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Monetary Policy and Economic Performance since the Financial Crisis

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Monetary Policy and Economic Performance since the Financial Crisis

Dario Caldara, Etienne Gagnon, Enrique Martínez-García, and Christopher J. Neely

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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

We review macroeconomic performance over the period since the Global Financial Crisis and the challenges in the pursuit of the Federal Reserve's dual mandate. We characterize the use of forward guidance and balance sheet policies after the federal funds rate reached the effective lower bound. We also review the evidence on the efficacy of these tools and consider whether policymakers might have used them more forcefully. Finally, we examine the post-crisis experience of other major central banks with these policy tools.

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Executive Summary

- This paper summarizes macroeconomic performance over the period since the Global Financial Crisis (GFC) and the challenges the Federal Reserve faced in pursuing its statutory goals of maximum employment and price stability. It then characterizes the use of forward guidance (FG) and balance sheet policies (BSPs) after the federal funds rate reached the effective lower bound. The paper reviews the evidence on the efficacy of these tools and considers whether policymakers might have used them more forcefully. Finally, it examines the post-GFC experience of other major central banks with these tools.
- The large negative GFC shock sharply raised unemployment. Inflation has persistently undershot the Federal Open Market Committee's (FOMC) symmetric 2 percent inflation goal since its adoption in January 2012.
    - *Maximum employment:* Unemployment initially rose substantially in the wake of the crisis, but the labor market recovered at a pace within range of the historical experience. The unemployment rate fell to its lowest level in 50 years and stayed there in 2019.
    - *Price stability:* PCE (personal consumption expenditures) inflation has averaged only 1½ percent since 2012. Persistent shortfalls raise the concern that longer-run inflation expectations become unanchored or are anchored at too low a level.
- The weakness in inflation and in the pace of the economic recovery surprised policymakers.
    - Policymakers and market participants generally expected a faster return of inflation to 2 percent and stronger economic activity than realized, while the unemployment rate declined faster than expected.
    - Structural transformations that were difficult to ascertain in real time may partially explain these forecast errors.
    - Policymakers have been learning about the effect of changes to their framework: making much greater use of BSPs and FG, adopting an inflation target, and introducing regular press conferences.

- The GFC was an extraordinary event that prompted use of BSPs and FG on an unprecedented scale.
    - BSPs and FG meaningfully supported U.S. employment and helped raise inflation toward 2 percent, although considerable uncertainty remains about the size and scalability of their effects. At the same time, some of the costs and risks associated with these tools turned out not to have been as large as some policymakers had feared.
- The European and Japanese experiences offer some lessons.
    - The struggles of the Bank of Japan (BOJ) and European Central Bank (ECB) to meet their inflation objectives illustrate the difficulty of raising inflation once longer-run inflation expectations become entrenched at a too-low level.
    - The BOJ, ECB, and Bank of England (BOE) greatly expanded their balance sheets without impairing market functioning, though probably with decreasing marginal macro benefits.
    - The international experience also suggests that the efficacy of both BSPs and FG hinges in part on the credibility of the central bank's commitment to pursuing accommodative policies for an extended period.
    - Limited policy space in advanced foreign economies going into the GFC, particularly in Japan, may have exacerbated their downturns and thereby modestly worsened U.S. outcomes.
- The FOMC might be able to employ BSPs and FG more forcefully in the future, but that more forceful use might have limited benefits.
    - The ECB, BOJ, and BOE have expanded their balance sheets to higher levels relative to domestic gross domestic product than did the Federal Reserve without incurring substantial costs.
    - The FOMC employed FG in a manner that was consistent with the current framework, but alternative frameworks would require untested types of FG. Specifically, the FOMC did not use FG to ease financial conditions through a projected overshooting of inflation above its longer-run objective.
    - Model simulations suggest that the FOMC improved macroeconomic outcomes by delaying federal funds rate liftoff relative to Taylor rule

prescriptions and that providing even more accommodation early in the recovery would have been beneficial.

- Did the use of BSPs and FG within the current framework fully mitigate the effects of the ELB? We draw mixed conclusions.
    - The pace of the employment recovery from the trough was consistent with historical experience.
    - Although longer-run inflation expectations were initially well anchored during and after the GFC, U.S. inflation has run below 2 percent in recent years, and some measures of long-run inflation expectations have softened to undesirably low levels. Whether the FOMC can achieve its symmetric inflation objective under the current framework is an important unresolved issue.

I. Introduction

In this paper, we summarize macroeconomic outcomes since the Global Financial Crisis (GFC) from the point of view of the dual mandate. Unemployment rose sharply during the crisis and declined steadily thereafter, whereas inflation has persistently fallen short of the symmetric 2 percent longer-run inflation goal adopted in January 2012. We highlight that, to some extent, departures from mandated goals reflected structural changes—some preceding the GFC, others brought about by the shock of the GFC—that took time to recognize and may have inhibited the policy response. We then review the evolving policy response through the increasingly forceful use of balance sheet policies (BSPs) and forward guidance (FG), and we assess their efficacy, costs, and risks. We then consider how perceptions of these benefits and potential costs likely shaped the deployment of these policies. We ask to what extent more forceful use of these policies within the current framework could have mitigated the constraints imposed by the effective lower bound (ELB) on the attainment of policymakers' objectives.

The labor market recovery was within the range of historical experience, with monetary policy supporting steady job gains despite impairment of some transmission channels. With respect to price stability, longer-run inflation expectations generally proved well anchored during the crisis, but inflation has subsequently run below 2 percent, and some measures of long-run inflation expectations have softened to undesirably low levels.

We contend that, under the current policy framework, policymakers could have employed accommodation more forcefully. That policymakers did not judge it appropriate to do so, especially in the early years of the post-crisis period, was not a shortcoming of the current framework but arguably reflected the challenges of conducting monetary policy in an uncertain economic environment using largely untested policy tools. In particular, we describe several structural transformations that were difficult to discern in real time, including a diminished sensitivity of inflation to resource slack, a decline in the natural rate of unemployment, and a decline in the neutral federal funds rate (r*). These transformations limited the scope of federal funds rate policies, weakened the effect of monetary policy on inflation, and revealed the labor market gap to

be larger than once thought. Recognition of these changes would have strengthened the case for even greater accommodation.

The evidence shows that the BSPs and FG deployed at the ELB eased financial conditions, supported employment, and helped raise inflation toward 2 percent in a manner roughly consistent with expectations at the time, though much uncertainty remains about the size and persistence of these effects. By contrast, worries that BSPs would disrupt market functioning, induce excessive risk-taking, or fuel inflation did not materialize as some had feared. This experience with the efficacy and costs of BSPs and FG suggests that the Federal Open Market Committee (FOMC) could deploy the tools more quickly or on a larger scale in the future. In recent years, with inflation running below 2 percent but the unemployment rate at or below longer-run estimates, it is possible that reluctance to overshoot the inflation goal has limited policymakers' willingness to pursue the more accommodative policies that could have sustainably achieved the inflation target.

A number of foreign central banks responded to the GFC with strategies and tools that were similar to those used by the FOMC. Their experiences highlight the importance of anchoring longer-term inflation expectations, the risk of potentially inconsistent policy actions, and the possibility of pursuing BSPs on a larger scale than the FOMC did.

Our paper is organized as follows. In Section II, we review macroeconomic performance over the past decade and discuss the challenges in recognizing ongoing structural transformations. In Section III, we discuss the extent to which the ELB constrained policymakers' ability to support the economy. We also review the evidence on the benefits and costs of BSPs and FG as well as the implications of these assessments for the amount of accommodation that policymakers can provide under the current framework. In Section IV, we draw lessons for the U.S. monetary policy framework from the experience of foreign central banks. Section V concludes.

II. U.S. Macroeconomic Performance in a Changing Economy

The GFC had multiple causes and aggravating factors, including negative foreign shocks, notably the European debt crisis, that hindered the ensuing recovery. Thus, in assessing the effectiveness of the policy measures taken, the question is not whether

economic performance was unsatisfying—it clearly was—but rather what lessons we have learned about the uses and risks of monetary policy tools. With the benefit of hindsight, we judge that the policies deployed under the current framework achieved mixed success by this criterion.

U.S. Macroeconomic Performance in the Aftermath of the Global Financial Crisis

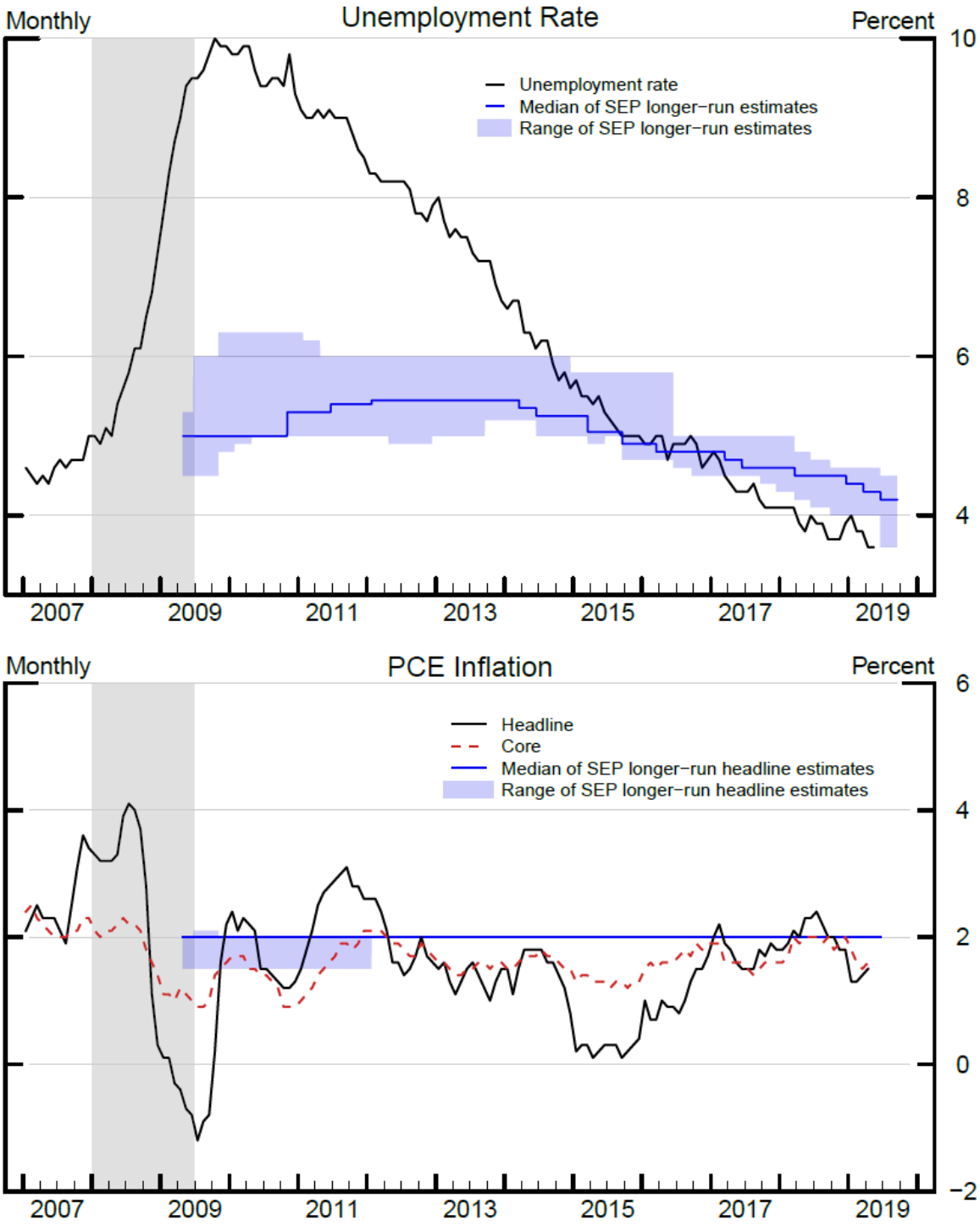
Figure 1 shows that the GFC led to an acute rise in the unemployment rate and a marked step down in inflation in the fall of 2008. The unemployment rate peaked at 10 percent in 2009, 5 percentage points above the median longer-run value in the Summary of Economic Projections (SEP).[1] Sharp drops in energy and food prices dragged headline PCE (personal consumption expenditures) inflation well below the median SEP longer-run estimate of 2 percent.

In the recovery phase, the economy absorbed the recessionary labor market slack at a pace within the range experienced in the past few recoveries. In particular, the unemployment rate declined ¾ percentage point per year, on average, from its peak in late 2009 until it reached estimates of its longer-run level around 2015. This pace was faster than the corresponding averages in the previous two labor market recoveries, at about ½ percentage point per year, but slower than the average in the recovery from the 1981–82 recession, at about 1 percentage point per year.[2] Whether the labor market could have recovered faster—say, as fast as during the early 1980s—is unclear because the crisis probably impaired some of the transmission channels of monetary policy. In any case, limitations of, and lags in, the transmission of monetary policy would have precluded the economy from quickly and fully absorbing the labor market slack created

[1] The SEP added the central tendency and range of longer-run estimates for the unemployment rate, headline PCE inflation, and real GDP growth in April 2009, and corresponding median estimates in September 2015. Before the latter date, we derive median estimates from declassified individual SEP contributions where possible and report the midpoint of the central tendency otherwise.

[2] These statistics are based on the peak-to-NAIRU analysis of Eberly, Stock, and Wright (2020). Comparisons across recoveries are sensitive to the reference period. For example, the unemployment rate rose modestly in the first two years of the 1990s and early 2000s economic expansions, making the labor market recovery from the GFC look especially strong relative to those episodes when measured from the start of the economic expansion rather than from the peak in the unemployment rate. By contrast, the unemployment rate fell 3½ percentage points in the first year and a half following the 1981–82 recession, making the initial labor market recovery from the GFC look especially weak relative to that episode.

Figure 1: Macroeconomic Outcomes



Note: Headline and core PCE (personal consumption expenditures) inflation are shown on a 12-month basis. The unemployment rate is on a monthly basis. The gray shaded bars indicate periods of U.S. business recession as defined by the National Bureau of Economic Research. SEP is Summary of Economic Projections.

Source: Federal Reserve Board; FRED, Federal Reserve Bank of St. Louis.

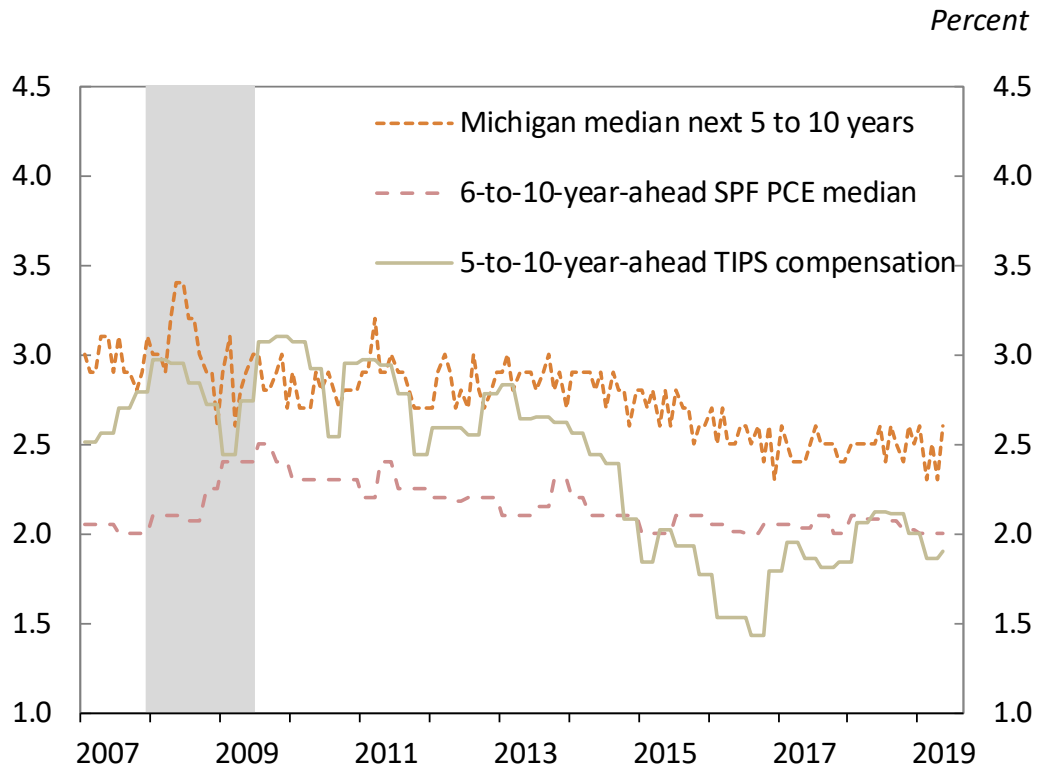
by the GFC. The unemployment rate dropped to its lowest level in mid-2018 and remained there until early 2020, with labor force participation moving above its trend during that period.[3]

Figure 2 shows that longer-run inflation expectations were stable during the GFC and the early years of the recovery. Survey-based measures—such as the Michigan median, next 5 to 10 years, and the SPF median 6 to 10 years ahead—remained near pre-GFC levels. Although the measure of inflation compensation based on Treasury Inflation-Protected Securities slid during the depths of the crisis, it quickly retraced its losses at the end of the recession. The anchoring may have helped maintain inflation nearer the 2 percent target than historical experience would suggest, given ample resource slack.[4] It also helped support real activity and employment because reductions in nominal interest rates passed through, almost one-for-one, to lower expected real interest rates.

On the negative side, real activity and the productive capacity of the economy grew modestly for many years. Moreover, PCE inflation has run below 2 percent for most of the past decade, raising concerns that longer-run inflation expectations could become unanchored or anchored at too low a level. Some survey-based measures of longer-run inflation expectations (such as the Michigan measure shown in figure 2) and measures of inflation compensation have been running below their pre-GFC trend and possibly below levels consistent with the 2 percent goal in recent years. In mid-2014, the Federal Reserve Board's staff Tealbook projection became conditioned on the explicit assumption that "underlying inflation"—defined as the level of PCE inflation that would prevail in the absence of slack or other shocks—was below 2 percent.[5] In short, longer-run inflation expectations appear to be lower than the FOMC's target. Letting inflation

[3] More precisely, the labor force participation rate has held steady, on net, since late 2013, in contrast with the trend decline projected by Aaronson and others (2014).
[4] For evidence on the role of longer-run inflation expectations and slack in determining realized inflation, see Ball and Mazumder (2011); Del Negro, Giannoni, and Schorfheide (2015); Duncan and Martínez-García (2015); Coibion and Gorodnichenko (2015); and Yellen (2015).
[5] As of the release of this working paper, 2014 is the latest calendar year for which Tealbook forecasts and FOMC memos are publicly available. In mid-2014, the staff also projected longer-run inflation expectations to eventually drift higher, pushing underlying inflation toward 2 percent, but acknowledged that such an upward drift was highly uncertain. See Linder (2014).

Figure 2: Estimates of U.S. Long-Term Inflation Expectations and Compensation



Note: Treasury Inflation-Protected Securities (TIPS) compensation values are based on comparisons of an estimated TIPS yield curve with an estimated nominal off-the-run Treasury yield curve, with an adjustment for the indexation lag effect. The gray shaded bar indicates a period of U.S. business recession as defined by the National Bureau of Economic Research. PCE is personal consumption expenditures.
Source: For Michigan, University of Michigan Surveys of Consumers; for Survey of Professional Forecasters (SPF), Federal Reserve Bank of Philadelphia; for TIPS, Federal Reserve Board staff calculations.

expectations remain below target would likely make achievement of the dual mandate more challenging. As we discuss later, the Bank of Japan (BOJ) has struggled to raise inflation expectations. Too-low inflation expectations fuel weak inflation and leave the economy more exposed to adverse shocks.

Did the U.S. Economy Behave as in the Past?

A number of structural transformations occurred over the past decade that could only be recognized over time:

Fall in the natural rate of employment. The paucity of price and wage pressures as slack disappeared suggests that the labor market had more room to run than previously thought. From 2015 to 2019, the median SEP value for the unemployment rate in the longer run fell from 5.5 to 4.2 percent (see figure 1). Factors such as population aging, rising educational attainment, or other aspects of human capital formation may have reduced the natural rate.[6]

Step-down in the trend rate of productivity growth. Real output per hour in the business sector has grown a little under 1¼ percent at an annual rate during the economic expansion, half its pace during the previous two economic expansions.[7]

Decline in r.* As figure 3 shows, time-series estimates of r*, both in the United States and abroad, have declined notably from their pre-GFC levels. The median SEP estimate has fallen from 2¼ percent in the first quarter of 2012 (when this information was first gathered) to only ½ percent during the second half of 2019. A decline in r* could reflect several factors, including the effects of population aging, the step-down in the pace of productivity growth, and lower risk tolerance.[8]

Diminished sensitivity of inflation to resource slack. Inflation has become less sensitive to contemporaneous movements in domestic resource slack and less persistent, so that a given movement in resource slack today will result in a smaller cumulative price response than previously. A decline in sensitivity need not imply a structural change: A monetary policy that stabilizes inflation weakens the correlation between inflation and resource slack.[9] However, policymakers' continued difficulties in raising inflation to 2 percent despite extraordinary policy actions suggest that the diminished sensitivity is, at least in part, of a structural nature.

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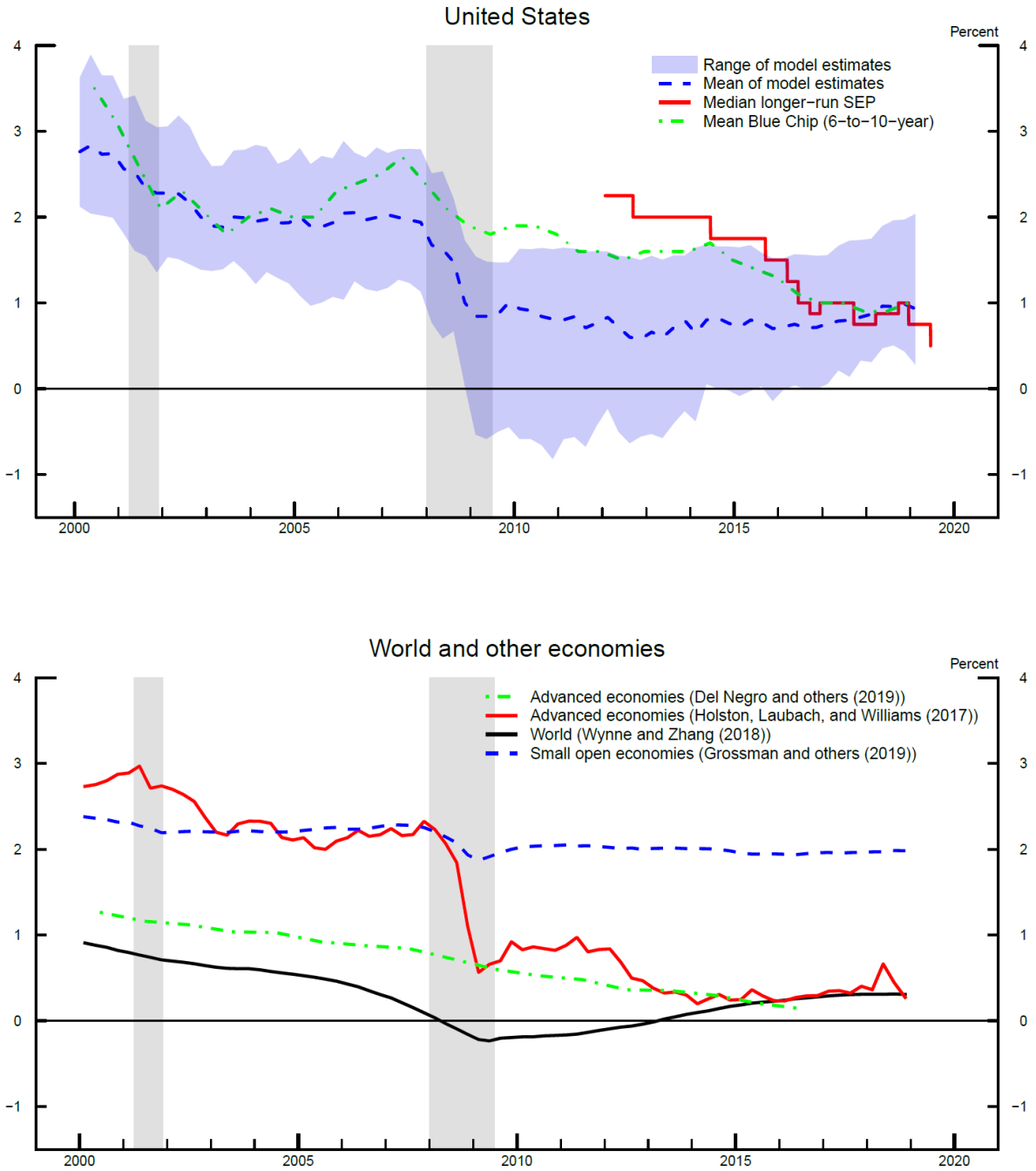
[6] See, for example, Aaronson and others (2015) and Cairó and Cajner (2018).

[7] To some extent, a step-down in productivity growth following the information technology boom of the mid-1990s to early 2000s is unsurprising, though the extent and timing of that step-down were difficult to predict. See Fernald (2015) and Gordon (2015).

[8] All estimates but one in figure 2 are "one sided," meaning that, at each date, they use historical data only up to that date. Accordingly, the fact that many series show a decline around the GFC need not imply that r* itself fell as a result of the crisis, but rather that the crisis marked the moment when models began to identify the fall.

[9] For evidence suggesting such a change in monetary policy, see Clarida, Galí, and Gertler (2000); Boivin and Giannoni (2006); and Boivin, Kiley, and Mishkin (2010).

Figure 3: Long-Run Estimates of Real Neutral Interest Rates



Note: All estimates are one-sided, with the exception of Del Negro and others (2019), which is two sided. The statistics in the top panel are based on eight time-series models maintained by the System's staff. The gray shaded bars indicate periods of U.S. business recession as defined by the National Bureau of Economic Research. Mean Blue Chip (6-to-10-year) values are deflated by corresponding values for the gross domestic product deflator. SEP is Summary of Economic Projections.

Source: System staff; Federal Reserve Board; National Bureau of Economic Research; Wolters Kluwer Legal and Regulatory Solutions U.S., Blue Chip Economic Indicators.

Identifying the previously discussed transformations in real time in an economy constantly buffeted by shocks is an inherently challenging task, and there remains substantial uncertainty about these phenomena and their evolution. Policymakers and market participants learned only slowly about these transformations through their forecast errors. Figure 4 illustrates that, during the economic recovery, policymakers and market participants systematically underpredicted the speed at which the unemployment rate fell and overpredicted real gross domestic product (GDP) growth—that is, their projections implied overly optimistic views of labor productivity growth.[10] It also shows that market participants were repeatedly disappointed by the failure of inflation to rise to 2 percent over the medium term as the labor market tightened. By contrast, FOMC participants generally saw medium-term inflation falling short of 2 percent under appropriate policy during much of the recovery, including for a few years after they adopted 2 percent as their longer-run goal.[11]

As will be discussed in the companion paper "Monetary Policy Tradeoffs and the FOMC's Dual Mandate," structural transformations can call for changes in the conduct of monetary policy to achieve the dual mandate. Earlier recognition of these structural transformations might have strengthened the case for more accommodative policies. Consistent with this conjecture, figure 4 shows that market participants and policymakers repeatedly deferred the projected liftoff date as they came to the conclusion that the labor market had greater room to run, and that r* had fallen more, than they had previously assumed.

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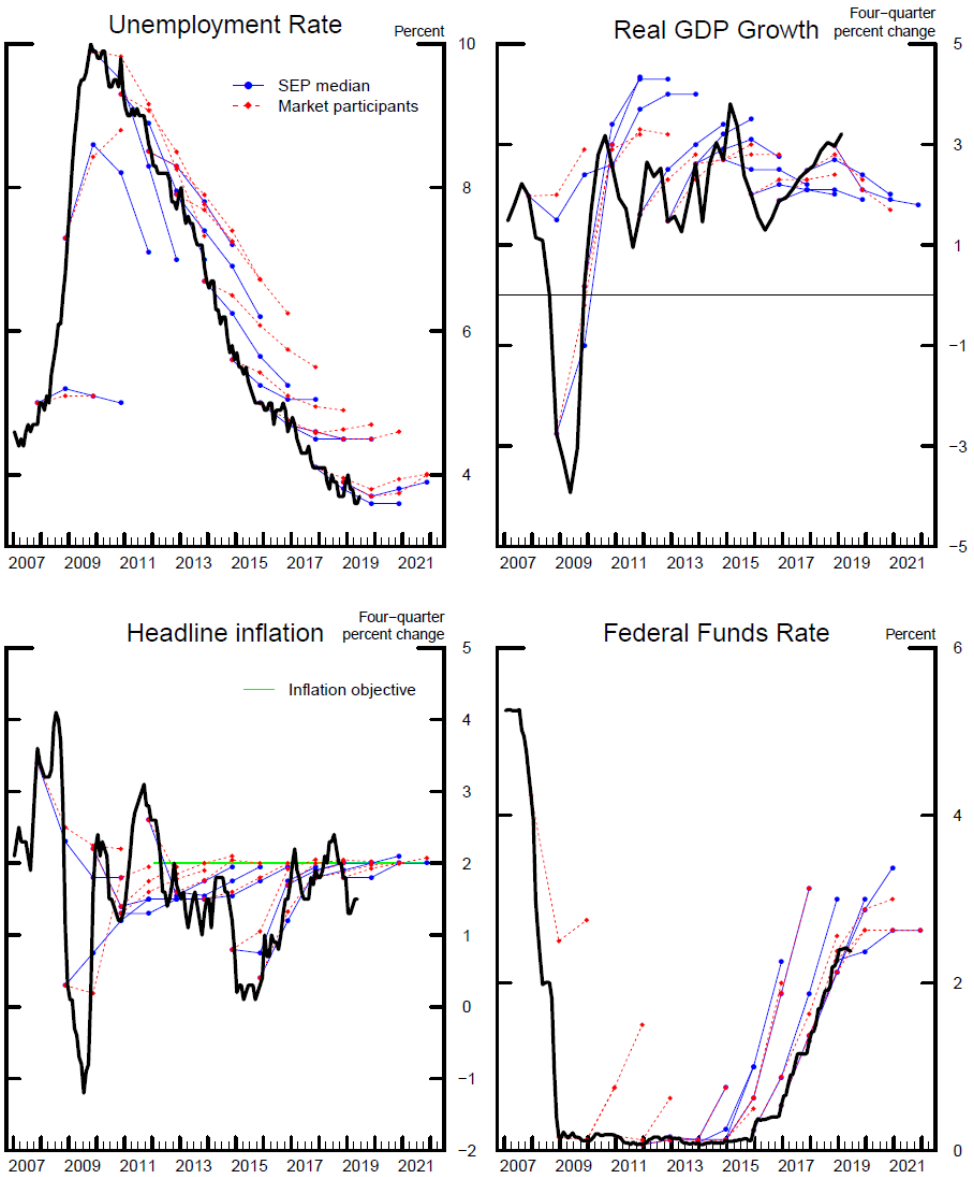
[10] Based on information before 2020, figure 4 reports, for the first quarter of each calendar year, median SEP projections at various yearly horizons, along with corresponding medium-term projections from market participants. Individual SEP projections are conditional on each policymaker's assessment of appropriate monetary policy, whereas market participants' projections are modal forecasts. For this reason, the two projection concepts reported in figure 3 differ. Evidence of policymakers' slow recognition of the fall in productivity growth is corroborated by the significant downward revisions to real output growth in the longer run: Median SEP estimates fell from 2.6 percent in April 2009 to 1.9 percent in the latest survey.

[11] Policymakers expected inflation to be weaker than did market participants during the first years of the recovery, even though policymakers held relatively upbeat views of future real GDP growth and unemployment. This observation is consistent with policymakers assuming that a larger reduction in slack was necessary to lift inflation by a given amount than did market participants. We also note that policymakers' inflation forecast errors averaged about zero, even though the unemployment rate fell faster than policymakers had anticipated, suggesting that inflation proved even less responsive to movements in slack than policymakers had assumed.

Figure 4: Forecast Revisions



Note: Summary of Economic Projections (SEP) median values correspond to projections made in the first quarter of each year. Where unavailable, we approximate SEP medians with the midpoints of central tendencies. In January 2012, the Federal Open Market Committee (FOMC) established a longer-term inflation goal and began reporting FOMC participants' appropriate policy rate assumptions. Market participants' values are from the Survey of Professional Forecasters for the unemployment rate and PCE (personal consumption expenditures) inflation, the BCEI for real gross domestic product (GDP) growth, and the Survey of Primary Dealers for the federal funds rate.

Source: For FRED, the Federal Reserve Bank of St. Louis; Federal Reserve Board; for the Survey of Professional Forecasters, the Federal Reserve Bank of Philadelphia; for the Survey of Primary Dealers, the Federal Reserve Bank of New York; Wolters Kluwer Legal and Regulatory Solutions U.S., Blue Chip Economic Indicators.

III. The Federal Open Market Committee's Policy Tools and Their Deployment

The rapid worsening of the economic outlook in the fall of 2008 led the FOMC to slash the target for the federal funds rate to a 0 to 25 basis point range. The simple rules in Yellen (2017) prescribe lowering the policy rate to between negative 1½ and negative 9 percent during the GFC. The FOMC judged that a cost-benefit analysis, including practical and legal considerations, made negative deposit rates unappealing.[12] Accordingly, the FOMC used BSPs and FG to provide additional monetary stimulus.[13]

The Federal Reserve's BSPs comprised three large-scale asset purchase (LSAP) programs (henceforth LSAP1, LSAP2, and LSAP3) and a maturity extension program. These programs focused on the purchases of longer-term Treasury bonds, agency mortgage-backed securities (MBS), or both, with gross purchases totaling $4.65 trillion. The FOMC also attempted to manage expectations about future policy with FG. From December 2008 to the summer of 2011, FG was of a qualitative nature, conveying the FOMC's anticipation that short-term interest rates would remain low "for some time" or "for an extended period." In August 2011, the FOMC switched to a calendar-based approach that emphasized its expectation that the funds rate would remain exceptionally low at least until some preannounced date. Then, in December 2012, the FOMC began using a threshold-based approach that signaled a low policy rate for at least as long as unemployment and inflation stayed above or below preannounced values.[14]

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[12] For of review of the considerations raised by staff at the time, see Burke and others (2010).

[13] The FOMC's use of BSPs and FG in response to the GFC was unprecedented. Though the FOMC purchased longer-term Treasury securities using proceeds from sales of shorter-term holdings in the early 1960s (the so-called Operation Twist), the total size of this program, at 1.7 percent of GDP, was much smaller than total purchases during the GFC and its aftermath (Swanson, 2011). Also, before the GFC, the FOMC used FG regarding the likely path of interest rates on occasion, but that guidance was usually confined to a relatively short time frame.

[14] FG can serve dual purposes: It can convey policymakers' *predictions* about future economic conditions and policies, or their *commitment* to a future policies (these two purposes are called "Delphic" and "Odyssean," respectively, by Campbell and others (2017)). Del Negro, Giannoni, and Schorfheide (2015) argue that the FOMC's FG became more of a commitment to stimulative policies with the introduction of the 2 percent inflation target and the release of FOMC participants' assessments of appropriate monetary policy in 2012.

Did Balance Sheet Policies and Forward Guidance Lead to Better Outcomes?

There is broad consensus that BSPs and FG helped at least partially overcome the ELB constraint. For example, Eberly, Stock, and Wright (2020) argue that BSPs and FG reduced the unemployment rate by as much as 2 percentage points and raised the inflation rate a few tenths of 1 percentage point in the first years of the recovery.[15] That said, researchers debate the effectiveness of BSPs and FG. Some observers argue that BSPs and FG fully substituted for the shortfall, so that the ELB did not really constrain the response to the GFC, while other observers see alternative policy tools as having had little, if any, positive macroeconomic effects (see our review of estimates below).[16] The majority view is that BSPs and FG likely made up for some, though not all, of the shortfall.

Were the Efficacy and Costs of Balance Sheet Policies and Forward Guidance as Expected?

In memos sent to the FOMC in late 2008, the staff judged that BSPs would likely support the economy by reducing borrowing costs for the private sector and by exerting downward pressure on the exchange value of the dollar. The staff also noted that only very large purchases would likely have the desired effects.[17] Similarly, the staff indicated that FG could lessen policy uncertainty and reduce longer-term interest rates.[18] However, the paucity of historical precedents and exceptionally stressed financial conditions left great uncertainty about these judgments. FOMC participants expressed similar judgments that BSPs would likely have positive effects, in addition to raising a number of concerns (as will be discussed). Our review of the evidence on the financial and macroeconomic effects of BSPs and FG suggests that early estimates of the likely

[15] The mean DSGE estimates in Gust, Herbst, Lopez-Salido and Smith (2017) suggest that a binding ELB accounted for about 30 percent (roughly 2 percentage points) of the 6 percent contraction in GDP in 2009 relative to peak in 2007 and was responsible for an even larger fraction of the ensuing slow recovery. The estimates of Gust and others (2017), which embed the effects of FG and LSAP, are consistent with more immediate negative effects of the ELB on outcomes than those of Eberly, Stock, and Wright (2020).
[16] See, for example, Swanson (2018); Debertoli, Galí, and Gambetti (2019); and Sims and Wu (2019).
[17] For example, Cabana and others (2008) estimate that "purchases of $50 billion of longer-term Treasury securities [. . .] would lower the 10-year Treasury yield somewhere between 2 and 10 basis points." See also Gagnon and Holscher (2008) and Erceg, Kiley, and Levin (2008a).
[18] See Erceg, Kiley, and Levin (2008b).

effects were in the right ballpark, and that adverse side effects have been less severe than feared.

Financial effects

Researchers have most often evaluated the financial effects of BSPs and FG on asset prices with event studies to exploit the rapid reaction of asset prices to shocks, such as unexpected announcements. Market participants were surprised by the advent of LSAP1, and event studies around LSAP1 communications show large, immediate financial effects.[19]

Depending on the study, LSAP1 reduced the 10-year Treasury yield by 50 to 100 basis points. Table 1 presents results from Gagnon and others (2011), showing that LSAP1 announcements reduced 10-year Treasury yields by 55 to 107 basis points, depending on the event set. Corporate yields fell even more. The magnitude of the effects is sensitive to the details of the specification but is typically large.[20] Larger event sets tend to imply smaller policy effects. Using alternative model-based approaches, Ihrig and others (2018) assess that altogether, past BSPs had reduced the 10-year term premium 100 basis points by early 2015. Other studies indicate that these yield declines stimulated bond issuance.[21]

The lower panels of table 1 show that LSAP1 announcements also reduced 10-year government yields in the advanced foreign economies (AFEs) by more than 40 basis points, on average, and depreciated the U.S. dollar relative to AFE currencies by almost 6 percent.[22] BSP announcements also reduced derivative-market estimates of tail risk but only modestly raised equity prices (Wright, 2012).

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[19] Because of the novelty of LSAP1, FOMC announcements were presumably the main source of information about that program, so researchers have used the reactions to a set of LSAP1 announcements to estimate the total effect of the program. This was not possible for later programs because a much wider set of news presumably affected the expectations of market participants.
[20] One exception is Greenlaw and others (2018), who take a skeptical view of the Federal Reserve's asset purchase policies. Bhattarai and Neely (2018) and Kuttner (2018) review the literature on BSPs and FG.
[21] See Di Maggio, Kermani, and Palmer (2016).
[22] These estimates are excerpted from Neely (2015).

A number of studies have found that the type of asset purchased mattered: MBS purchases particularly pushed down mortgage rates and had a greater effect on lending

Table 1: The Effect of LSAP1 Events on U.S. and Foreign Yields (in basis points) and on the Foreign Exchange Value of the Dollar

	Baseline events	*p* value	All FOMC events	*p* value
Effect on U.S. yields (in basis points)				
2-year U.S. Treasury	-34		-1	
10-year U.S. Treasury	-91		-55	
10-year agency	-156		-134	
Agency MBS	-113		-114	
10-year term premium	-71		-47	
10-year swap	-101		-75	
Baa index	-67		-72	
Effect on foreign yields (in basis points)				
Australia (10-year)	-63	(.01)	-26	(.49)
Canada (10-year)	-50	(.00)	-47	(.06)
Germany (9-to-10-year)	-39	(.01)	-5	(.84)
Japan (10-year)	-18	(.04)	-9	(.54)
United Kingdom (10-year)	-43	(.02)	-21	(.46)
Average effect	*-42.6*	*(.00)*	*-21.6*	*(.23)*
Effect on exchange rate (in percent change)				
AUD/USD	-6.16	(.01)	-13.00	(.00)
CAD/USD	-7.76	(.00)	-9.74	(.01)
EUR/USD	-6.70	(.01)	-5.20	(.19)
JPY/USD	-3.54	(.12)	-9.68	(.01)
GBP/USD	-5.98	(.00)	-10.15	(.00)
Average effect	*-5.73*	*(.12)*	*-13.11*	*(.03)*

Note: The top panel is excerpted from table 1 in Gagnon and others (2011). It shows sums of one-day nominal U.S. yield changes, in basis points, for two event sets: a "baseline events" set of 8 LSAP1 news events (11/25/2008, 12/1/2008, 12/16/2008, 1/28/2009, 3/18/2009, 8/12/2009, 9/23/2009, and 11/4/2009) and an "all FOMC events" set consisting of those 8 events plus all FOMC meetings and minutes releases from November 2008 through January 2010. The second and third panels are excerpted from tables 2 and 3, respectively, in Neely (2015). These panels show one-day nominal foreign long-term yield changes, in basis points, and 1-day exchange rate (FX per USD) changes in percent changes for the same event sets. The "*p* values" show the proportions of 8-day or 13-day changes from July 2007 through January 2010 that were larger in absolute value than the actual change in the corresponding 8-day or 13-day event windows.

Source: Authors' calculations.

for banks that owned greater amounts of MBS.[23] Table 2 describes key results from selected studies of effects of U.S. BSPs and FG on financial markets.

BSPs affect yields through several channels. Signaling reduces expected future interest rates, while duration-risk effects reduce term premiums by lowering the quantity of duration risk held by the public. A third channel, "local supply effects," reduces the yields of bonds whose duration was similar to that of bonds that were actually purchased. Studies disagree about the relative importance of these channels, but there is evidence that all three had economically significant effects.

Regarding FG, the qualitative guidance provided by the FOMC until mid-2011 did not induce market participants to expect a much easier path of monetary policy: As the lower-right panel of figure 4 makes clear, private agents continued to expect the federal funds rate to rise after four quarters. The introduction of calendar-based FG in August 2011, when the FOMC stated its expectations that the policy rate would stay near zero "at least through mid-2013," led market participants to push back the expected liftoff from three to seven quarters. Yields on one- and two-year Treasury securities became less responsive to economic news.[24] That said, despite these developments, Del Negro, Giannoni, and Patterson (2012) argue that the August 2011 date-based FG failed to stimulate because it was interpreted as predicting low future growth. These authors argue that the September 2012 FOMC statement was stimulative because markets interpreted it as a commitment to a policy course of prolonged accommodation. By contrast, the rollout of threshold-based FG in December 2012 elicited little, if any, market reaction, consistent with the FOMC's indication that the new guidance was consistent with the date-based FG it replaced.

U.S. Treasury debt issuance may have lessened the macroeconomic effects of the Federal Reserve's BSP and FG policies over time. Greenwood and others (2014) compare the effect of the Treasury's maturity extensions on 10-year yields with those of the Federal Reserve's BSP and FG programs using data from the end of 2007 to

[23] See Rodnyansky and Darmouni (2017); Chakraborty, Goldstein, and MacKinlay (2017); and Kurtzman, Luck, and Zimmermann (forthcoming).
[24] See Swanson and Williams (2014).

Table 2: Selected Studies of the Financial Market Effects of Balance Sheet Policies and Forward Guidance

Study	Key Finding
Gagnon and others (2011)	10-year Treasury yield fell 91 basis points over baseline event set and 55 basis points over the "all-event" set.
Lo Duca, Nicoletti, and Martinez (2016)	Yield declines stimulated bond issuance, especially in emerging markets.
D'Amico and King (2013)	Asset purchases produce local supply effects.
Di Maggio, Kermani, and Palmer (2016)	MBS purchases, but not Treasury purchases, depressed mortgage rates with particularly strong effects on conforming mortgages.
Rodnyansky and Darmouni (2017)	Institutions with relatively large holdings of MBS expanded lending after LSAP1 and LSAP3, but not after LSAP2.
Kurtzman, Luck, and Zimmermann (forthcoming)	Banks with greater MBS holdings reduced lending standards and made riskier loans.
Chakraborty, Goldestein, and MacKinlay (2017)	Banks that owned greater amounts of MBS increased mortgage lending at the expense of commercial and industrial lending.
Neely (2015)	BSPs spilled over to foreign exchange markets and foreign bond markets, reducing the value of the dollar and foreign bond yields.
Kiley (2014)	BSPs had modest effects on equities because it moved the medium and long yields but not short yields.
Hamilton and Wu (2012)	A segmented markets model implies that a $400 billion purchase will reduce 10-year Treasury yields by 13 basis points.
Greenwood and Vayanos (2014)	Maturity-weighted debt-to-GDP increases long-term yields. The Federal Reserve's LSAP1 and LSAP2 together reduced yields 40 basis points.
Altavilla and Giannone (2015)	The unconventional policy effects on SPF forecasts are persistent and consistent with those from event studies.
Greenwood and others (2014)	U.S. Treasury lengthening the maturity structure of U.S. debt may have offset one-third of the effects of Federal Reserve asset purchases on long yields.
Raskin (2013)	The FOMC's promise to keep rates low until "mid-2013" had a much bigger effect than the promise to keep rates low until "mid-2014."
Femia, Friedman, and Sack (2014)	The New York Fed's Survey of Primary Dealers indicates that FG provides market participants with information about the state of the economy.

Note: MBS is mortgage-backed securities; BSPs are balance sheet policies; GDP is gross domestic product; SPF is Survey of Professional Forecasters; FOMC is Federal Open Market Committee; FG is forward guidance.

Source: Authors' calculations.

mid-2014. During that period, the Treasury increased the average duration of the publicly held debt from 3.9 to 4.6 years, which is consistent with its desire to reduce refinancing and rollover risk when debt-to-GDP rises. That increase in the duration of the publicly held debt offset the Federal Reserve's efforts to reduce yields by reducing the duration of outstanding debt. Greenwood and others (2014) calculate that the Treasury's duration increase raised 10-year yields by about 48 basis points. That is, these authors argue that Treasury debt management offset about 35 percent of the Federal Reserve's BSPs and FG.[25] Greenwood and others (2014) further argue that the Treasury and Federal Reserve should coordinate their efforts when the economy is at the ELB.

The results on the effects of BSPs and FG on financial markets come with several caveats. First, although monetary policy announcements can have immediate, sometimes large effects, calculating the effects of a whole program is hazardous because policy announcements are generally partially expected or generate expectations of further actions. Such leakage can render the market reaction as judged by event studies an inaccurate guide to the actual effect of the policy. Second, announcements on LSAPs probably contain signals about future short rates; hence, disentangling the effects of BSPs and FG is difficult.[26] Third, event studies estimate the reaction of asset prices in a narrow window around policy announcements, typically one day, but are agnostic about the persistence of the effects. Looking over a longer horizon, Wright (2012) and Swanson (2017) find that the effects of BSPs and FG are relatively short lived. Neely (2016) criticizes Wright's (2012) model, however, arguing that it is unreliable. Finally, because event studies are generally based on few key announcements, the estimates are sensitive to individual observations, and the statistical significance is sometimes unclear (Kuttner, 2018).

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[25] Using data from 2007 to mid-2014, Greenwood and others (2014) report that the Federal Reserve's BSP programs reduced the publicly held 10-year equivalent universe (Treasury securities, MBS, and agencies) by approximately 15.6 percent of GDP, while Treasury maturity extensions increased the outstanding 10-year equivalents by 5.5 percent of GDP. Greenwood and others (2014) then calculate that the Treasury's duration increase offset more than 35 percent ($\approx$ 5.5/15.6) of the effect of the Federal Reserve's BSP and FG policies on 10-year yields. Greenwood and others (2014) cite meta estimates from Williams (2014) to put the total effect of Federal Reserve policies on 10-year yields at 137 basis points, so the offset was 48 basis points.

[26] Swanson (2017) carefully disentangles the effects of policy rate cuts, FG, and BSPs and finds that the effects of FG were more transient—lasting only several months—than those of policy rate cuts or BSPs.

Macroeconomic effects

In contrast to the many empirical estimates of the effects of BSPs on financial conditions, relatively fewer studies quantify the effects on economic activity and inflation. The studies reviewed in table 3 find support for the notion that BSPs have important macroeconomic effects, but there is much uncertainty about their magnitude. Differences in estimates can be ascribed mainly to alternative modeling frameworks and assumptions about the channels through which unconventional policies stimulate the economy. Table 3 reports results from selected studies of the effects of U.S. BSPs and FG on the macroeconomy.

Table 3: Selected Studies of the Macro Effects of Balance Sheet Policies and Forward Guidance

Study	Key Finding
Walentin (2014)	LSAP1 increased consumption and GDP by 3.2 percent and 3.8 percent at peak, respectively, largely by increasing residential investment.
Baumeister and Benati (2013)	LSAP1 prevented inflation dropping by 1 percentage point and output growth reaching a trough of negative 10 percent.
Wu and Xia (2016)	Without the Federal Reserve's BSPs and FG, the unemployment rate would have been 1 percentage point higher at peak than actually observed. The macro effects of these policies are modest but nontrivial.
Swanson (2017)	FG has transient effects, lasting 1 to 4 months, whereas asset purchases and policy rate adjustments have more persistent effects.

Note: GDP is gross domestic product; BSPs are balance sheet policies; FG is forward guidance.

Source: Authors' calculations.

There are three broad classes of models used to estimate the effects of BSPs on output and inflation: dynamic stochastic general equilibrium (DSGE) models, structural vector autoregressions (SVARs), and large-scale "semi-structural" models such as the FRB/US model. Among DSGE models, Gertler and Karadi (2013) find that the peak

effect of a balance sheet intervention along the lines of LSAP2 is about an additional 1 percent on the level of real output. By contrast, Chen, Curdia, and Ferrero (2012) find only modest effects of LSAP2 on the level of output, a 0.1 percent increase. Using a SVAR, Baumeister and Benati (2013) find that the level of GDP was about 3 percent higher at its peak than it would have been absent LSAP1, while the inflation rate was about 1 percentage point higher. Weale and Wieladek (2016) find similar effects using different identifying assumptions. Engen, Laubach, and Reifschneider (2015) use the FRB/US model and find that the collective effect of all of the Federal Reserve's asset purchase programs and FG subtracted 1.2 percentage points from the unemployment rate at its peak in early 2015 and would have had a peak effect of raising inflation by 0.5 percentage point in 2016.

Costs and risks

Policymakers and analysts expressed a range of concerns regarding BSPs and FG during the debate on their use. Some worried that a huge increase in the monetary base would lead to an inflation breakout. Others worried that plentiful bank reserves might make it difficult to raise the funds target when that eventually would become necessary. Another concern was that unusual accommodation could create incentives for excessive risk-taking—that is, reaching for yields—and so undermine financial stability. Adverse effects of large purchases on market functioning were also feared. For example, if the Federal Reserve were to buy most or all Treasury issues, liquidity in that market would be adversely affected. Yet another concern was that BSPs might permanently ratchet up the size of the Federal Reserve's balance sheet if subsequent economic expansions did not provide enough time for normalization. With respect to FG, FOMC participants extensively discussed the risk that their communications might be misinterpreted as unconditional commitments, might not convey the complexities of the economy and the policy process, or might downplay the data-dependent nature of their policy communications.[27]

[27] See, for example, the minutes to the September 2012 FOMC meeting, available on the Board's website at https://www.federalreserve.gov/monetarypolicy/files/fomcminutes20120913.pdf.

If we look back, many of those potential risks raised by policymakers did not materialize. Worries that inflation might run above 2 percent, or that longer-run inflation expectations might become unmoored, proved to be unwarranted. Elevated reserves did not prevent raising the policy rate when it was deemed appropriate. Thanks to the Federal Reserve's ability to pay interests on excess reserves, and the creation of an overnight reverse repurchase agreement facility, the FOMC successfully raised the federal funds rate from its ELB in a context of abundant reserves starting in December 2015. Furthermore, BSPs supported market functioning rather than impaired it. For example, Federal Reserve purchases of agency MBS reduced agency spreads, and LSAP announcements trimmed corporate credit risks.[28] Moreover, the FOMC reduced the size of its balance sheet largely uneventfully through runoffs starting in October 2017.[29] While the "taper tantrum" episode illustrates that communicating with the public can be challenging, it is not clear that the Committee's FG created much confusion. Evidence accumulated since the crisis indicates that the costs and risks attached to the BSP and FG actions were probably overstated.

Could the Committee Have Used Existing Policy Tools to Support More Stimulative Policy under the Current Framework?

Overall, the evidence suggests that, had the Committee chosen to do so, it could have provided greater accommodation through BSPs and FG under the existing framework. Specifically, the size of the Federal Reserve's balance sheet peaked at 25 percent of GDP, a ratio lower than the European Central Bank (ECB), BOJ, and Bank of England (BOE) achieved through their LSAP programs (reviewed in section IV).

Moreover, the FOMC made only moderate use of FG during the recovery, mostly to clarify the path of monetary policy. For many of the years during which the Committee employed FG, most FOMC participants projected that inflation would fall short of 2 percent and that the unemployment rate would exceed its longer-run level over the medium term. Thus, as is the case with BSPs, FG could have been used without creating a conflict between achievement of the maximum-employment and price-stability

[28] See Gilchrist and Zakrajsek (2013).
[29] See Kiley (2018) and Chung and others (2019) for stochastic simulations of the U.S. economy under an endogenous balance sheet response.

legs of the dual mandate. In sum, our view is that the Committee could have done more under the current framework, had it chosen to do so, though any further policy action would have been further outside of the historical experience and thus subject to considerable uncertainty regarding the efficacy and risks.

We note, however, that there were limits to the extent that policymakers could have used BSPs and FG under the existing framework. The Federal Reserve's review of its monetary policy framework takes as given the working understanding that, under the current framework, policymakers use their tools to achieve the dual-mandate goals, but they never seek to deliberately overshoot or undershoot the longer-run inflation goal.[30] Alternative "makeup" strategies would attempt to improve near-term macroeconomic conditions by making greater use of BSPs and FG, including inflation overshooting, which the current framework rules out. With the exception of the BOJ's (so far unsuccessful) attempt at lifting inflation above its objective, the ability to use BSPs, FG, and other tools to engineer a substantial easing of financial conditions and create expectations of future inflation running above the stated goal is untested.

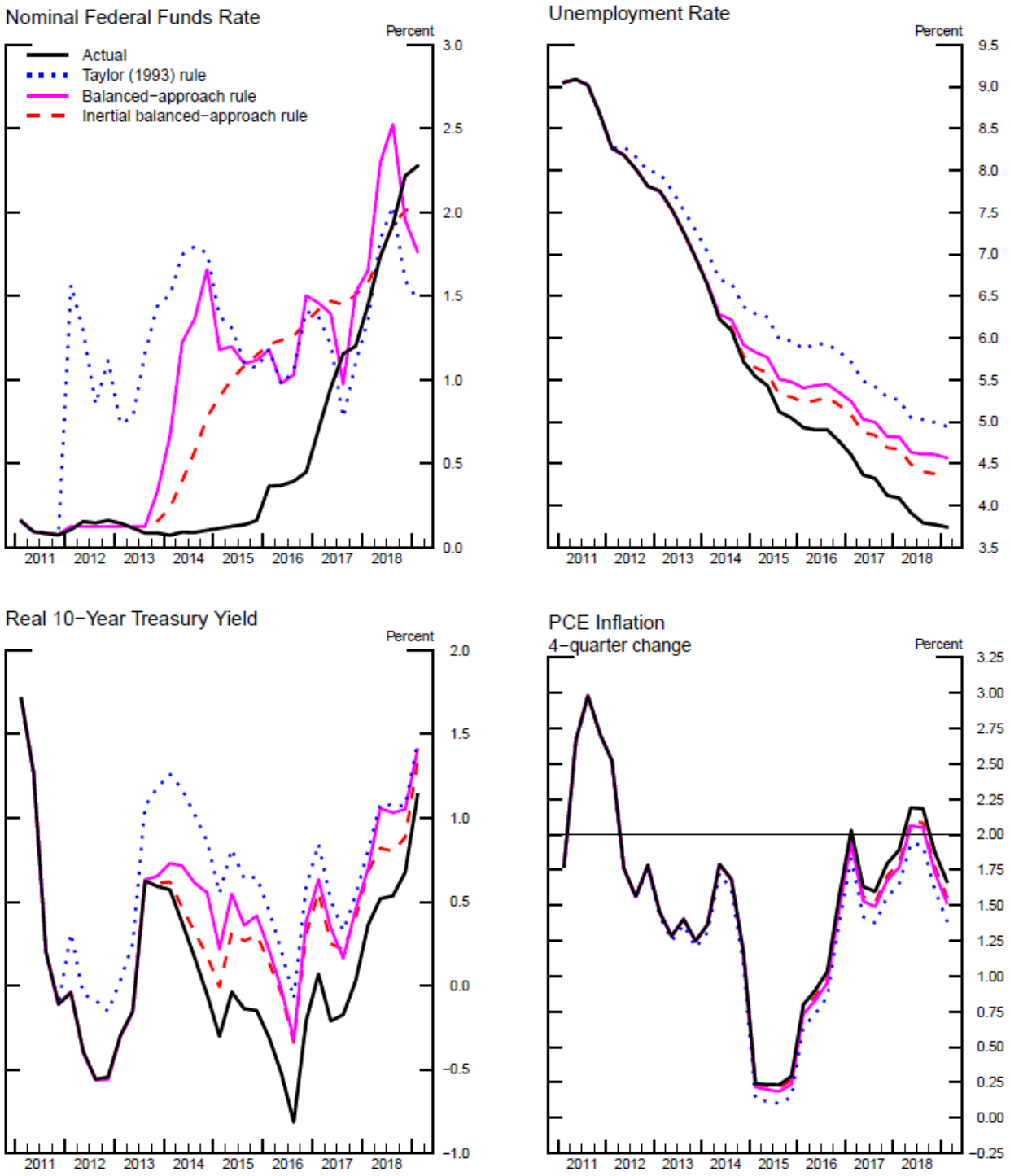
How Much Benefit Would Additional Accommodation Have Provided?

Next, we discuss a number of counterfactual model simulations that support the argument that the FOMC might have improved inflation and employment outcomes by pursuing more accommodative policies during the recovery.

By some metrics, the Committee showed patience in deferring policy normalization. Figure 5 shows the results from three counterfactual simulations of the FRB/US model in which policymakers followed three Taylor-type rules, starting from 2012:Q1.[31] The simulations suggest that following such rules would have produced worse economic outcomes. The well-known Taylor (1993) rule called for raising the federal funds rate in early 2012, which would have delayed the return of the

[30] See Clarida (2019a) for a discussion of the Federal Reserve's current monetary policy framework and the scope of the Federal Reserve's review of its monetary policy strategy, tools, and communication practices.
[31] See appendix A for a description of these simulations.

Figure 5: Counterfactual Simple Rule Policies and Outcomes



Note: We perform the simulations using the FRB/US model under the assumptions that agents form VAR-based expectations and that the intercepts and gaps in each policy rule are consistent with the median longer-run projections of Federal Open Market Committee participants over time. See appendix A for details. PCE is personal consumption expenditures.

Source: Authors' calculations.

unemployment rate to its longer-run level by several years and led to a more pronounced undershoot of the 2 percent inflation goal. Adherence to the balanced-approach rule or its inertial version would have similarly delayed achievement of the dual mandate relative to the strategy pursued by the FOMC, though not as much as adhering to the Taylor (1993) rule.[32]

Given the realized evolution of the U.S. economy, other model simulations suggest that the provision of even more policy accommodation during the recovery may have improved outcomes. Eberly, Stock, and Wright (2020) use a SVAR model to compute outcomes under alternative historical paths for the federal funds rate and the 10-year term spread. They treat this spread as a policy variable that captures the combined effects of BSPs and FG on the slope of the term structure of interest rates. Their simulations suggest that policies that would have flattened the yield curve an extra 1 percentage point from late 2008 to late 2013 would have shaved a bit over 1 percentage point off the unemployment rate during the recovery. However, these policies may not have pushed inflation sustainably to the 2 percent target. FRB/US simulations using the staff balance sheet model suggest that very large asset purchases would have been required to raise medium-term inflation even modestly.[33]

IV. The International Experience: Cautionary Tales from Europe and Japan

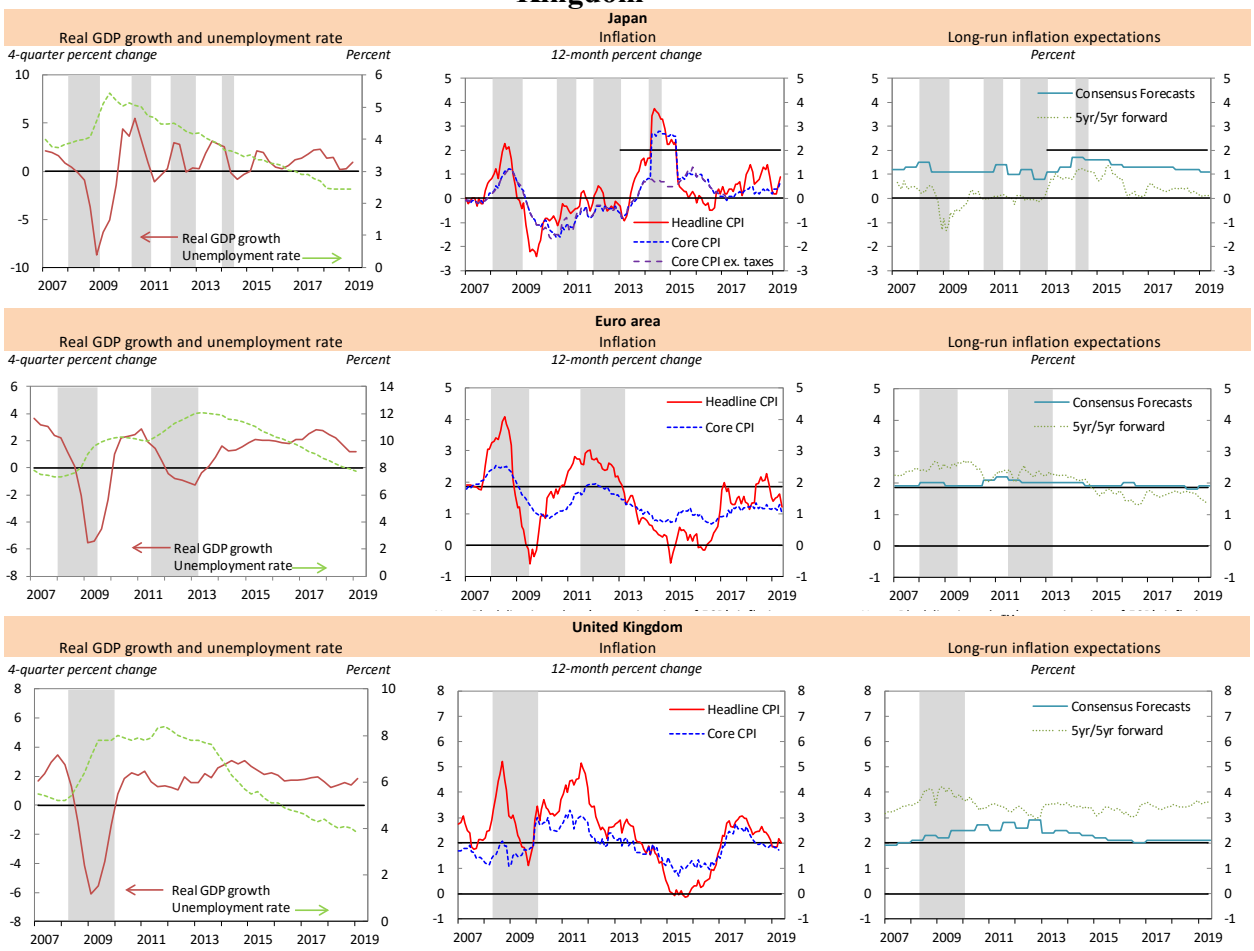
Macroeconomic Performance in Europe and Japan in the Aftermath of the Global Financial Crisis

Figure 6 shows that, during the GFC, the euro-area and Japanese economies suffered large contractions in economic activity and increases in unemployment, with euro-area labor markets deteriorating further during the European sovereign debt crisis.

[32] Taylor (1993) shows that the rule now bearing his name fits policy rate settings well during the 1987–92 period. See Yellen (2017) for an application of the balanced-approach rule. The inertial version of the balanced-approach rule has been featured in Federal Reserve Board staff analysis; see, for example, Erceg and others (2014).

[33] The median SEP projection for core inflation three years out was only 1.8 percent when the FOMC announced its 2 percent objective in 2012. The FRB/US model simulations in Engen, Laubach, and Reifschneider (2015) and Chung and others (2019) suggest that policymakers would have needed to boost asset purchases by an extra couple trillion dollars to meet their inflation objective over the medium term.

Figure 6: Macroeconomic Performance of Japan, the Euro Area, and the United Kingdom



Note: The Bank of Japan implemented an inflation target of 2 percent in January 2013, replacing its explicit "positive range of 2 percent or lower" in place since February 2012. The European Central Bank's inflation target is "close to but below" 2 percent over the medium term, which we approximate with a black line at 1.85 percent. The headline inflation measure plotted is the consumer price index (CPI) for Japan and the harmonized index of consumer prices (HICP) for the euro area and the United Kingdom. The core inflation measure plotted is the CPI excluding fresh food and energy (with and without a staff adjustment for consumption tax changes) for Japan; the HICP excluding energy and unprocessed food for the euro area; and the HICP excluding food, energy, tobacco, and alcohol for the United Kingdom. Consensus Forecasts are for expected CPI percent change over previous year, 6 to 10 years ahead. The market-based long-run inflation expectations are the 5-year, 5-year-forward implied inflation rate from Bloomberg. Shaded bars indicate recessions based on the ECRI chronology for each economy. GDP is gross domestic product.

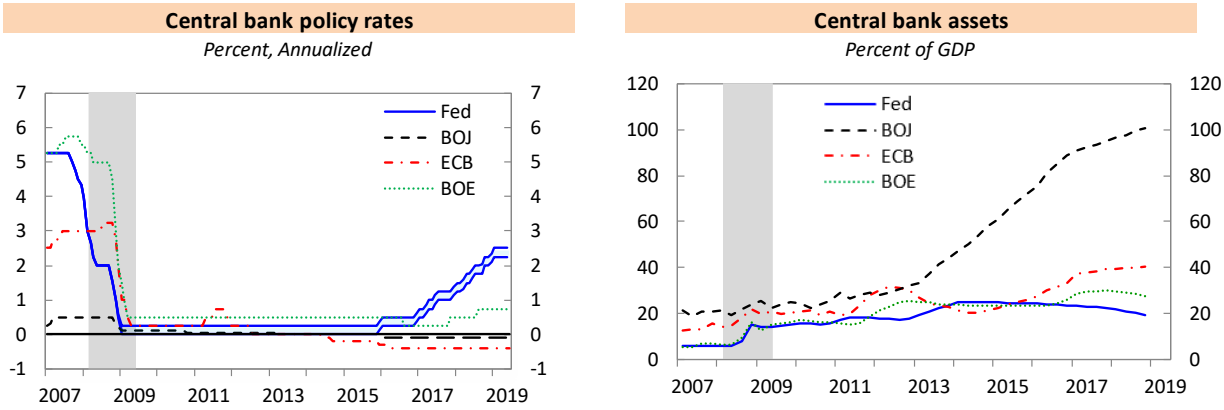
Source: Bloomberg; Consensus Economics; Economic Cycle Research Institute; Haver Analytics.

Unemployment rates have since fallen to near or below pre-GFC levels in these economies. Despite tightening labor markets, the ECB and, particularly, the BOJ have struggled to raise inflation to their targets on a sustained basis. In Japan, core inflation (excluding food and energy) has averaged only 0.7 percent since the adoption of an explicit inflation target in January 2013.[34] In the euro area, core inflation has averaged only 1.2 percent since May 2009—a level short of the ECB's mandate of maintaining inflation "below, but close to, 2 percent over the medium term."[35] Longer-run Japanese inflation expectations have been well below the target level and have even retraced the gains registered following the adoption of the inflation target. Euro-area survey-based measures of longer-run inflation expectations have been more consistent with the stated objective, but market-based inflation compensation has recently softened to about 1.2 percent. By contrast, in the United Kingdom, inflation has averaged about 2 percent since the GFC, and longer-run inflation expectations are near pre-GFC levels. In part, U.K. inflation was supported by temporary import price pressures from sterling depreciation.

The BOJ, BOE, and ECB took substantial policy steps to raise inflation to mandated levels and to support employment and economic activity.[36] Figure 7 illustrates that the ECB cut its policy rate from 3.25 to 1 percent in response to the GFC and to 0.25 percent in 2014 following the deepening of the European sovereign debt crisis. The BOJ entered the GFC with its policy rate very near its ELB. With policy rates near zero, these central banks deployed BSPs, FG, and other tools to provide additional policy accommodation.[37] The ECB expanded its balance sheet from about 13 percent of GDP in 2007 to 40 percent of GDP in 2018. The BOJ has boosted its balance sheet even more, from 21 percent of GDP in 2007 to 100 percent of GDP in 2018. Before the Brexit referendum in 2016, the BOE expanded its balance sheet in a similar proportion to the

[34] The BOJ set a "price stability goal in the medium to long term" of 1 percent in February 2012. In January 2013, the BOJ revised the objective to a "price stability target" of 2 percent.
[35] Although headline inflation exceeded the targets in those economies on occasion, that achievement typically reflected temporary factors; for example, the effects of the 2014 value-added tax, or VAT, hike in Japan and of global oil price rebounds in the euro area.
[36] Appendix B describes the current framework of the BOJ, ECB, and BOE, and appendix C summarizes their key policy actions and communications since the GFC.
[37] Some policy tools used by the ECB and BOJ—such as negative policy rates and yield curve control—are not part of the FOMC's current framework.

Figure 7: Policy Actions of Major Advanced Economies



Note: For the Federal Reserve (Fed), the policy rate displayed is the point target for the federal funds rate before December 2008 and the target range thereafter. For the Bank of Japan (BOJ), the policy rate displayed is the overnight call rate until March 2013 and the policy rate balance rate since February 2016. For the European Central Bank (ECB) and the Bank of England (BOE), the policy rates shown are the deposit rate and the bank rate, respectively. Central bank assets as a percent of gross domestic product (GDP) are calculated using quarterly balance sheet data from central banks and quarterly nominal GDP in local currency from national sources. Shaded bars indicate global recessions according to the chronology of Grossman, Mack, and Martinez-Garcia (2015).

Source: Haver Analytics; Grossman, Mack, and Martinez-Garcia (2015).

economy as the Federal Reserve. The additional asset purchases conducted in response to Brexit raised holdings to as much as 30 percent of GDP by 2017.

As with FOMC policy actions, market participants and academics generally agree that BSPs, FG, and other measures implemented by the BOJ, BOE, and ECB eased financial conditions, supported economic activity and inflation, and put downward pressure on currencies, although these effects are imprecisely estimated.[38]

What Are the Lessons from the European and Japanese Experience for the U.S. Monetary Policy Framework?

First, the struggles of the BOJ and ECB to achieve their mandates illustrate the difficulties in raising inflation once longer-run inflation expectations become entrenched

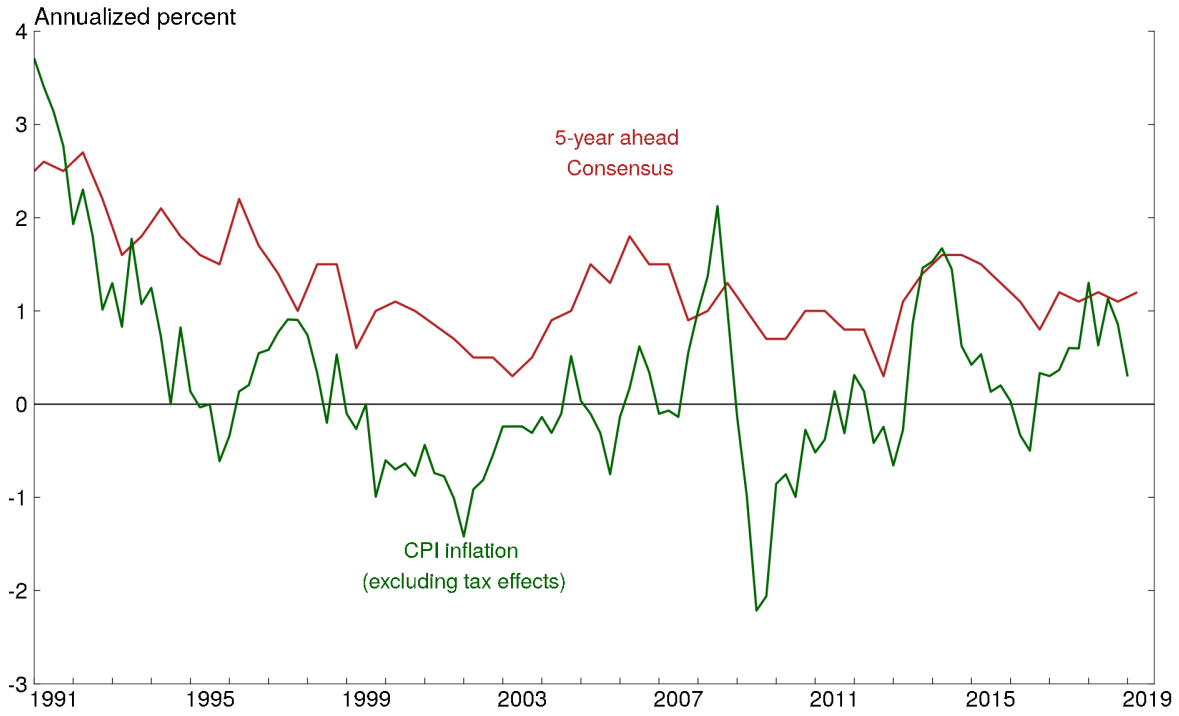
[38] For a review of financial and macroeconomic effects in the United States and abroad, see Andrade and others (2016); Lombardi, Siklos, and St. Amand (2018); Kuttner (2018); and Dell'Ariccia, Rabanal, and Sandri (2018) on the effect on yields and bank lending. On the international experience and spillovers, see Clarida (2019b), Martínez-García (2019), and the evidence in Haldane and others (2016), Chen and others (2016), and Martínez-García (2018).

at too low a level. Most notably, in Japan, inflation dropped from a 2 to 4 percent range in the early 1990s to essentially zero by 1995 and was then mildly negative in most years until 2012 (see figure 8). Low inflation realizations likely eroded the public's longer-run inflation expectations, reducing incentives to raise prices and wages and thus creating a vicious circle. The BOJ arguably allowed deflation to become entrenched by not acting promptly and forcefully enough, lowering its key policy rate to zero only in 1999 and initiating asset purchases in 2001—several years after the onset of deflation. The task of gauging the appropriate amount of monetary stimulus required was likely complicated by policymakers' slow recognition of a fall in r* and by impaired balance sheets in the banking sector that hindered the transmission of monetary policy.[39] BOJ communications and actions at the time also conveyed a lack of confidence in its tools and uneasiness with their deployment.[40] Some observers have argued that proximity to the ELB has created a situation in which low inflation and low GDP growth is self-fulfilling.[41] BOJ officials have further suggested that a rapidly aging population and a tendency of labor and management to prioritize employment stability over wage increases have contributed to the entrenched perception that wages and prices will not rise.[42] Appendix D further discusses monetary policy and low long-run inflation expectations in Japan.

Second, the foreign experience with BSPs suggests that the Federal Reserve could have expanded its balance sheet further without adversely affecting market functioning and still have positive financial and macroeconomic effects at the margin. The ECB, BOE, and, especially, BOJ increased their balance sheets uneventfully to higher shares of their GDPs than the FOMC did. That said, there is some evidence that, while positive, the marginal macroeconomic effects of BSPs abroad were smaller for more recent than

[39] See Carvalho and Ferrero (2013) on the BOJ's slow acknowledgment of the fall in r* and Correa and Davies (2008) on the monetary policy implications of Japanese banking-sector weaknesses.
[40] Japanese asset purchases during this period were probably unsuccessful partly because the BOJ purchased bonds of relatively short remaining maturity (McCauley and Ueda, 2009). The average maturity of the BOJ's portfolio actually declined from 2001 to 2005.
[41] See Krugman (1999); Benhabib, Schmitt-Grohe, and Uribe (2001); Eggertsson (2010); and Bullard (2010) for a discussion of self-fulfilling deflationary expectations and policy options in a liquidity trap (when policy rates are constrained at the ELB).
[42] See Shirakawa (2012) and Kuroda (2019).

Figure 8: Japanese Inflation and Survey-Based Longer-Term Inflation Expectations



Note: Consumer price index (CPI) inflation adjusted by staff to exclude effects of value-added tax hikes. Actual inflation shown in 4-quarter changes.
Source: Consensus Economics; Haver Analytics; staff calculations.

earlier programs.[43] Hence, setting aside complications regarding the subsequent reduction of balance sheets, scaling up BSPs seems to have limited adverse effects, even if they may also have limited efficacy.

Third, half-hearted commitments, or the perception that a central bank would tolerate persistent deviations from its objectives, can undermine the efficacy of both current and future policy actions. For example, the ECB's open-ended asset purchases since 2014 have been seen as more potent than its earlier long-term refinancing

[43] Hesse, Hofmann, and Weber (2018) revisit the macroeconomic and financial effects of the asset purchase programs launched by the Federal Reserve and the BOE from 2008 and suggest that the early programs "had significant positive macroeconomic effects, while those of the subsequent ones were weaker and in part not significantly different from zero." See also Joyce and Tong (2012) and Churm and others (forthcoming).

operations (LTROs), perhaps because open-ended purchases and the associated large balance sheet expansion convey a clearer commitment to maintaining accommodative conditions for an extended period.[44] President Draghi's "whatever it takes" remarks in 2012 immediately and persistently calmed financial markets because they conveyed a credible commitment—even though these policies were not detailed. As previously noted, the BOJ's timid use of FG and BSPs in the 1990s and 2000s may have undermined the credibility of the policies deployed since 2013 in support of the 2 percent inflation target.

Finally, limited space to cut policy rates abroad, along with the challenges of deploying untested tools, likely left foreign economies more exposed to the GFC and created negative spillovers for the United States. For instance, the BOJ entered the GFC with its policy rate barely above its ELB, which may have exacerbated its slump and called for greater reliance on BSPs and other tools. Figure 9 illustrates the possible spillovers by showing simulated paths of U.S. macro variables in a GFC-like scenario in which the ELB constrains both U.S. and AFE policy rates (labeled "baseline") and a counterfactual scenario that relaxes the ELB in AFEs.[45] Our simulations suggest that the ELB constraint on AFE policy rates depressed U.S. real GDP as much as 0.6 percent, lowered U.S. core inflation as much as 0.15 percentage point, and delayed U.S. liftoff from the ELB by one quarter.[46]

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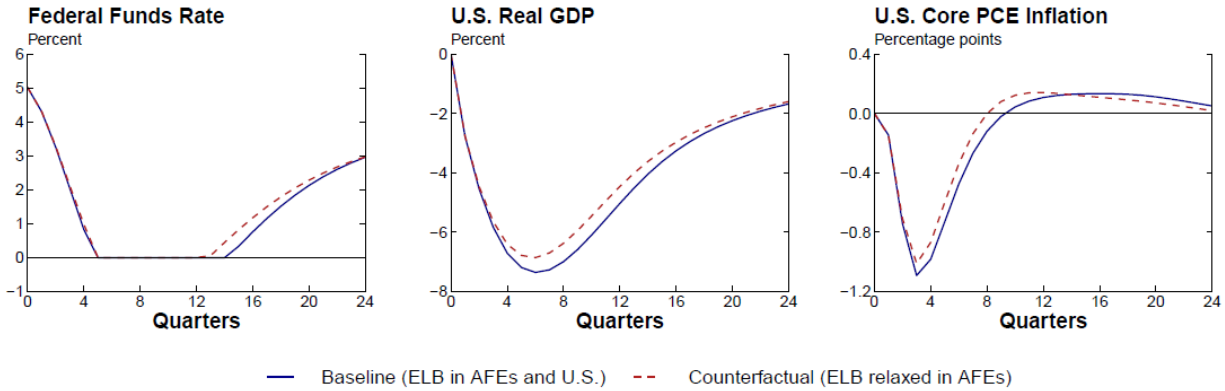
[44] See Andrade and others (2016), Doehr and Martínez-García (2015), and Weale and Wieladek (2016) for a related discussion of the macroeconomic effects of news and announcements about asset purchase programs in the United States and the United Kingdom.

[45] We use a three-country version of SIGMA, a DSGE model maintained by Board staff. In this simulation, AFE policymakers cut their policy rate 350 basis points at the recession's onset.

[46] In the current low interest rate environment, the ELB would bind faster in the AFEs for a given recessionary shock than in our scenario, leading to larger downturns abroad and greater negative spillovers for the U.S. economy, unless AFE central banks provide accommodation through other tools.

Figure 9: Implications of the Effective Lower Bound Abroad for U.S. Economic Performance in a Global Recession Scenario



Note: We constructed the recession scenario in the SIGMA model using a sequence of shocks to aggregate demand, financial conditions, and the exchange rate to match key features of the data during the Global Financial Crisis (GFC). In particular, we match selected targets that describe the experience of advanced foreign economies (AFEs) and the United States during the GFC. We assume that the simulation starts with the federal funds rate at 5 percent and the policy rate in AFEs at 3.5 percent. U.S. real gross domestic product (GDP) and core inflation are shown in deviations from their steady-state values. To calibrate the size and timing of the shocks, we used the following targets: a trough in real GDP and core inflation in AFEs and the United States in line with the experience of the GFC; a 15 percent appreciation of the real broad dollar; a 320 basis point increase in corporate spreads in AFEs and on the sequence of shocks. We then compute the path of the variables that would have been observed had the effective lower bound (ELB) not constrained the short rate in AFEs. PCE is personal consumption expenditures.

Source: Authors' calculations.

Conclusion

The FOMC has operated in a challenging environment from the GFC through 2019. The financial crisis produced a sharp rise in unemployment, and inflation has persistently fallen short of 2 percent. Structural transformations that could not be quickly recognized likely weakened the transmission channels of monetary policy and revealed the labor market gap to be larger than previously thought. With the ELB constraining the federal funds rate, the FOMC employed novel tools, BSPs and FG, to further provide much-needed accommodation. These tools effectively facilitated the return to full employment and helped mitigate the ELB, though inflation has run somewhat below 2 percent. With the benefit of hindsight, even bolder use of these tools to achieve mandated goals seems feasible in the future and might have been helpful in the past. However, the experiences of the BOJ and ECB suggest that more forceful deployment of these tools might still fail to return longer-run inflation expectations to target once they have slipped. Instead, these international episodes point to the importance of prompt

action with clear and sustained commitment. An important unresolved question is whether the FOMC can achieve its symmetric inflation objective in a low r* environment under the existing framework that precludes a commitment to inflation overshooting.

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Appendix A. Description of Counterfactual Policy Rate Simulations

This appendix describes how we compute the counterfactual historical policy rates and outcomes shown in figure 5 under the assumption that policymakers strictly followed the prescriptions of either the Taylor (1993) rule, the balanced-approach rule, or an inertial version of the balanced-approach rule. The following table describes the rules.

Simple Rules

Taylor (1993) rule	$R_t = r_t^{LR} + \pi_t + 0.5(\pi_t - \pi^{LR}) - ugap_t$
Balanced-approach rule	$R_t = r_t^{LR} + \pi_t + 0.5(\pi_t - \pi^{LR}) - 2ugap_t$
Inertial balanced-approach rule	$R_t = 0.85R_{t-1} + 0.15(r_t^{LR} + \pi_t + 0.5(\pi_t - \pi^{LR}) - 2ugap_t)$

Consistent with the annual Statement on Longer-Run Goals and Monetary Policy Strategy, we set the inflation goal (π^{LR}) to 2 percent. As intercept of the rules (r_t^{LR}), we use the median SEP projection for the real federal funds rate in the longer run. For the unemployment gap ($ugap_t$), we use the percentage point deviation of the unemployment rate from the median longer-run estimate in the SEP.

We perform the simulations using an approach broadly similar to that described by Kashkari (2017). For all simulations, we use the data and model equations in the public release of the FRB/US model that are consistent with the March 2019 SEP. We assume that agents form VAR-based expectations so that they do not anticipate events such as the aggravation of the European sovereign debt crisis. For each simple rule, we begin by calculating the equation residuals of the model such that it perfectly replicates the historical data. Next, we iteratively calculate the model's counterfactual solution under each rule, zeroing out the residuals in the monetary policy rule equation. This procedure ensures that monetary policy strictly follows the assumed policy rule, while all other shocks in the model are held constant. It also means that the effects of the Federal Reserve's BSPs and FG are subsumed in the equation residuals and thus held constant across all simulations.

Appendix B. Description of Mandates and Strategies of the Bank of Japan, European Central Bank, and Bank of England

This appendix describes the current monetary policy frameworks of the BOJ, ECB, and BOE. Unlike the Federal Reserve, these central banks' mandates define price stability as the primary objective. However, like the Federal Reserve, these central banks have pursued flexible inflation-targeting strategies in practice (Bernanke, 2003). Moreover, in responding to the GFC and other shocks, these central banks have also used BSPs and FG (as well as a number of other tools that we will describe). Appendix C provides a chronology of these central banks' policy actions since the GFC.

BOJ: In 1997, the Japanese government significantly increased the BOJ's independence and established its price-stability objective, which the BOJ defined as a situation in which inflation rates do not affect economic decisions. In February 2012, the BOJ clarified that its price-stability goal meant aiming for annual inflation "within a positive range of 2 percent or lower" and set a goal of "1 percent for the time being." In January 2013, the Japanese government and BOJ jointly announced the current 2 percent consumer price index (CPI) inflation target.

In the 1990s, the BOJ fought low inflation through low policy rates. In April 1999, it introduced its zero interest rate policy (ZIRP), along with supporting FG, and, in 2001, launched its first quantitative easing (QE) program, purchasing short-term securities; these measures continued until 2006. Following the GFC, the BOJ launched a comprehensive monetary easing (CME) strategy in 2010 that included FG and a loan support program. The BOJ redoubled its antideflationary efforts in early 2013 with the adoption of its 2 percent inflation target and the announcement of a package of stimulative measures called quantitative and qualitative monetary easing (QQME). This package included large-scale, open-ended purchases of Japanese government bonds (JGBs), exchange-traded funds, and Japanese real estate investment trusts. These purchases have expanded the BOJ's balance sheet to a much larger extent than its previous BSPs. In 2016, the BOJ expanded its QQME strategy further, introduced negative interest rate policies (NIRPs), and soon after added yield curve control (YCC). Under YCC, the BOJ explicitly targets both short- and long-term interest rates, setting the

overnight deposit rate at negative 0.1 percent and conducting asset purchases to target a yield on 10-year JGBs at "around zero percent." In April 2019, the BOJ said that it intends to leave both short- and long-term policy rates at current levels "until at least the spring of 2020."

ECB: The Treaty on the Functioning of the European Union establishes price stability as the primary objective of Eurosystem monetary policy. It also provides that the ECB should avoid excessive fluctuations in employment and output as it pursues price stability. In 1998, the ECB's Governing Council defined price stability "as a year-on-year increase in the Harmonized Index of Consumer Prices for the euro area of below 2%." In 2003, the Governing Council clarified that it seeks to maintain "inflation rates below, but close to, 2% over the medium term."

In response to the GFC, the ECB lowered the rate on its main refinancing operations to a bit above 0 percent (figure 7), conducted LTROs of three- and six-month maturities, and eventually complemented these measures with a covered bond purchase program (CBPP1) in 2009 and a securities market program (SMP) in 2010. The resulting expansion of the ECB's balance sheet was more modest than that of the Federal Reserve and BOE at the time. As economic conditions improved, the ECB raised its policy rate in 2011 while keeping BSPs in place, but it then reversed course before the end of the year with the onset of the European sovereign debt crisis. The crisis led the ECB to deploy further accommodative measures. The ECB lengthened the maturity of its LTROs up to three years and launched a new round of covered bond purchases (CBPP2) in November 2011. President Draghi's "whatever it takes" remarks in July 2012, which had a calming effect on financial markets, foreshadowed the introduction of qualitative FG and further BSPs—notably the replacement of SMP with the outright monetary transactions program in September 2012. Despite these measures, the ECB's balance sheet expansion was temporary in nature—particularly LTROs—and shrank by 2014 to its 2009–11 levels as banks made early repayments and financial conditions started to ease.

By mid-2014, the ECB's third phase started to reverse course and to again expand its balance sheet—the ECB introduced targeted LTROs (TLTRO I) in June 2014, launched a new round of its corporate bond purchase program (CBPP3) in October 2014,

and added its asset-backed securities purchase program in September 2014 and its public-sector purchase program in January 2015. In June 2014, the ECB introduced negative interest rates, and, since 2016, the deposit rate has been at negative 0.4 percent. The ECB further strengthened its BSP actions later on with another round of TLTRO (TLTRO II) in March 2016, the introduction of its corporate-sector purchase program in June 2016, and an emergency liquidity assistance facility in June 2017. An additional round of TLTROs (TLTRO-III) was announced in June 2019. As of mid-2019, the size of the ECB's balance sheet stood at around 40 percent of euro-area GDP, a footprint about twice as large as the Federal Reserve (see figure 7).

BOE: The BOE seeks to achieve CPI inflation at the annual rate of 2 percent. In response to the GFC, the BOE cut its main policy rate from 5.75 percent to an ELB of 0.5 percent. In March 2009, it embarked on the first of three LSAP phases. Its purchases totaled £200 billion and comprised mostly gilts, along with residual amounts of commercial paper and corporate bonds to support private debt issuance. In response to the European sovereign debt crisis, the BOE launched a second phase of LSAPs in October 2011, introduced a Funding for Lending Scheme in 2012, and used threshold-based FG. In August 2016, following the Brexit referendum, the BOE cut its policy rate to 0.25 percent, announced a third phase of asset purchases, and enhanced its liquidity provision.

Appendix C. Summary of Policy Actions and Communications in Selected Major Advanced Economies at the Effective Lower Bound

Balance sheet policies	Federal Reserve	Bank of Japan (BOJ)	European Central Bank (ECB)	Bank of England (BOE)
	Large-Scale Asset Purchase (LSAP) Program *LSAP1:* November 2008 to March 2010 *LSAP2:* November 2010 to June 2011 *LSAP3:* September 2012 to October 2014 *Maturity Extension Program (MEP)* September 2011 to June 2012	*Comprehensive Monetary Easing (CME)*[2] October 2010 to March 2013 *Quantitative and Qualitative Monetary Easing (QQME)* *(JGB Purchases)* April 2013 to present *QQME (ETF and JREIT Purchases)* April 2013 to present	*Longer-Term Refinancing Operations (LTRO)* 3 months: Starting in August 2007 6 months: March 2008 to May 2010 12 months: June 2009 to October 2011 *Covered Bond Purchase Program (CBPP1)* July 2009 to June 2010 *Securities Markets Program (SMP)* May 2010 to September 2012[5] *Covered Bond Purchase Program (CBPP2)* November 2011 to October 2012 *Longer-Term Refinancing Operations (LTRO)* 3 years: In December 2011 and March 2012 *Outright Monetary Transactions Program (OMTP)* September 2012 to present[5] *Targeted Longer-Term Refinancing Operations (TLTRO)* TLTRO I: June 2014 to present *Asset Backed Securities Purchase Program (ABSPP)* September 2014 to December 2018[6] *Covered Bond Purchase Program (CBPP3)* October 2014 to December 2018[6] *Public Sector Purchase Programme (PSPP)* January 2015 to present *Corporate Sector Purchase Program (CSPP)* June 2016 to December 2018[6] *Targeted Longer-Term Refinancing Operations (TLTRO)* TLTRO II: March 2016 to present TLTRO III: To be launched in September 2019	*Asset Purchase Facility (APF) – Gilt (BQE1)* January 2009 to February 2010 *Asset Purchase Facility (APF) – Commercial Paper* March 2009 to November 2011 *APF – Secured Commercial Paper & Corporate Bond Secondary Market Scheme* March 2009 to August 2016 *APF – Gilt (BQE2)* October 2011 to October 2012 *APF – Gilt (BQE3)* August 2016 to present *APF – Corporate Bond Purchase Scheme* September 2016 to April 2017

Forward guidance	Federal Reserve	Bank of Japan (BOJ)	European Central Bank (ECB)	Bank of England (BOE)
Qualitative	December 2008 to July 2011[1]		July 2013 to present[5]	Early 2015 to present[7]
Calendar	August 2011 to November 2012[2]		October 2014 to early 2015[5]	
Threshold	December 2012 to February 2014	*With Quantitative Easing (QE)* March 2001 to March 2006 *With Comprehensive Monetary Easing (CME)* October 2010 to March 2013 *With Quantitative and Qualitative Monetary Easing (QQME) with Price Stability Target of 2 Percent*[3] April 2013 to present	Early 2015 to present[5]	August 2013 to early 2015[7]

Negative interest rates	Federal Reserve	Bank of Japan (BOJ)	European Central Bank (ECB)	Bank of England (BOE)
Short rates			*Negative Deposit Facility Rate* June 2014 to present	
		QQME with Negative Interest Rate Policy (NIRP) January 2016 to August 2016		
Short and long rates		*QQME with Yield Curve Control (YCC)*[4] September 2016 to present		

Note: Facilities whose primary purpose was the provision of liquidity (and incentives to loan) for the banking system as well as U.S. dollar liquidity swaps between the Federal Reserve and a number of central banks (including the BOJ, ECB, and BOE) were also deployed during the Global Financial Crisis (GFC) to help ease financial conditions but are not included in this summary of policy tools employed to facilitate monetary accommodation while at the effective lower bound.

[1] The Federal Reserve used qualitative forward guidance (FG) before the GFC during the "deflation scare" episode (August 2003 to December 2005).

[2] The Federal Reserve's communication practices evolved significantly with the introduction, in January 2012, of an explicit inflation target of 2 percent on headline PCE (personal consumption expenditures) inflation and of a depiction of the Committee's assumptions for the federal funds rate (informally known as the "dot plot") in the Summary of Economic Projections.

[3] Another policy tool considered by the BOJ is raising the inflation target—Japanese policymakers did this while implementing QQME with a 2 percent Price Stability Target (up from a midpoint of 1 percent earlier) in April 2013.

[4] The BOJ introduced YCC to enhance its QQME with Negative Interest Rate Policy (NIRP) program.

[5] President Draghi's "whatever it takes" remarks on July 26, 2012, preceded the formal implementation of FG and the deployment of the Outright Monetary Transactions Program (OMTP). The ECB's SMP was discontinued at the same time as the OMTP was introduced, which would then allow purchases ("outright transactions") in secondary, sovereign bond markets, under certain conditions, of bonds issued by euro-area member states.

[6] The ECB stopped net purchases in January 2019 but continues to reinvest the principal payments from maturing securities held in the ABSPP, CBPP3, and CSPP portfolios.

[7] The BOE committed not to raise rates until the unemployment rate fell to 7 percent, which happened sooner than expected. It then revamped its FG strategy in February 2014, promising to focus on 18 measures of spare capacity instead, but stopped mentioning threshold-based FG in its quarterly economic updates by early 2015. The BOE has continued to use qualitative FG to signal the path of interest rates but only incidentally.

Source: Board of Governors of the Federal Reserve System; Bank of Japan; Bank of England; European Central Bank.

Appendix D. Monetary Policy's Contribution to the Decline of Longer-Run Inflation Expectations in Japan

The BOJ's difficulties in raising expected inflation have prompted the question of how expected inflation became entrenched at such a low level. Our review of the Japanese experience suggests that unsuccessful efforts by the BOJ partly contributed to inflation expectations becoming stuck at low levels. We briefly summarize our view of these efforts before describing them in more detail.

Summary

The BOJ's insufficiently strong response to deflation in the 1990s and 2000s contributed to a firm entrenchment of low inflation expectations. Although inflation had dropped near zero by 1995, the BOJ waited until 1999 to announce a commitment to a ZIRP strategy, adding in BSPs in 2001. Between August 2000 and March 2001, the BOJ reversed its ZIRP, even though mild deflation continued. In 2006, citing "steady improvement in economic activity and prices," the BOJ raised its policy rate modestly above its ELB. Headline inflation had turned back slightly positive but, with core inflation still running below zero, the increase in overall prices proved short lived. These early and arguably modest BSP and FG actions had little sustained effects on inflation, perhaps partially because of reversals and design of the BSPs. The BOJ then did little about deflation from 2006 to 2013, when it enacted a series of new policies and commitments to raise the inflation rate to 2 percent. However, after averaging a meager negative 0.1 percent inflation between 1995 and 2012, the BOJ is now finding it very difficult to raise inflation to its 2 percent target.

History

After the popping of the Japanese asset price bubble in the late 1980s, inflation in Japan dropped from the 2 to 4 percent range in the early 1990s to essentially zero in 1995, and it remained near or below that level until late 2013. Forecasts of Japanese inflation followed actual inflation down in the 1990s and tended to systematically overstate price increases (see figure 8). In response, the BOJ repeatedly lowered its policy rate in the 1990s. In February 1999, the BOJ reduced the policy rate to 0 percent.

In April 1999, the BOJ promised to continue a ZIRP until deflation was ended (Kuroda, 2014). By this time, though, the BOJ had already let zero inflation become entrenched for several years.

The BOJ's promise to continue ZIRP tested the central bank's commitment when, in August 2000, the BOJ raised the policy rate to 25 basis points only to retract this step in March 2001 (Bernanke, Reinhart, and Sack, 2004). After continued years of subzero inflation, the BOJ also opted to introduce QE in March 2001 and effectively reinstated ZIRP by renewing its promise to keep the interest rate low until CPI inflation was projected to be in positive territory.

The financial and macro effects of QE were limited from 1999 to 2006, with continued subzero readings of inflation. As a share of GDP, the BOJ's assets peaked at 30 percent in 2005, up from 14 percent in 1999. Moreover, Japanese asset purchases during this period were probably unsuccessful partly because the BOJ purchased bonds of relatively short remaining maturity (McCauley and Ueda, 2009). The maturity of the BOJ's portfolio actually declined from 2001 to 2005. Thus, the BOJ's purchases did not alter the characteristics of the public's portfolio. It purchased essentially zero-interest short-term securities for a similar asset, money.

After almost five years of QE, on March 9, 2006, the BOJ cited upward movement in the CPI in deciding to revert to using the overnight interest rate as its main monetary policy tool. In reverting to use of the overnight rate, the BOJ may have removed accommodation prematurely; headline inflation did not exceed 1 percent on a 12-month basis, and core inflation remained in negative territory. Longer-run inflation forecasts, though, remained less than 1 percent but in positive territory, as seen in figure 8.

The BOJ's policy actions to dispel deflation before the GFC may have eroded the credibility of its attempts to boost inflation, reinforcing the private agent's belief that expected inflation would remain low. In addition, the resulting lack of policy space likely aggravated the adverse effects of the GFC, and Japan experienced deflation and a very slow recovery (figure 6).

Policy actions by the BOJ during the GFC were timid. The BOJ launched its CME strategy that included FG and a loan support program for the provision of liquidity to the banking system in 2010. The BOJ's response continued to be cautious and lagged behind that of other major advanced economies' central banks during the recovery from the GFC. The BOJ's assets grew very little during this period; the BOJ largely sterilized its lending and banking support actions, unlike the other three major central banks (figure 7).

In February 2012, the BOJ moved to clarify that its price-stability goal of achieving an inflation rate that would not affect economic conditions was aimed for more than positive inflation, setting an annual inflation goal of 1 percent "within a positive range of 2 percent or lower." Following the electoral victory of Prime Minister Shinzo Abe on December 26, 2012, the BOJ and the Japanese government jointly announced new stimulative measures, including large and open-ended asset purchases, a doubling of the inflation target to 2 percent, and new loan support programs (see appendix C).

The BOJ's QQME actions in 2013 intended to drastically change market expectations and raise inflation toward its 2 percent inflation target over the medium term. These efforts were not completely successful, as inflation has averaged only 0.9 percent since 2013. With likely diminished credibility due to its earlier unsuccessful efforts and a long history of low inflation, the BOJ continued its BSPs and by 2016 introduced NIRP and YCC (figure 7). Although a consumption tax increase temporarily boosted inflation and longer-run inflation forecasts firmed up, measures of inflation and forecasts have not consistently exceeded 1 percent for the past three years and have even retraced some of their early gains.