

**Finance and Economics Discussion Series
Divisions of Research & Statistics and Monetary Affairs
Federal Reserve Board, Washington, D.C.**

Issues in the Use of the Balance Sheet Tool

**Mark Carlson, Stefania D’Amico, Cristina Fuentes-Albero, Bernd
Schlusche, and Paul Wood**

2020-071

Please cite this paper as:

Carlson, Mark, Stefania D’Amico, Cristina Fuentes-Albero, Bernd Schlusche, and Paul Wood (2020). “Issues in the Use of the Balance Sheet Tool,” Finance and Economics Discussion Series 2020-071. Washington: Board of Governors of the Federal Reserve System, <https://doi.org/10.17016/FEDS.2020.071>.

NOTE: Staff working papers in the Finance and Economics Discussion Series (FEDS) are preliminary materials circulated to stimulate discussion and critical comment. The analysis and conclusions set forth are those of the authors and do not indicate concurrence by other members of the research staff or the Board of Governors. References in publications to the Finance and Economics Discussion Series (other than acknowledgement) should be cleared with the author(s) to protect the tentative character of these papers.

Issues in the Use of the Balance Sheet Tool

Mark Carlson, Stefania D'Amico, Cristina Fuentes-Albero, Bernd Schlusche,
and Paul Wood

August 2020

The analysis in this paper was presented to the Federal Open Market Committee as background for its discussion of the Federal Reserve's review of monetary policy strategy, tools, and communication practices. The Committee discussed issues related to the review at five consecutive meetings from July 2019 to January 2020. References to the FOMC's current framework for monetary policy refer to the framework articulated in the Statement on Longer-Run Goals and Monetary Policy Strategy first issued in January 2012 and reaffirmed each January, most recently in January 2019.

Abstract

This paper considers various ways of using balance sheet policy (BSP) to provide monetary policy stimulus, including the BSPs put in place by the Federal Reserve in the wake of the Global Financial Crisis, the choice between fixed-size and flow-based asset purchase programs, policies targeting interest rate levels rather than the quantity of asset purchases, and programs aimed at increasing more direct lending to households and firms. For each of these BSP options, we evaluate benefits and costs. We conclude by observing that BSPs' relative effectiveness and thus optimal configuration will depend on the shocks affecting the economy. Consequently, it would be valuable for the Federal Reserve to keep a variety of tools at its disposal and employ the ones that best fit the situation that it faces.

JEL classification: E43, E44, E58, G12, G21, G51.

Keywords: balance sheet policy, quantitative easing, yield curve control, credit easing, central bank lending authority.

Note: Authors' affiliations are Board of Governors of the Federal Reserve System (Carlson, Fuentes-Albero, Schlusche and Wood) and Federal Reserve Bank of Chicago (D'Amico), respectively. The authors benefited from the comments and suggestions of David Altig, Marco Del Negro, Thomas Laubach, Marc Giannoni, Ellis Tallman, and Min Wei. The analysis and conclusions set forth in this paper are those of the authors and do not indicate concurrence by other Federal Reserve System staff, the Federal Reserve Board, or the Federal Reserve Bank of Chicago.

I. Introduction

Balance sheet policy (BSP) is one of the tools that the Federal Open Market Committee (FOMC or the Committee) has at its disposal to provide monetary policy stimulus in situations when its primary tool, the federal funds rate, is at or near its effective lower bound (ELB). In this paper, we review 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 later.

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 (GFC)—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 (for example, outbreak in inflation) or materialized to a degree smaller than initially feared (for example, financial stability issues). On the benefits side, moving beyond the initial evidence provided by early event studies, recent empirical findings point to a significant QE pass-through to prices of 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, we focus on actual and potential risks such as communication challenges arising from the novelty of the BSP tool and the use of multiple tools, some degree of nonproductive risk-taking behavior by investors, and some political economy risks related to the volatility of remittances.

Regarding the evolution of the efficacy of QE, overall the evidence available suggests that the marginal benefits of QE programs did not diminish despite varying economic and financial conditions. Specifically, empirical work that carefully controls for market expectations about the BSP finds that financial market effects of QE announcements and associated macroeconomic effects do not seem to have declined across consecutive programs or in periods of normal market functioning. Further, model-based evidence on the interaction of BSP with financial constraints shows that tighter financial constraints can either magnify or damp QE's macroeconomic effects and that, even in normal times, there are collateral constraints that can make QE

effective. However, it may be hard to extrapolate such evidence to states with very low levels of longer-term interest rates. For example, it is conceivable that the duration-risk channel might be weakened amid extended periods at the ELB that reduce interest rate volatility, making changes to the average duration of investors' portfolios less effective. Moreover, if, at the onset of QE, long-term rates are already very low, there is less scope for QE to reduce them, similar to any other policy working through a reduction in interest rates.

Second, we discuss the use of flow-based asset purchase programs similar to QE3 instead of fixed-size programs such as QE1 and QE2. We find that the main benefits of flow-based programs derive from their state-contingent nature, which implies an automatic-stabilizing function—that is, more stimulus when the economy deteriorates and vice versa. This feature should increase investor confidence in the FOMC's ability to make timely policy adjustments, which could result in faster adjustments to investor expectations. Further, aligning the state contingencies of the flow-based program with those of forward guidance (FG) about the policy rate attenuates the risk of the two tools working at cross-purposes. The state-contingent nature of flow-based programs comes at the cost of higher investor uncertainty about the magnitude and persistence of the reduction in asset supply induced by the program, which can delay or diminish its full effect because of slower or only partial portfolio rebalancing. Flow-based programs also entail the risk of a very large balance sheet. However, aligning the state contingencies of those programs and FG could increase their complementarity and credibility, likely helping contain program size.

Third, we consider using BSP to target interest rates along the yield curve, by committing to adjust the balance sheet size 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. Ceilings could be placed on either shorter- or longer-term rates. Ceilings on short rates might reinforce FG's credibility and the associated balance sheet expansion would be easier to unwind, because the securities acquired would have shorter maturities. By contrast, ceilings on longer rates would

affect rates more relevant for the economic decisions of households and businesses but may be harder to maintain, because longer rates are more sensitive to factors other than monetary policy. Both types of ceilings should be particularly effective in reducing interest rate volatility and tails risks in addition to helping maintain a particular level of rates, but at the cost of balance sheet control. Further, similar to flow-based programs, rate ceilings are associated with high uncertainty about the total amount of asset purchases, which may delay market responses. Finally, it may become costly to defend the ceiling toward the end of the program as investors sell securities in anticipation of the lift of the ceiling.

Fourth, we discuss using BSP involving assets other than Treasury securities. These BSPs include the purchases of mortgage-backed securities (MBS) by the Fed as well as corporate bond purchase programs and “funding for lending” programs conducted by foreign central banks. The main benefit of these BSPs is that they directly target specific economic sectors and, hence, seem more effective than government bond purchases in improving credit spreads and debt issuance in the targeted markets. However, even if legally permitted, such programs may create a political economy risk for the Committee since they could be interpreted as engaging in credit allocation, and some of these BSPs entail taking increased credit risk.

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 it faces. We illustrate this point by providing a few examples of different combinations of economic shocks and related BSP options.

The rest of the paper is organized as follows: Section II details benefits and costs of QE. Section III describes potential benefits and costs of flow-based programs relative to fixed-size programs. Section IV discusses BSPs that target asset prices rather than asset quantities. Section V reviews BSPs involving assets other than Treasury securities.

Finally, section VI concludes by considering possible combinations of BSPs and economic situations that the Fed might face.

II. Assessment of the Benefits and Costs of Balance Sheet Policies since the Global Financial Crisis

As described in previous studies of QE, the traditional transmission channels of BSP are the signaling channel, the duration-risk channel, and the portfolio rebalance channel (also known as the supply–scarcity channel). In brief, the signaling channel works through changes in the expected future path of the policy rate induced by Fed communications or actions related to BSP. The duration-risk channel affects term premiums as BSPs change the amount of aggregate duration risk held by private investors. The supply channel works by changing the available supply of the program-eligible assets and tends to have the greatest effect on the yields of the acquired assets and their close substitutes. In this section, we discuss recent findings related to the efficacy of these channels and additional aspects of QE.

Benefits of Balance Sheet Policies and Effect 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. In what follows, we analyze whether BSPs were successful in achieving these goals, and we do so by summarizing the main results of several recent studies, while leaving to the appendix details about the methodologies used in those studies.

Recent studies find QE pass-through to be large and significant for stock returns, investment-grade (IG) corporate yields, real 30-year MBS yields, and real 30-year fixed-rate mortgage (FRM) rates.¹ The pass-through appears to occur gradually, reaching its

¹ See Gilchrist and Zakrajsek (2013); Gilchrist, Lopez-Salido, and Zakrajsek (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

peak after a few months from the start of the policy intervention.² 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.³

Recent research also provides evidence on QE increasing bank lending and risk tolerance. Several studies find that QE1 and QE3 had larger effects on bank lending of those 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 reshuffle their lending activities toward riskier loans and easier lending standards.⁴ Regarding the composition of lending, there is evidence that QE1 translates into increased mortgage lending and refinancing but is associated with a slowdown in commercial and industrial (C&I) lending; QE3 increased not only home-purchase mortgage originations, but also C&I lending.⁵

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

empirical approaches do not seem very robust. The appendix discusses differences in the empirical approaches and explains why we focus on more recent evidence.

² These results are consistent with the theory of Greenwood, Hanson, and Liao (2018), who show that, in partially segmented asset markets, prices in a related market not directly targeted by the supply shock (for example, the corporate bond market in reaction to supply shocks in the government bond market) initially underreact; however, as investors gradually rebalance their portfolios, prices change by more in the longer run.

³ See, for example, D'Amico and Kaminska (2019) and Di Maggio, Kermani, and Palmer (forthcoming).

⁴ See Rodnyansky and Darmouni (2017); Chakraborty, Goldstein, and MacKinlay (forthcoming); and Kurtzman, Luck, and Zimmermann (forthcoming).

⁵ See Chakraborty, Goldstein, and MacKinlay (forthcoming); and Luck and Zimmerman (forthcoming). The latter 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 data set used in the latter study is more comprehensive (it also includes smaller loans, nonsyndicated loans, or both, and it is at a quarterly frequency) and arguably encompasses the data set used in the former.

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. 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.

Regarding nonfinancial firms' financing and investment decisions, Foley-Fischer, Ramcharan, and Yu (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.⁶ Other studies, such as Eberly, Stock, and Wright (2019), find that, in the absence of QE, unemployment would have been about 1 percentage point higher from 2014 to 2018.⁷ 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

⁶ Engen, Laubach, and Reifschneider (2015) estimate that the FG and BSPs combined had a peak unemployment effect of 1¼ percentage points. Chung and others (2019) find that the FOMC's ability to contain the initial rise 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 damps the effects of BSP.

⁷ 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 gross domestic product (GDP) contraction by 3.5 percentage points, while QE2 increased GDP by 1 percentage point.

future, such as challenges in communications, nonproductive risk-taking behavior by investors, risks associated with elevated scarcity of securities being purchased, and fiscal risks. The experience with BSPs that policymakers, investors, and researchers have gained over the past 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; and 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, 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 nonproductive 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 because of principal-agent issues or for accounting purposes (Stein, 2013). However, Kuttner (2018), in reviewing the evidence on excessive risk-taking by

financial and nonfinancial 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 GFC, 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 (for example, money market funds at shorter maturities and pension funds and insurance companies at longer maturities).⁸ For example, Kandrac (2018) finds that the Fed'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, Fan, and Kitsul (2018) find that the scarcity of Treasury securities resulted in some price distortions in the Treasury repurchase agreement (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 past 10 years, the lower interest rates generated by QE have reduced the costs of issuing public debt and have facilitated its maturity extension. However, Cavallo and others (2018) highlight that the Fed 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 that the Fed would record losses and temporarily cease remittances has been relatively small over the past 10 years, this may not be the case if BSPs are in place in the future.

⁸ See, for example, D'Amico and King (2013) and Gagnon and others (2011) for the Treasury market, and Hancock and Passmore (2011) and Krishnamurthy and Vissing-Jorgensen (2011) for the agency MBS market.

Does QE Have Diminishing Returns?

Most previous research assessing whether QE has diminishing returns in financial markets has not controlled for expectations about the future size or composition of the balance sheet at the time of the BSP announcements.⁹ 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.¹⁰ Further, the recent experience with the normalization process—or quantitative tightening (QT)—has allowed researchers to study the effect of the Fed’s BSP on Treasury yields across diverse macroeconomic and financial market conditions.

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 and others (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 and others (2013) find that the responses of Treasury yields to a given amount of QE surprise do not appear 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 effects of QE programs is the size of the supply surprise resulting from the announcements. Relatedly, Hesse, Hofmann, and Weber (2018) and Kim, Laubach, and Wei (2019) find that, once anticipation about asset purchases is accounted for, the effects of asset purchase programs on macroeconomic variables did not notably diminish as new rounds of asset purchases were added.

⁹ See, for example, Krishnamurthy and Vissing-Jorgenson (2011, 2013).

¹⁰ The Treasury yield sensitivity is obtained by dividing the yield reaction by the size of the supply surprise.

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.¹¹ 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.¹² 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) demonstrates 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.¹³

Taken together, these findings suggest that the strength of some QE channels (for example, 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 (for example, the duration-risk channel) does. It also seems that the efficacy of the state-

¹¹ 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.

¹² 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.

¹³ In this model, there are also other frictions such as sticky prices and cash-in-advance constraints.

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 2 percent and thus may not be directly applicable to environments with very low longer-term rates. Finally, as noted earlier, low levels of longer-term Treasury rates constrain the amount of “space” available for BSPs, which might mean that QE becomes less effective, similar to other policies that work through a reduction in interest rates.

III. Benefits and Costs of Flow-Based Programs Relative to Fixed-Size Programs

While the Fed'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 (for example, 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.¹⁴ Under a flow-based program, if the economy experiences negative shocks, the statements the FOMC has made linking the program to the economy should result in economic agents quickly updating their expectations for the length of the program and therefore the amount of asset purchases, which, in turn, should lead to rapid 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

¹⁴ 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 rule-based QE should focus on the Federal Reserve's holdings of longer-term assets and exhibit a considerable degree of inertia.

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 questioning whether future asset purchases will be completed as announced. Overall, flow-based programs can be linked to greater investor 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 conditions stated in the 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 continue 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 or diminish—or both—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 Fed's balance sheet may grow to undesirable sizes.¹⁵ A related concern is that the Fed could end up holding a large share of outstanding government securities, which might be detrimental to market functioning. However, the Fed'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 Fed would grow to very high levels, as, during economic downturns, Treasury debt issuance rises sharply, creating room for the Fed to expand its balance sheet through purchases of government securities without necessarily crowding out private investors.

IV. Targeting Quantities versus Targeting Prices: Defining Balance Sheet Policies through Purchase Amounts versus 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 FOMC 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 FG about the policy rate, or focused on the longer end of the yield curve, which might be more relevant for the economic decisions of households and businesses (we will discuss this issue in more detail). 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 following discussion focuses on the use of ceilings, which do not necessitate responding to declining yields by tightening the BSP when economic conditions worsen.¹⁶ However, most of the arguments would apply to the use of interest rate targets as well.

¹⁵ 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."

¹⁶ 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.

Setting BSP in terms of interest rates has the potential to reduce interest rate volatility in addition to helping maintain a particular level of rates; in particular, it reduces the likelihood that rates might rise suddenly. 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, Erceg, and Leahy, 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 Fed acquiring a significant portion of outstanding securities, then many of the costs noted in the subsection “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 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 Fed purchases securities, as investors rebalance their portfolios and use the money obtained from selling securities to the Fed to purchase other securities that are considered to 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 FOMC 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 Fed 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 tail risks. 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. Relative to firm ceilings, softer ceilings allow the Committee greater ability to manage how quickly the balance sheet expands but may not necessarily result in a smaller overall balance sheet or 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. For example, ceilings could be used to reinforce FG by signaling that the Fed 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 the ceilings if the FG were 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 were framed in other terms, such as macroeconomic thresholds, then aligning FG and interest rate ceilings would be more challenging. In this case, the FOMC 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 rate 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 rate path would increase the likelihood that the Fed 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 not only the likelihood of substantial purchases but also the extent to which the ceilings reinforced the FG's credibility.

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 decided to tighten policy.¹⁷ 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 FOMC 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 10 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

¹⁷ It would always be possible for the Committee to abandon the ceilings and raise rates if conditions changed. Doing so would result in mark-to-market losses on the securities in the Fed's portfolio. Such losses would likely be lower if the Committee were targeting shorter-term rates rather 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 was willing to sell assets to reach the desired size.

boost than targeting shorter-term rates. Counterfactual simulations by Eberly, Stock, and Wright (2019) suggest that a BSP that, following the GFC, had pinned the 10-year yield to 2 percent for five years would have resulted in the unemployment rate decreasing faster.¹⁸ They also report that such policies would have notably increased the size of the Fed'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 Fed's balance sheet.

It is important to note that interest rate ceilings provide accommodation through a somewhat different transmission mechanism from QE programs. On the one hand, 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 effect on longer-term rates while having a smaller effect on the Fed's balance sheet.

Securities accumulated while maintaining a ceiling on longer-term rates would be of longer maturities. Thus, if the FOMC subsequently wanted to tighten policy, it might need to rely on exit strategies similar to those used for previous QE programs rather than

¹⁸ Their simulations technically focused on a policy of reducing the slope of the yield curve out to 10 years; because the overnight rate was already at the ELB in the simulations, that policy is very similar to imposing a ceiling on the 10-year rate.

waiting for securities to roll off naturally. If the Committee determined that it needed 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 implemented policies for managing the yield curve. The Fed maintained a ceiling on the yield on long-term Treasury bonds of 2½ percent from 1942 to 1951 and maintained a ceiling of ¾ 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.¹⁹ The ceiling on the Treasury bill rate was lifted to provide the Fed some ability to tighten policy in the face of rising inflation. The ceiling on longer-term bonds was lifted in conjunction with the 1951 Treasury–Federal Reserve 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 Fed 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 securities.

While the Fed 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 triple-A-rated corporate bonds and

¹⁹ 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.

long-term Treasury securities widened some in 1947, around the time when the ceiling on the bill rate ended and amid purchases of Treasury securities by the Fed to defend the ceiling on long-term rates. However, the spread narrowed subsequently and remained low even in the months just before the 1951 Accord, when the Fed was again engaging in purchases to maintain the ceiling on longer-term rates. While these historical episodes are suggestive that Fed actions to place ceilings on Treasury yields in the 1950s were generally transmitted to private markets, it is not certain whether transmission would be larger or smaller 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 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 JGBs, up from a roughly 10 percent share in 2013 when it began large-scale purchases. 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. As of the writing of this paper, 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.

V. 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 FOMC will reduce private borrowing costs generally. However, it may be more effective to provide accommodation that directly targets households or businesses. This section discusses some options for doing that, including purchases of MBS, which were part of previous Fed QEs; corporate bond purchases, for which the Fed has no authority under normal circumstances but that 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.²⁰

Programs that target particular economic agents or transactions—home buyers or owners, corporations, or banks and bank borrowers—present an inherent political economy risk for the FOMC, as the programs 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 Fed’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.

²⁰ If the economy is in dire condition and financial intermediation is significantly disrupted, then the Board may deem it an unusual and exigent circumstance and use section 13(3) of the Federal Reserve Act to establish a program for lending directly to businesses and households (or some selected group thereof, such as small businesses).

Purchases of Non-Treasury Securities

There is compelling evidence that the MBS purchases conducted during QE1 and QE3 influenced MBS yields and mortgage rates.²¹ For example, those rates fell more than 120 basis points over the six months following the announcement of QE1. Beyond the interest rate effects, Di Maggio, Kermani, and Palmer (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 an increase in refinancing activities, lower interest rate payments for refinancing households, a boom in home equity extraction, and 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.²² 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 European Union referendum 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

²¹ See, for example, Fuster and Willen (2010); Hancock and Passmore (2011); Krishnamurthy and Vissing-Jorgenson (2011 and 2013); Boyarchenko, Fuster, and Lucca (2015); and Di Maggio, Kermani, and Palmer (forthcoming).

²² While Di Maggio, Kermani, and Palmer (forthcoming) estimate that following QE1, conforming mortgage rates fell 120 basis points and jumbo mortgage rates fell 55 basis points. Following QE2 and MEP, mortgage rates fell 36 basis points and 47 basis points, respectively, and without any differential effects across the two mortgage segments.

CE to be more effective than QE in reducing credit spreads, especially for higher-rated bonds. The authors also find that, in contrast to QE, CE seems to stimulate new issuance of corporate bonds quite rapidly.²³ This aspect of their findings is consistent with the 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 sheets to provide monetary policy stimulus is through the use of their lending authority—for instance, by providing low-cost, stable funding to banks.²⁴ Reductions in bank funding costs should lead to declines in the rates that banks charge on their loans; Illes, Lomobardi, and Mizen (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. For example, during its long-term refinancing operations (LTROs) between 2008 and 2012, the European Central Bank (ECB) provided banks with low-cost loans that had maturities of up to three years. Jossova, Mendicino, and Supera (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 extend credit to new borrowers. Providing such long-term funding stability would be difficult for the Fed because of limits on the maturity of discount window loans. However, an effectively similar program could be established if the Fed 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

²³ D’Amico and Kaminska (2019) find that QE does not seem to stimulate new issuance of corporate bonds over the program’s entire duration.

²⁴ The Federal Reserve made extensive use of its lending authority, both under regular and emergency authorities, during the GFC. 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.

the minimum bid rate was set at a level below the rate prevailing on wholesale funding liabilities of banks.²⁵

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. 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, Nwankwo, and Meaning, 2018). Assessments of the effects of an earlier BOE lending program, the Funding for Lending Scheme, have been more mixed. The ECB 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; 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 Fed 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; because 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,

²⁵ The Federal Reserve could also reduce the primary credit rate to very low levels. This reduction is likely to be less effective, as the stigma associated with borrowing from the discount window 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.

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 Fed.²⁶

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 GFC and an extended period in which the level of nonperforming loans has been elevated. By contrast, in the United States, the recovery of the banking system was much stronger, reflecting both a stronger macroeconomic recovery and a robust effort by bank supervisors and regulators to encourage banks to write down nonperforming loans and promote the health of the banking system.²⁷ 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 banks funding markets in the United States were disrupted, then actions by the Fed to improve functioning in those markets would be valuable; however, it is not clear that it would be necessary for any support provided by the Fed to be conditioned on banks providing additional loans to businesses and households.

VI. Balance Sheet Policies Through the Lens of the Poole Model

This paper 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 the shocks

²⁶ However, the discount window is available to a few more institutions than FHLB advances are and can accept a wider range of collateral.

²⁷ Some research, such as Acharya and others (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 and others (2019), found no such dynamic. Regardless, the low levels of nonperforming loans at U.S. banks should alleviate concerns about this issue in the United States.

expected to hit the economy, the sensitivity of medium- and longer-term rates to different policy tools, and the uncertainty around these sensitivities.²⁸ 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 smaller use of that tool or use of that tool in combination with other tools to diversify risks.²⁹

The optimal configuration 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—in which 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, 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 removing duration risk from the market, thus triggering more rapid and larger portfolio rebalancing. Finally, if the shock is due to a decline in consumer or business confidence,

²⁸ 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.

²⁹ 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 (that is, the 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 and others, 2015).

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 II and V

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: (1) the use of an event-study approach focused on short-event windows, (2) the use of aggregate corporate and stock price indexes, 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, Hanson, and Liao, 2018). The second feature limits the ability to identify substitution effects across assets; only security-level data can be used to build, for each security, buckets of substitute securities purchased, which is critical for determining the size of localized supply effects and therefore the extent of the pass-through. 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 longer time windows, granular security-level data, and QE shocks proxied by amounts purchased. Importantly, all the studies used in our analysis employ methodologies that control for market expectations about BSP.

- Gilchrist, Lopez-Salido, and Zakrajsek (2015) isolate the unexpected component of the policy announcement before analyzing its effect 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. The authors show that a large share of this shock is due to a decline in the term premium.

- Gilchrist and Zakrajsek (2013), who analyze the effect 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 (based on the methodology developed by Rigobon and Sack, 2004) to correct for the simultaneity bias that affects standard event-study analysis.
- The empirical strategy of Cahill and others (2013) and D’Amico and Seida (2019) relies on the fact that, even if the total size of the QE program is well anticipated, market participants are unsure about the distribution of purchases across specific securities. Rather than examining how QE announcements affect overall yields, those studies look at how QE announcements affect the relative yields of individual securities (the authors used the SPD to measure changes in expectations about BSP during the announcements).
- Evidence suggesting that the Treasury yield sensitivity to asset purchases is symmetric over purchases and sales is provided in Cahill and others (2013). They exploit the fact that both asset purchases and sales took place during the Federal Reserve’s MEP and use that information to compare their respective effects. They find that the effects of asset sales and purchases arising through the supply–scarcity channel are similar. Furthermore, Rogers, Scotti, and Wright (2014) provide evidence that announcements that signal an earlier-than-expected end to QE3—such as Chair Bernanke’s testimony to the Congress in May 2013—produce 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, Kermani, and Palmer (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 120 basis points, 40 basis points more than QE-ineligible mortgage rates, refinancing increased \$100 billion (56 percent) over the first six months of QE1, increasing

the consumption of refinancing households \$13 billion. Later QE rounds had smaller effects.

- D'Amico and Kaminska (2019) group individual quantities of government bonds purchased by the BOE in different sets of substitute purchases for each 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 analysis 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.

References

- Abidi, Nordine, and Ixart Miquel-Flores (2018). “Who Benefits from the Corporate QE? A Regression Discontinuity Design Approach,” Working Paper Series 2145. Frankfurt: European Central Bank, April,
<https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2145.en.pdf>.
- Acharya, Viral, Tim Eisert, Christian Eufinger, and Christian Hirsch (2019). “Whatever It Takes: The Real Effects of Unconventional Monetary Policy,” *Review of Financial Studies*, vol. 32 (September), pp. 3366–411.
- Andreeva, Desislava C., and Miguel García-Posada, (2019). “The Impact of the ECB’s Targeted Long-Term Refinancing Operations on Banks’ Lending Policies: The Role of Competition,” Working Papers 1903. Madrid: Banco de España,
<https://www.bde.es/f/webbde/SES/Secciones/Publicaciones/PublicacionesSeriadas/DocumentosTrabajo/19/Fich/dt1903e.pdf>.
- Baumeister, Christiane, and Luca Benati (2013). “Unconventional Monetary Policy and the Great Recession: Estimating the Macroeconomic Effects of a Spread Compression at the Zero Lower Bound,” *International Journal of Central Banking*, vol. 9 (June), pp. 165–212.
- Bennetton, Matteo, and Davide Fantino (2018). “Competition and the Pass-Through of Unconventional Monetary Policy: Evidence from TLTROs,” Working Paper 1187. Rome: Bank of Italy, September,
<https://www.bancaditalia.it/publicazioni/temi-discussione/2018/2018-1187/index.html>.
- Bernanke, Ben, and Vincent Reinhart (2004). “Conducting Monetary Policy at Very Low Short-Term Interest Rates,” *American Economic Review*, vol. 94 (May), pp. 85–90.
- Bottero, Margherita, Camelia Minoiu, José-Luis Peydro, Andrea Polo, Andrea Presbitero, and Enrio Sette (2019). “Negative Monetary Policy Rate and Portfolio Rebalancing: Evidence from Credit Register Data,” Working Paper 19/44. Washington: International Monetary Fund, February,
<https://www.imf.org/en/Publications/WP/Issues/2019/02/28/Negative-Monetary-Policy-Rates-and-Portfolio-Rebalancing-Evidence-from-Credit-Register-Data-46638>.
- Bowman, David, Christopher Erceg, and Mike Leahy (2010). “Strategies for Targeting Interest Rates Out the Yield Curve,” memorandum to the Federal Open Market Committee, Board of Governors of the Federal Reserve System, Division of Research and Statistics, October 13,
<https://www.federalreserve.gov/monetarypolicy/2010-fomc-memos.htm>.

- Boyarchenko, Nina, Andreas Fuster, and David O. Lucca (2015). “Understanding Mortgage Spreads,” Staff Report 674. New York: Federal Reserve Bank of New York, April, https://www.newyorkfed.org/medialibrary/media/research/staff_reports/sr674.pdf.
- Brainard, William (1967). “Uncertainty and the Effectiveness of Policy,” *American Economic Review*, vol. 57 (May), pp. 411–25.
- Brunnermeier, Markus, and Yann Koby (2018). “The Reversal Interest Rate,” NBER Working Paper Series 25406. Cambridge, Mass. National Bureau of Economic Research, December, <https://www.nber.org/papers/w25406>.
- Cahill, Michael, Stefania D’Amico, Canlin Li, and John Sears (2013). “Duration Risk versus Local Supply Channel in Treasury Yield: Evidence from the Federal Reserve’s Asset Purchase Announcements,” Finance and Economics Discussion Series 2013-35. Washington: Board of Governors of the Federal Reserve System, April, <https://www.federalreserve.gov/pubs/feds/2013/201335/201335pap.pdf>.
- Cavallo, Michele, Marco Del Negro, W. Scott Frame, Jamie Grasing, Benjamin A. Malin, and Carlo Rosa (2018). “Fiscal Implications of the Federal Reserve’s Balance Sheet Normalization,” FEDS Notes. Washington: Board of Governors of the Federal Reserve System, January 9, <https://www.federalreserve.gov/econres/notes/feds-notes/fiscal-implications-of-the-federal-reserve-balance-sheet-normalization-20180109.htm>.
- Chakraborty, Indraneel, Itay Goldstein, and Andrew MacKinlay (forthcoming). “Monetary Stimulus and Bank Lending,” *Journal of Financial Economics*.
- Chaurushiya, Radha, and Ken Kuttner (2003). “Targeting the Yield Curve: The Experience of the Federal Reserve, 1942-1951,” memorandum to the Federal Open Market Committee, Board of Governors of the Federal Reserve System, Division of Research and Statistics, June 18, <https://www.federalreserve.gov/monetarypolicy/2003-fomc-memos.htm>.
- Chung, Hess, Etienne Gagnon, Taisuke Nakata, Matthias Paustian, Bernd Schulusche, James Trevino, Diego Vilan, and Wei Zheng (2019). “Monetary Policy Options at the Effective Lower Bound: Assessing the Federal Reserve’s Current Policy Toolkit,” Finance and Economics Discussion Series 2019-003. Washington: Board of Governors of the Federal Reserve System, February, <https://doi.org/10.17016/FEDS.2019.003>.
- Curdia, Vasco, and Michael Woodford (2011). “The Central-Bank Balance Sheet as an Instrument of Monetary Policy,” *Journal of Monetary Economics*, vol. 58 (January), pp. 54–79.

- D'Amico, Stefania, Roger Fan, and Yuriy Kitsul (2018). "The Scarcity Value of Treasury Collateral: Repo Market Effects of Security-Specific Supply and Demand Factors," *Journal of Financial and Quantitative Analysis*, vol. 53 (October), pp. 2103–29.
- D'Amico, Stefania, and Iryna Kaminska (2019). "Credit Easing versus Quantitative Easing: Evidence from Corporate and Government Bond Purchase Programs," Staff Working Paper 825. London: Bank of England, September, <https://www.bankofengland.co.uk/working-paper/2019/credit-easing-versus-quantitative-easing-evidence-from-corporate-and-government-bond-purchase>.
- D'Amico, Stefania, and Thomas B. King (2013). "Flow and Stock Effects of Large-Scale Treasury Purchases: Evidence on the Importance of Local Supply," *Journal of Financial Economics*, vol. 108 (May), pp. 425–48.
- D'Amico, Stefania, and Tim Seida (2019). "Unexpected Supply effects of Quantitative Easing and Tightening," Working Paper 2020-17. Chicago: Federal Reserve Bank of Chicago, July, <https://www.chicagofed.org/publications/working-papers/2020/2020-17>.
- Di Maggio, Marco, Amir Kermani, and Christopher Palmer (forthcoming). "How Quantitative Easing Works: Evidence on the Refinancing Channel," *Review of Economic Studies*.
- Eberly, Janice, James Stock, and Jonathan Wright (2019). "The Federal Reserve's Current Framework for Monetary Policy: A Review and Assessment," paper presented at the Conference on Monetary Policy Strategy, Tools, and Communication Practices (A *Fed Listens* Event), held at the Federal Reserve Bank of Chicago, June 4–5, <https://www.chicagofed.org/~media/others/events/2019/monetary-policy-conference/review-current-framework-eberly-stock-wright-pdf>.
- Engen, Eric, Thomas Laubach, and Dave Reifschneider (2015). "The Macroeconomic Effects of the Federal Reserve's Unconventional Monetary Policies," Finance and Economics Discussion Series 2015-005. Washington: Board of Governors of the Federal Reserve System, February, <http://dx.doi.org/10.17016/FEDS.2015.005>.
- Evans, Charles, Jonas Fisher, Francois Gourio, and Spencer Kane (2015). "Risk Management for Monetary Policy near the Zero Lower Bound," Brookings Papers on Economic Activity, Spring, https://www.brookings.edu/wp-content/uploads/2015/03/2015a_evans.pdf.
- Foley-Fisher, Nathan, Rodney Ramcharan, and Edison Yu (2016). "The Impact of Unconventional Monetary Policy on Firm Financing Constraints: Evidence from the Maturity Extension Program," *Journal of Financial Economics*, vol. 122 (November), pp. 409–29.

- Friedman, Milton, and Anna J. Schwartz (1963). “Money and Business Cycles,” *Review of Economics and Statistics*, vol. 45 (February), pp. 32–64.
- Fuster, Andreas, and Paul S. Willen (2010). “\$1.25 Trillion Is Still Real Money: Some Facts About the Effects of the Federal Reserve’s Mortgage Market Investments,” Public Policy Discussion Paper 10-4. Boston: Federal Reserve Bank of Boston, November, <https://www.bostonfed.org/publications/public-policy-discussion-paper/2010/125-trillion-is-still-real-money-some-facts-about-the-effects-of-the-federal-reserves-mortgage-market-investments.aspx>.
- Gagnon, Joseph, Matthew Raskin, Julie Remache, and Brian Sack (2011). “The Financial Market Effects of the Federal Reserve’s Large-Scale Asset Purchases,” *International Journal of Central Banking*, vol. 7 (March), pp. 3–43.
- Gagnon, Joseph, and Brian Sack (2018). “QE: A User’s Guide,” Policy Brief 19-19. Washington: Peterson Institute for International Economics, October, <https://www.piie.com/system/files/documents/pb18-19.pdf>.
- Gertler, Mark, and Peter Karadi (2013). “QE 1 vs. 2 vs. 3. . . . : A Framework for Analyzing Large-Scale Asset Purchases as a Monetary Policy Tool,” *International Journal of Central Banking*, vol. 9 (January), pp. 5–53.
- Gilchrist, Simon, David Lopez-Salido, and Egon Zakrajsek (2015). “Monetary Policy and Real Borrowing Costs at the Zero Lower Bound,” *American Economic Journal: Macroeconomics*, vol. 7 (January), pp. 77–109.
- Gilchrist, Simon, and Egon Zakrajsek (2013). “The Impact of the Federal Reserve's Large-Scale Asset Purchase Programs on Corporate Credit Risk,” *Journal of Money, Credit and Banking*, vol. 45 (s2), pp. 29–57.
-
- Greenwood, Robin, Samuel Hanson, and Gordon Liao (2018). “Asset Price Dynamics in Partially Segmented Markets,” *Review of Financial Studies*, vol. 31 (September), pp. 3307–43.
- Greenwood, Robin, and Dimitri Vayanos (2014). “Bond Supply and Excess Bond Returns,” *Review of Financial Studies*, vol. 27 (March), pp. 663–713.
- Hancock, Diana, and Wayne Passmore (2011). “Did the Federal Reserve's MBS Purchase Program Lower Mortgage Rates?” *Journal of Monetary Economics*, vol. 58 (July), pp. 498–514.
- He, Zhiguo, and Arvind Krishnamurthy (2013). “Intermediary Asset Pricing,” *American Economic Review*, vol. 103 (April), pp. 732–70.
- Hesse, Henning, Boris Hofmann, and James Weber (2018). “The Macroeconomic Effects of Asset Purchases Revisited,” *Journal of Macroeconomics*, vol. 58 (December), pp. 115–38.

- Illes, Anamaria, Marco Lombardi, and Paul Mizen (2019). “The Divergence of Bank Lending Rates from Policy Rates after the Financial Crisis: The Role of Bank Funding Costs,” *Journal of International Money and Finance*, vol. 93 (May), pp. 117–41.
- Jossova, Martina, Caterina Mendicino, and Dominik Supera (2018). “Rollover Risk and Bank Lending Behavior: Evidence from Unconventional Central Bank Liquidity,” 2018 Meeting Papers 500, Society for Economic Dynamics.
- Kandrac, John (2018). “The Costs of Quantitative Easing: Liquidity and Market Functioning Effects of Federal Reserve MBS Purchases,” *International Journal of Central Banking*, vol. 14 (December), pp. 259–304.
- Kandrac, John, and Bernd Schusche (2017). “Quantitative Easing and Bank Risk Taking: Evidence from Lending,” Finance and Economics Discussion Series 2017-125. Washington: Board of Governors of the Federal Reserve System, December, <https://doi.org/10.17016/FEDS.2017.125>.
- Kim, Kyungmin, Thomas Laubach, and Min Wei (2020). “Macroeconomic Effects of Large-Scale Asset Purchases: New Evidence,” Finance and Economics Discussion Series 2020-047. Washington: Board of Governors of the Federal Reserve System, June, <https://doi.org/10.17016/FEDS.2020.04>.
- King, Thomas (forthcoming). “Expectation and Duration at the Effective Lower Bound,” *Journal of Financial Economics*.
- Krishnamurthy, Arvind, and Annette Vissing-Jorgensen (2011). “The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy,” *Brookings Papers on Economic Activity*, Fall, https://www.brookings.edu/wp-content/uploads/2016/07/2011b_bpea_krishnamurthy.pdf.
- (2013). “The Ins and Outs of LSAPs,” paper presented at the Proceedings of the Economic Policy Symposium, held in Jackson Hole, Wyoming.
- Kurtzman, Robert, Stephan Luck, and Tom Zimmermann (forthcoming). “Did QE Lead Banks to Relax Their Lending Standards? Evidence from the Federal Reserve’s LSAPs,” *Journal of Banking and Finance*.
- Kuttner, Kenneth (2018). “Outside the Box: Unconventional Monetary Policy in the Great Recession and Beyond,” Working Paper 47. Washington: Hutchins Center, October, <https://www.brookings.edu/wp-content/uploads/2018/10/WP47-Kuttner.pdf>.
- Luck, Stephan, and Tom Zimmerman (forthcoming). “Employment Effects of Unconventional Monetary Policy: Evidence from QE,” *Journal of Financial Economics*.

- Mamaysky, Harry (2018). “The Time Horizon of Price Responses to Quantitative Easing,” *Journal of Banking and Finance*, vol. 90 (May), pp 32–49.
- Nardi, Bianca, Chukwuma Nwankwo, and Jack Meaning (2018). “The Term Funding Scheme: Design, Operation, and Impact,” Bank of England, Quarterly Bulletin (Q4). London: Bank of England, <https://www.bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/2018/term-funding-scheme-web-version.pdf?la=en&hash=547FDDCF2F459CBF463E0A12CE1700AA9D4E727B>.
- Poole, William (1970). “Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Macro Model,” *Quarterly Journal of Economics*, vol. 84 (May), pp. 197–216.
- Rigobon, Roberto, and Brian Sack (2004). “The Impact of Monetary Policy on Asset Prices,” *Journal of Monetary Economics*, vol. 51 (November), pp. 1553–75.
- Rodnyansky, Alexander, and Olivier M. Darmouni (2017). “The Effects of Quantitative Easing on Bank Lending Behavior,” *Review of Financial Studies*, vol. 30 (November), pp. 3858–87.
- Rogers, John H., Chiara Scotti, and Jonathan H. Wright (2014). “Evaluating Asset-Market Effects of Unconventional Monetary Policy: A Cross-Country Comparison,” International Finance Discussion Paper Number 1101. Washington: Board of Governors of the Federal Reserve System, March, <https://www.federalreserve.gov/pubs/ifdp/2014/1101/ifdp1101.pdf>.
- Schabert, Andreas (2015). “Optimal Central Bank Lending,” *Journal of Economic Theory*, vol. 157 (May), pp. 485–516.
- Stein, Jeremy (2013). “Yield-Oriented Investors and the Monetary Transmission Mechanism,” speech delivered at “Banking, Liquidity and Monetary Policy,” a symposium sponsored by the Center for Financial Studies, Frankfurt, Germany, September 26.
- Tobin, James (1969). “A General Equilibrium Approach to Monetary Theory,” *Journal of Money, Credit and Banking*, vol. 1 (February), pp. 15–29.
- Todorov, Karamfil (forthcoming). “Quantify the Quantitative Easing: Impact on Bonds and Corporate Debt Issuance,” *Journal of Financial Economics*.
- Williams, John C. (2013). “A Defense of Moderation in Monetary Policy,” *Journal of Macroeconomics*, vol. 38 (part B), pp. 137–50.

Wu, Cynthia J., and Fan D. Xia (2016). “Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound,” *Journal of Money, Credit and Banking*, vol. 48 (March), pp. 253–91.

Zaghini, Andrea (2019). “The CSPP at Work: Yield Heterogeneity and the Portfolio Rebalancing Channel,” Working Paper Series 2264. Frankfurt: European Central Bank, April,
<https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2264~c4382400c5.en.pdf>.