $13 billion. Later QE rounds had smaller effects.

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