

## 18-19 QE: A User's Guide

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In recent years several major central banks have conducted large-scale purchases of long-term bonds and other financial assets to stimulate economic growth, boost employment, and raise inflation towards its targeted level. These policies have come to be known as quantitative easing (QE). Central banks turned to QE when they believed that further reductions in their conventional short-term policy interest rates were either not possible or not helpful. With interest rates expected to remain at historically low levels around the world, it is likely that central banks will have to turn to QE again the next time a recession strikes.

Even though QE has assumed a prominent role as a policy instrument for central banks, the implementation of QE has differed significantly both across countries and over time. This variation is perhaps not surprising for a policy instrument that was novel. However, despite the prominent role played by QE over this period, surprisingly little discussion exists among policymakers or academic researchers on what type of approach for QE is the most appropriate.

This Policy Brief aims to fill in that gap. It draws on the literature measuring the effects of QE as well as the historical experience in implementing QE to lay out a simple strategy for how to use QE. It makes a proposal that arguably tran-

sitions most effectively from the interest rate adjustment process that central banks have employed with their primary policy instrument and shares many of the desirable properties of traditional monetary policy.

In particular, this Brief proposes that central banks should characterize QE in terms of the stock of long-term asset holdings and should announce purchases of assets in discrete increments that are designed to deliver macroeconomic stimulus equivalent to the policy rate cut that they would otherwise desire to implement. For the United States and some other countries, research suggests that a purchase of long-term bonds equivalent to 1.5 percent of GDP has a stimulative effect roughly equal to a cut in the policy rate of 0.25 percentage point. The vast majority of policy moves historically have been around 0.25 and 0.50 percentage point, and hence the typical size of asset purchase announcements under this rule would be either 1.5 or 3.0 percent of GDP.

Moreover, central banks should convey that these adjustments will be made under a policy approach that responds routinely to economic developments and displays considerable inertia, as has typically been the case with the conventional policy interest rate. As a result, market participants could expect an announcement of asset purchases in the recommended range to be followed by additional policy steps, with those additional steps depending critically on how the economy evolves.

This proposal is more consistent with the traditional policy framework of central banks than is the case for most QE programs that have been implemented, as those programs have tended to either (1) announce a much larger amount of purchases all at once or (2) announce a much smaller amount of purchases that continue indefinitely on a monthly flow basis. The analysis here compares these approaches and discusses their relative merits.

### REVIEW OF QE IN THE UNITED STATES

The Federal Reserve used QE as a way to achieve more accommodative financial conditions over the period during and after the global financial crisis that began in 2008. QE can reduce bond yields both because it may signal that the policy interest rate is likely to remain near zero for a long time and because it reduces the supply of longer-term bonds for private investors. The latter effect, known as the portfolio

balance effect, operates by reducing the aggregate amount of duration risk held by private investors, which in turn should push down the term premium in bond yields.<sup>1</sup> The analysis in this paper focuses on how to structure asset purchases assuming that the portfolio balance channel is the primary manner in which asset purchases affect the economy.<sup>2</sup>

The Federal Reserve implemented QE through four separate programs over the period from late 2008 until 2014. As described next, there were significant differences across the QE programs.

### QE1

The Federal Reserve Board first announced large-scale purchases of longer-term assets in November 2008 and indicated its intention to buy \$600 billion of agency bonds and agency mortgage-backed securities (MBS). At their next meeting in December 2008, the Federal Open Market Committee (FOMC) released a statement that took the federal funds rate target down to its effective lower bound of 0 to 0.25 percent.<sup>3</sup> In March 2009, the Fed expanded the asset purchase program to “up to” \$1.75 trillion, including purchases of \$1.25 trillion of MBS, \$200 billion of agency debt, and \$300 billion of Treasuries. Total QE1 purchases were equivalent to 12 percent of GDP.<sup>4</sup>

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1. Duration risk refers to the uncertain fluctuations in a security's value that are created by changing market rates of discount applied on future coupon and principal payments. A security's duration is the average waiting time until future coupons and principal are paid weighted by the amounts of each future payment.

2. Because the QE proposal in this paper (detailed in the next section) retains the considerable inertia already inherent in conventional policy approaches, a decision to purchase long-term assets likely would be followed by additional purchases and would signal that the policy interest rate is likely to remain near zero for a long time. The signal from QE about future policy rates under this proposal would therefore be similar to the signal in a conventional reduction of the policy rate.

3. The FOMC includes all members of the Federal Reserve Board plus 5 of the 12 presidents of the regional Federal Reserve Banks on a rotating basis. All 12 presidents participate in FOMC meetings, though only 5 are voting members at any time. The FOMC normally decides on open market operations and the federal funds rate target, whereas the Federal Reserve Board determines the interest rates paid on bank reserves and charged on Fed loans to banks. The Board's November 2008 decision to buy agency-related securities technically impinged on the prerogative of the FOMC, but it received retroactive approval from the FOMC. Subsequent asset purchases were decided by the FOMC. The term “Fed” is used here loosely to refer to the Board, the FOMC, and the Reserve Banks.

4. QE purchases are expressed as a percent of the annual GDP in the year they were announced. For QE1, the \$600 billion in November is divided by 2008 GDP, the additional

The initial announcement in November was aimed in large part at addressing stresses in the US mortgage market and at improving market functioning. However, the extension of the program in March was clearly aimed at providing monetary stimulus to the economy.<sup>5</sup> At the March 2009 meeting, Fed staff presented economic model simulations showing that the optimal path of monetary policy, if unconstrained by the zero bound, would have taken the federal funds rate to around -6 percent. By announcing the \$1.75 trillion asset purchase program, now commonly referred to as QE1, the Fed intended to replicate the effects of a significant reduction in the federal funds rate.<sup>6</sup>

Notably, this policy decision was made as if it were a one-time policy action, in that the entirety of the program was announced in March 2009, even though it was expected to take until December 2009 to complete all of the purchases.<sup>7</sup> This approach of announcing the full extent of the program upfront is remarkable, given the amount of stimulus that the FOMC was trying to provide and the uncertainty about the effects of asset purchases.<sup>8</sup> Indeed, based on the staff analysis just mentioned, these actions were much larger than any other single policy step taken throughout the crisis.

### QE2

With the benefit of hindsight, it is now clear that QE1 was not sufficient to generate a robust economic recovery. Indeed, employment and GDP growth over the subsequent years would repeatedly turn out softer than expected, leading

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\$1,150 billion in March is divided by 2009 GDP, and the total is the sum of these two percentages.

5. From the beginning, the Fed stressed the effects of its purchases on the asset prices in the markets in which it made purchases and the spillover effects to related markets. It did not stress the liability side of its balance sheet and the effects on various monetary aggregates, as it generally believed that those effects were unimportant.

6. The staff Bluebook prepared for the March 2009 meeting suggested that \$1 trillion of additional purchases of longer-term Treasury and MBS (implying total purchases of \$1.6 trillion, close to the amounts implemented in QE1) might move the employment and inflation paths roughly one-third of the way toward the optimal path associated with a federal funds rate of -6 percent (Board of Governors of the Federal Reserve System, Bluebook, March 17-18, 2009, <https://www.federalreserve.gov/monetarypolicy/fomchistorical2009.htm>). Later studies led to some downward revision of the estimated effects, suggesting that QE1 may have been equivalent to cutting the federal funds rate by 1 percent (Engen, Laubach, and Reifschneider 2015).

7. Later in 2009, the pace of purchases was slowed gradually so that the program ended in March 2010.

8. In light of the uncertainties involved, the FOMC left open the possibility of curtailing the program before reaching the stated maximum purchases.

the FOMC to implement a series of additional asset purchase programs.

In November 2010, the Fed announced the first of those additional steps, which involved purchases of \$600 billion of long-term Treasury securities, to be completed by June 2011.

## The Federal Reserve used QE as a way to achieve more accommodative financial conditions over the period during and after the global financial crisis that began in 2008.

At 4 percent of GDP, this program was obviously smaller than the first asset purchase program. One important aspect of QE2 was that it made clear that the FOMC would use asset purchases in an ongoing manner to achieve macroeconomic objectives.<sup>9</sup>

### Maturity Extension Program

The third program implemented by the Fed was the Maturity Extension Program (MEP), which was announced in September 2011. Under this program, the Fed initially decided to purchase \$400 billion in Treasury securities with maturities greater than six years and sell an equal amount of securities with maturities less than three years, with implementation taking place over a period of nine months. In June 2012, the Fed extended the program through the end of 2012, which meant that the program ultimately removed \$667 billion of long-term securities from the market, equivalent to 4 percent of GDP.

The MEP was similar to the earlier QE programs in that its primary focus was on the net amount of duration risk removed from the market. However, it had the twist of accompanying asset purchases with sales of securities of equal par value. The Fed added this feature primarily to allay any concerns, whether within the FOMC or external, about a further expansion of the Fed's balance sheet, even though the sale of short-term securities was expected to have little impact. This feature created an unnecessary restriction that limited the scope of this program.

9. Many observers at that time still considered QE1 to have been aimed strictly at market functioning. For these observers, the initiation of QE2 was seen as a considerable shift in the behavior of the Fed, prompting a strong critical reaction from economists, politicians, and foreign policymakers—raising concerns about inflation, risky investments, and net capital outflows that never materialized. Of course, the view that QE1 was entirely focused on market functioning is incorrect, as indicated in the FOMC materials that have been released for that period.

### QE3

QE3 began even before the MEP was completed. In September 2012, the Fed decided to start purchases of MBS of \$40 billion per month with no set end date. In December 2012, the Fed decided to continue Treasury purchases at the MEP rate of \$45 billion per month indefinitely and to stop selling off shorter-term Treasury securities. Total monthly purchases were thus \$85 billion, or 0.5 percent of GDP. The program continued at that pace until December 2013, when the Fed decided to slow the pace of purchases to \$35 billion in MBS and \$40 billion in longer-term Treasuries per month. These purchase rates were then gradually reduced over subsequent months until they ceased in October 2014. In total, the Fed bought \$1.5 trillion of Treasury debt and MBS under QE3, or 9 percent of GDP.<sup>10</sup>

The notable difference between QE3 and earlier asset purchase programs was that it was a flow-based program. That is, it specified a monthly flow of purchases rather than an overall stock of purchases for the program. Prior to the launch of QE3, Fed staff prepared a memo with results from economic model simulations showing that the stock- and flow-based approaches have identical effects on the economy when they both culminate in equal volumes of asset purchases and financial markets correctly anticipate such equal purchases. This result reflects the fact that, in the Fed's model, QE operates through the expected stock of Fed asset holdings. The primary argument in favor of the flow-based approach is that it may make it easier to communicate about the Fed's policy reaction function—an issue discussed in the next section.

### A PROPOSED APPROACH FOR QE

The reason that central banks have turned to asset purchases has been that their primary policy instrument, the short-term interest rate, was constrained by the zero lower bound.<sup>11</sup> Given that asset purchases substituted for cuts in the policy rate, it would make sense for the policy rule governing asset purchases to be similar in nature to the policy rule that describes the policy rate. However, that has not been the case so far in the United States.

10. For QE3 and other flow-based programs, the monthly purchases within each year are summed up and divided by that year's GDP. Totals are arrived at by adding up the percentages of GDP over the life of the program.

11. In a few countries, short-term policy interest rates have been pushed slightly below zero, but it appears that the lower bound is not far below zero. When the European Central Bank (ECB) announced its QE program in January 2015, the accompanying statement said that "key ECB interest rates have reached their lower bound." At that time, the deposit facility rate was -0.4 percent, where it remains today. Switzerland has the lowest rate, at -0.75 percent.

To determine a policy rule that is “similar in nature” requires specifying the nature of QE effects and comparing them to the effects from the federal funds rate. Most researchers have settled on the stock theory of QE effects—that the effects on long-term interest rates and the economy are proportional to the stock of long-term bonds held by the central bank. In that regard, the size of the Fed’s long-term asset holdings may be viewed as analogous to the level of the federal funds rate.<sup>12</sup> Moreover, just as expectations of the federal funds rate affect financial conditions, it is generally assumed that the expected future asset holdings of the central bank drive financial conditions.

To be sure, no mapping between the central bank’s asset holdings and the use of its policy instrument is perfect. However, as noted above, even from the early days of QE1, the Fed staff calibrated the effects in this manner; the size of the QE1 program was set to replicate the effects of moving the federal funds rate to a substantially negative level. And that type of comparison was repeated in much of the staff analysis of QE programs over the subsequent years.

The research literature has extensively studied the effects of QE,<sup>13</sup> and the most plausible empirical estimates suggest that around \$300 billion of purchases (1.5 percent of GDP) should have an effect that is roughly equivalent to a 0.25 percentage point cut in the policy rate.<sup>14</sup> This mapping is

12. The balance sheet measure would ideally be based on the risk attributes of the assets held rather than the overall size of those holdings. For example, if removing aggregate duration risk is the primary channel through which QE operates, then it would make sense to use a measure such as “10-year equivalents,” which is the aggregate amount of duration risk expressed in terms of the amount of 10-year notes that are needed to replicate that risk. However, the focus on the overall size of long-term securities holdings is retained here for simplicity of communication. The term “long-term” is used to capture any assets with a meaningful amount of duration risk.

13. Gagnon (2016) reviews research on the effects of QE in the United States, United Kingdom, euro area, Japan, and Sweden. Gagnon (2018) refutes the claim that QE works only during times of market stress.

14. Fed staff estimate that \$1.5 trillion of asset purchases under QE3 reduced the 10-year term premium 0.60 percentage point in late 2013 (Engen, Laubach, and Reifschneider 2015). Comparing the economic effects of such a program with those of a cut in the federal funds rate depends on many factors, including assumptions about the monetary policy rule in the future, how markets form expectations concerning future policy, and how one weighs different implications for output and inflation. Roughly speaking, a 0.60 percentage point reduction in the 10-year yield would be equivalent to a cut in the federal funds rate of 1 to 2 percent (Laforte and Roberts 2014). Kiley (2014) raises some theoretical reasons that empirical models may overestimate the macroeconomic effects of yield changes driven by the term premium as opposed to the expected path of future short rates, but the magnitude of this discrepancy is uncertain. Bernanke

based on the composition of assets purchased in QE3, which had a somewhat longer duration than the composition of QE1 and QE2. It is also based on an assumption that market participants expect the assets will be retained on the Fed’s balance sheet for many years. If assets are expected to be sold or allowed to run off relatively quickly, QE’s potency is correspondingly reduced. Keeping these points in mind, this mapping is used here as a rough guide.

For the federal funds rate, the FOMC is generally seen as following an inertial policy rule that determines the intended level of the policy rate, typically moving in steps of 0.25 percentage point. If the mapping discussed above is applied to this policy rule, it suggests a particular approach for how the Fed should adjust the balance sheet, which is the basis of the proposal in this Brief.

Specifically, QE should be implemented through an approach that focuses on the stock of long-term asset holdings, adjusts that stock of holdings in increments of \$300 billion (1.5 percent of GDP), and demonstrates considerable inertia—so that market participants would likely expect the Fed to follow an increase in asset holdings with additional adjustments in the same direction.<sup>15</sup>

This approach most closely replicates the manner in which the FOMC sets its primary policy instrument, providing many of the same benefits offered by that approach. It is operationally feasible as \$300 billion of QE could be purchased in three months or less (within the span of two FOMC meetings, which is the frequency at which the FOMC has been acting recently) with little difficulty.<sup>16</sup> Moreover, as

(2017) refers to “the conventional rule of thumb” that a 0.10 percentage point reduction in the 10-year yield is equivalent to a 0.25 percentage point cut in the federal funds rate, which is consistent with the midpoint of the range in Laforte and Roberts. Thus, each \$100 billion in purchases would be equivalent to a cut of 0.10 percentage point. However, GDP in 2018 is roughly 20 percent larger than GDP in 2013, suggesting a somewhat larger amount of purchases would be needed to achieve the same results as five years ago. The analysis here follows previous studies in scaling by GDP, but other normalizations are possible, such as scaling by the size of the bond market.

15. Others have explored the benefits of applying policy rules to asset purchases. Kiley (2018), for example, showed that rules for long-term asset purchases based on the state of the economy can be helpful in alleviating excess unemployment and low inflation caused by the lower bound on the policy interest rate. In addition, the Fed staff studied a policy rule approach in an October 2011 memo and found that it performs well in response to various shocks (Dave Reifschneider, John Roberts, and Jae Sim, “Incremental Balance Sheet Policies,” October 24, 2011, Board of Governors of the Federal Reserve System, <https://www.federalreserve.gov/monetarypolicy/files/FOMC20111024memo01.pdf>).

16. In a speech in March 2013, the head of the Markets Group at the New York Fed, Simon Potter, made the following observation about the \$85 billion per month pace of purchases:

the economic effects of purchases largely begin with their announcement rather than their implementation, a temporary backlog of purchases underway is not a serious problem.

When it is time to tighten monetary policy after the start of QE purchases, there are grounds to support the current Fed practice of first starting to raise the federal funds rate above its lower bound and allowing asset holdings to run off gradually only after the funds rate is significantly above zero. The Fed always retains the option of outright sales of QE assets, but

### **Given that asset purchases substituted for cuts in the policy rate, it would make sense for the policy rule governing asset purchases to be similar in nature to the policy rule that describes the policy rate.**

in most circumstances tightening by the federal funds rate is likely to be preferred. The primary reason is that there is no constraint on raising the federal funds rate, and policymakers would prefer to rely on the traditional instrument if possible, given their greater familiarity with it. Another important reason for allowing only gradual run-off of QE assets is to maintain a precedent that such assets remain on the balance sheet for a long time after purchase. This precedent helps to boost the potency of QE to the extent that market participants respond not only to the current supply of longer-term assets but also to the expected future supply.

#### **Comparison to large, one-time programs**

This proposed policy approach for QE would have the Fed move in smaller steps than QE1, QE2, or the MEP under most circumstances. For example, the expansion of QE1 from \$600 billion to \$1.75 trillion in March 2009 was the equivalent of a 1.25 percentage point cut in the federal funds

rate—an unusually large policy step to be announced at a single point in time.<sup>17</sup>

This observation brings us to the key point. As noted above, QE1 was calibrated as if it were a one-time opportunity to expand the balance sheet. The program was not calibrated as if QE were an instrument to be regularly updated and sized under a policy rule with inertia. Under that type of rule, even if the FOMC felt that it would ultimately want to do the equivalent of 1.25 percentage points of easing, it would typically implement that move in a sequence of smaller policy steps in the same direction, allowing it to observe the economy on the way and make adjustments as needed. If the FOMC knows that it will be assessing QE holdings regularly, then it should determine the optimal size of its policy actions, keeping that in mind and allowing for future continuations of policy steps as needed.<sup>18</sup>

By adjusting QE holdings in more conventionally sized steps and making regular policy decisions at every meeting, the Fed would provide the markets with a considerable amount of information about its reaction function. The market could assess the monetary policy rule in the same way that it does for movements in the federal funds rate, seeing how those decisions are affected by changing economic conditions. To further boost the market's understanding of its policy approach, the FOMC should include projections of the Fed's long-term asset holdings alongside projections of the federal funds rate in its quarterly summary of economic projections.<sup>19</sup>

Comments on whether a large, one-time QE announcement is appropriate have been sparse. In a paper focused on changes to the Fed's inflation target to reduce the macroeconomic constraints imposed by the lower bound on interest rates, former Fed chair Ben Bernanke (2017) made the following observation on the future use of QE: "Moreover, because some significant part of its power comes through signaling effects, QE is also a difficult tool to use in a con-

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"So far, there seems to be little evidence that the current pace of purchases is straining the market's ability to deliver securities to us" (Simon Potter, "The Implementation of Current Asset Purchases," remarks at the Forecasters Club of New York, New York City, Federal Reserve Bank of New York, March 27, 2013, <https://www.newyorkfed.org/news-events/speeches/2013/pot130327>). A memo by Fed staff in October 2011 estimated that monthly purchases of longer-term Treasury securities and MBS as high as \$140 billion per month, on top of purchases needed to replace securities running off, might be possible without significant adverse effects on market functioning (Reifschneider, Roberts, and Sim, "Incremental Balance Sheet Policies"). Even faster paces could be contemplated if the Fed decided that macroeconomic considerations outweighed concerns about market functioning.

17. Here the mapping is adjusted to be consistent with the lower level of GDP in 2009 and rounded to the nearest 0.25 percentage point. As discussed above, the average duration of QE1 purchases was lower than that of QE3, so that this move may have been equivalent to a 1 percentage point cut. On the other hand, the Fed staff's initial estimates suggested the move would be equivalent to a 2 percentage point cut.

18. It is important to note that large policy moves would still be possible under the approach in this paper, should the FOMC believe that economic circumstances warranted the equivalent of a very large rate cut. However, federal funds rate moves of 1 percentage point or more have happened only three times in the past 30 years.

19. This proposal is consistent with the recommendation of Ángel Ubide (2017) to adopt QE as a conventional part of monetary policy and to incorporate it into regular policy communications.

tinuous, gradated manner. I expect that QE will be used only occasionally in the future, during more severe downturns, and then typically in large discrete chunks.”

The signaling effects of implementing QE1 as a large, one-time program may have been particularly important because it represented a dramatic change in the Fed’s policy instrument and served as an aggressive response to substantial

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stress in the financial markets and the economy. However, in most circumstances a policy approach such as the one suggested here will be more appropriate, in that it will be as powerful but will also provide the benefits of the inertial policy approach that central banks use for their traditional policy instrument.

### **Comparison to flow-based programs**

The Fed in some ways swung to the other extreme when it shifted to a flow-based program for QE3. The FOMC decided to move in policy increments that were smaller than most central banks would ever consider for their primary policy instrument. Under the mapping described above, the Fed’s QE3 program involved the equivalent of easing the policy rate by 0.07 percentage point per month. In this regard, an even stranger decision was the degree of tapering at the end of QE3, as the Fed decided that it had to gradually slow that pace of easing by a minuscule 0.008 percentage point per month.

Why would a central bank operate in such trivial steps? The Fed staff argued prior to the launch of QE3 that doing so might improve the public’s understanding of the Fed’s reaction function.<sup>20</sup> However, it is not clear whether implementing such an unusual policy reaction function, one that differs so much from the manner in which the target federal funds rate has typically been set, improves the public’s understanding.

20. See Jean-Philippe Laforte, David López-Salido, Steve Meyer, Ed Nelson, and John Roberts, “Flow-Based Balance Sheet Policies: Communication Issues and Macroeconomic Effects,” memo, Board of Governors of the Federal Reserve System, August 28, 2012 (<https://www.federalreserve.gov/monetarypolicy/files/FOMC20120828memo02.pdf>).

The staff’s argument rested on the importance of articulating the stopping rule for purchases under a flow-based approach. But that is just one dimension through which the central bank affects the ultimate size of asset purchases. Indeed, other central banks have ratcheted up and down their pace of purchases in flow-based programs, highlighting that the flow-based approach does not reduce the reaction function to a single decision point. Any information on the expected end of purchases, or other decisions affecting the ultimate size of purchases, could also be conveyed under a stock-based policy rule.

Another potential problem with a flow-based rule is that the FOMC and other central banks may not be fully comfortable making unlimited commitments with their balance sheets. Whenever a central bank specifies conditions for stopping purchases in a flow-based rule, it runs the risk that markets would expect it to continue accumulating assets indefinitely if those conditions are not met, regardless of the level of assets already achieved.

Traditionally, central banks have taken the position that there is an appropriate *degree* of policy accommodation for a given state of the economy, rather than an appropriate *direction* for policy actions. This point is illustrated by the fact that economists typically express the monetary policy rule in terms of the level of the policy interest rate, rather than its change. Indeed, if the effects on the economy are associated with the stock of holdings (in the same way that they are associated with the level of the policy rate), then there are strong arguments to specify the rule in terms of the stock of holdings.

In effect, the flow-based rule involves a shift from a “level rule” to a “difference rule,” in that the amount of purchases would continue under a given set of economic conditions regardless of the stock of assets accumulated. There may be more subtle arguments for moving to a difference rule in this context, such as uncertainty about the effects of the policy instrument or a desire to create overshooting. In particular, some studies find that policy rules based on the change in the policy instrument rather than its level may be more robust to uncertainty about how the economy truly operates (Orphanides and Williams 2002).<sup>21</sup> Although there may be greater uncertainty about the effect of long-term asset purchases on the economy than about the effect of the policy

21. Mathematically, an inertial level rule may be viewed as a compromise between a simple level rule and a difference rule: A simple level rule has a coefficient of 0 on the lagged policy rate, a difference rule has a coefficient of 1, and an inertial level rule has a coefficient between 0 and 1. If policymakers are continually revising their estimates of the parameters of the rule, as, for example, in the recent downshift of estimates of the equilibrium real interest rate, then the distinction between the two classes of rules is even less sharp.

interest rate, the difference is a matter of degree, not type, and is likely to narrow over time. Moreover, such concerns were not articulated by the Fed or other central banks in their moves to flow-based QE. As long as level-based rules are dominant for implementing interest rate policy, stock-based rules should be the norm for QE.

## QE PROGRAMS IN OTHER COUNTRIES

The above discussion notes that there has been meaningful variation in the form of QE implemented in the United States. There has also been variation in how QE was implemented across central banks, which is useful to review in the context of the proposal above.

In all QE programs to date, the main assets being purchased have been longer-term government and government-guaranteed bonds. In the United States, these are the only assets that were purchased, while in other countries central banks have made smaller purchases of corporate bonds, covered bonds, equities, and real estate investment trusts.<sup>22</sup> This paper does not attempt to assess the choice of assets to include in QE but instead focuses on the best method for implementing purchases of longer-term bonds that are intended to affect financial conditions through their impact on the supply of duration to the market.

### United Kingdom

In March 2009, the Bank of England (BOE) lowered its short-term policy rate, or Bank rate, to 0.50 percent and announced that it would purchase up to £75 billion (5 percent of GDP) in medium- and long-term bonds, mainly Treasury bonds (gilts).<sup>23</sup> From the beginning, the BOE stated that “the scale and timing of purchases would be reviewed at each MPC [monetary policy committee] meeting.” However, the minutes of the meeting suggested members tended to center on £75 billion as the ultimate size of the program. At the time, the BOE had negotiated an agreement with the UK Treasury for an asset purchase facility with a maximum potential scale of £150 billion, so that £75 billion was at the time not seen as an incremental step in a much larger program.

22. Covered bonds are packages of mortgages guaranteed by the issuing bank. Bayoumi and Gagnon (2018) discuss the effects of central bank purchases of equities in the context of the Asian financial crisis of 1997–98.

23. The minutes stressed that purchases were a way to ease monetary conditions by increasing central bank reserves (BOE, “Minutes of the Monetary Policy Committee Meeting held on 4 and 5 March 2009,” March 18, 2009, <https://www.bankofengland.co.uk/minutes/2009/monetary-policy-committee-march-2009>). Over time, the BOE moved toward the Fed’s view that the asset side of its balance sheet is more meaningful than the liability side in transmitting monetary conditions.

Nevertheless, in May 2009 the amount to be purchased was increased by £50 billion (3 percent of GDP) even before the initial purchases were completed. The minutes noted that some committee members wanted an even larger increase and that the governor would request an increase in the maximum size of the facility if needed. From that point on, it was clear that total holdings of long-term bonds would be subject to regular review, and long-term asset holdings were increased in August 2009, November 2009, October 2011, February 2012, July 2012, and August 2016, reaching a total of £435 billion. The steps ranged in size from £25 billion to £75 billion (2 to 5 percent of GDP).

The approach of the BOE evolved into a form that is roughly in line with the proposal above. It always included the intended stock of its holdings in its policy statement, and it made frequent adjustments in a typical increment of £50 billion (3 percent of GDP), which would translate into 50 basis points under the mapping described earlier using GDP. The BOE never explicitly argued that its approach to QE was similar to its traditional policy framework, but it in effect delivered the most continuity.

The BOE is currently maintaining its QE holdings at £435 billion and has stated that it does not intend to start reducing these holdings until after the policy rate has reached “around 1.5 percent.”

### Euro Area

The European Central Bank (ECB) had asset purchase programs that were aimed at reducing market stress several years before the use of QE as a macroeconomic stabilization tool. In May 2009, the ECB announced that it would purchase €60 billion (1 percent of GDP) in long-term covered bonds. In May 2010, the ECB began discretionary purchases of sovereign bonds of member countries that were experiencing high yield spreads. It announced a second round of covered bond purchases in October 2011. The goal of these purchases was primarily to reduce yield spreads, restore orderly markets, and equalize credit conditions across the euro area. To a large extent, yield spreads reflected market concerns about the possibility that countries might leave the euro area and redenominate the assets into new currencies that would depreciate against the euro. The ECB was determined to counter the risk of a breakup of the euro area.

In September 2012, the ECB further refined its usage of asset purchases for these financial stability purposes. It announced it would consider unlimited purchases of sovereign debt of distressed member countries as needed to prevent a breakup of the euro, thereby ratifying ECB president Mario Draghi’s promise in July 2012 to do “whatever it takes.” This program, named Outright Monetary Transactions (OMT), clearly separated out asset purchases intended as a backstop

against financial turmoil from those that would later be implemented for achieving monetary policy stimulus. In the event, the ECB did not make any purchases under this program, as yield spreads narrowed and remained small.

The ECB first used QE to ease overall macroeconomic conditions in January 2015, when it announced that an expanded asset purchase program (APP) would begin in March, composed mainly of long-term government bonds. The APP was structured in a manner similar to the Fed's QE3, with a monthly purchase amount that could be adjusted up or down and that would persist until the ECB's inflation goal appeared to be secure. However, the program also had a large implied total volume, because the ECB said that purchases were "intended to be carried out until end-September 2016" or possibly longer. Initial purchases were €60 billion per month, which would have been equivalent to 10 percent of GDP over the 19 months to September 2016. Purchases were increased to €80 billion per month in April 2016 with guidance that they were expected to run for at least 12 more months (9 percent of GDP at an annual rate) and then were lowered back to €60 billion in April 2017. They were lowered further to €30 billion per month in January 2018 (3 percent of GDP at an annual rate). In June 2018, the ECB announced that purchases would be taken to zero by the end of 2018.

This program is somewhat of a hybrid between a large one-time purchase program and an open-ended flow-based program. It was specified in terms of the monthly pace of purchases. However, by giving guidance on the minimum length of the program, it was effectively moving in larger steps than implied by the monthly flows. Possibly the ECB chose to convey a large up-front total purchase because it felt behind the curve on its inflation goal by the time the program was launched. It may have chosen an adjustable monthly pace because of the perceived success of the Fed's QE3 program.

## Japan

The Bank of Japan (BOJ) was the first central bank to conduct large-scale asset purchases to ease monetary policy with interest rates at the zero bound. It started in 2000 and lasted until 2006. A second round began in December 2008. However, these programs were not QE as is currently understood, because they focused on government bonds with remaining maturity of about one year. Indeed, the average maturity of government bonds held by the BOJ actually fell between 2000 and 2006 (McCauley and Ueda 2009). The later program did include relatively small purchases of commercial paper and corporate bonds of about ¥2 trillion and ¥3 trillion, respectively, per year.

In April 2013, Haruhiko Kuroda became governor of the BOJ and launched the "quantitative and qualitative monetary easing" program, so named to distinguish it from the earlier "quantitative easing" program. Purchases would be ¥50 trillion per year (10 percent of GDP) of government bonds with an average maturity of seven years. In addition, the BOJ would purchase ¥1 trillion per year of equities and a modest amount of real estate assets. The program continued purchases of commercial paper and corporate bonds at their existing levels.

In October 2014, the BOJ announced an increased pace of purchases to ¥80 trillion per year (16 percent of GDP) of government bonds and ¥3 trillion of equities. The average maturity of the purchases was extended to a range of 7 to 10 years.

In many ways, the policy situation confronting the BOJ differed from that facing the other central banks considered here. Whereas the proposed policy approach is intended to allow the central bank to calibrate the degree of stimulus correctly to match recent changes in economic conditions, the BOJ was closer to a corner solution of trying to achieve as much stimulus as possible. In particular, it was trying to raise inflation to a new target of 2 percent after a long period in which there was no firm target and inflation had been below zero. It is therefore less productive to assess the form of the BOJ's asset purchases in the same context as the other central banks.

For related reasons, the BOJ in September 2016 moved to a form of asset purchases that had not been previously used by other central banks. The BOJ announced a new policy of "yield curve control," in which purchases would aim to keep the yield on the 10-year government bond around zero. The BOJ estimated that continued annual purchases of ¥80 trillion would be required under the new policy, but the emphasis was on the 10-year yield and not the amount to be purchased.<sup>24</sup> An evaluation of this approach is beyond the scope of this paper, and in any case cannot really be performed until the BOJ manages to exit from that regime.<sup>25</sup>

24. Equity purchases were increased to ¥6 trillion per year (1 percent of GDP), with a small increase in purchases of real estate assets and constant rates of purchase of commercial paper and corporate bonds.

25. The calibration of 1.5 percent of GDP in bond purchases as equivalent to a 0.25 percentage point reduction in the short-term interest rate may not apply when bond yields are near or below zero. Even before Japanese bond yields reached zero, studies suggested that QE purchases (normalized by GDP) had a smaller effect in Japan, perhaps because the Japanese bond market is larger (relative to GDP) than bond markets in other countries (Gagnon 2016).

**Table 1 Characteristics of QE programs**

Program	Stock/flow focus	Inertia in rule	Typical step size (percent of GDP)	Total size (percent of GDP)
United States				
QE1	Stock	No	4-8	12
QE2	Stock	No	4	4
MEP	Stock	No	2	4
QE3	Flow	Yes	0.5/month	9
United Kingdom	Stock	Yes	3	27
Euro area	Flow	Yes	0.6/month	23 (projected)
Japan	Flow	Yes	1.3/month	71 (to date)
Sweden	Stock	Yes	1	7
<b>Proposal</b>	<b>Stock</b>	<b>Yes</b>	<b>1.5-3</b>	<b>As needed</b>

QE = quantitative easing; MEP = Maturity Extension Program

Note: The euro area program is projected to end in December 2018. The Japanese program has no announced end date; the data are through August 2018. For stock programs, total size is scaled by GDP in the year of announcement. For flow programs, monthly purchases are scaled by annual GDP in the year they occur. Total sizes are the sums of these percentages. 2018 GDP is the IMF projection.

Sources: Central bank websites, *IMF World Economic Outlook* (April 2018), and authors' calculations.

## Sweden

In February 2015, the Riksbank lowered the repo rate to 0.10 percent and started a QE program with purchases of SEK10 billion (0.2 percent of GDP) of long-term government bonds. QE purchases were increased in 2015 by SEK30 billion in March, SEK50 billion in April, SEK45 billion in July, and SEK65 billion in October, bringing total planned holdings to SEK200 billion (5 percent of GDP). The repo rate continued to be lowered, reaching 0.50 percent in February 2016, where it remains.

QE holdings were increased by another 2 percent of GDP in three steps in April 2016, December 2016, and April 2017, with holdings reaching SEK290 billion. Redemptions are being fully reinvested but no further purchases are expected.<sup>26</sup> Interestingly, beginning in February 2018, the summary statements at the top of the minutes of the monetary policy meetings no longer mention the Riksbank's holdings of government bonds. The stance of monetary policy is now described solely in terms of the policy interest rate, and the debate in the policy committee is focused on when to start raising the policy rate.

This approach has some similarities to the proposal made here, in that the Riksbank made frequent adjustments to the size of its holdings. However, those increments were in steps that appear small relative to the benchmarks from

the proposal. Moreover, the Riksbank avoided making the explicit analogy between purchases and changes in the repo rate, and it downplayed asset holdings relative to the repo rate in describing its policy stance.

## Summary of the structures of QE programs

The different QE programs that have been implemented may be summarized with a few key parameters shown in table 1. As can be seen, the proposal in this Brief differs from most. The programs that have been focused on the stock of holdings have moved in relatively large increments as a share of GDP and have generally not conveyed inertia in the policy response. The programs that have focused on flow, while having inertia by design, typically focused on the monthly pace of purchases, which is a small step size as a share of GDP. The proposal here is intended to focus on the stock of holdings, to adjust that stock in reasonably-sized steps, and to convey inertia in QE policy decisions. The BOE's program in the United Kingdom is closest to this proposal.

## CONCLUSION

Ten years ago, the worst financial crisis since the Great Depression led central banks around the world to unleash a new type of monetary policy called quantitative easing. Given its novelty, it is not surprising that QE took on different forms across countries and over time. As central banks experimented with QE, they gained a better understanding of how it works and how to calibrate its macroeconomic effects. The time has come to take advantage of the lessons learned and to incorporate QE systematically into the monetary policy framework.

26. In December 2017, the Riksbank decided to make modest additional purchases in early 2018 in anticipation of a high volume of maturing bonds in late 2018 and early 2019. Holdings should return to target by late 2019.

Most central banks intend for QE to take over from the short-term policy interest rate when that rate reaches a level beyond which further cuts are either not possible or not helpful. Within that context, there are advantages for choosing a policy approach for QE that resembles the approach taken with the short-term interest rate.

Such an approach would have several key dimensions. First, asset purchases would focus on the stock of holdings of long-term assets rather than the monthly flow of purchases; second, long-term asset holdings would be changed in terms of reasonably-sized steps, calibrated to have effects comparable to typical (0.25 percentage point) changes in the traditional policy interest rate, which research suggests to be increments of 1.5 percent of GDP; and third, asset purchase decisions would be expected to have considerable inertia, so that a central bank wishing to make a large policy adjustment likely would implement it in several steps. The comparability in the policy rule between the conventional interest rate and QE purchases should make communicating policy intentions easier.

When it comes time to reverse course and tighten policy, the framework currently employed by the Federal Reserve works well: raise the conventional policy interest rate first until it is significantly above its lower bound, then allow a

gradual runoff of the QE assets. Outright sales of QE assets would not be ruled out, but the baseline case would require only the runoff of maturing and redeemed securities.

With interest rates expected to remain at historically low levels, central banks are likely to encounter the lower bound on conventional policy interest rates again in the next recession. Having a well-articulated plan for dealing with the lower bound is essential. Academics and former policymakers have spoken out on potential approaches that are exploratory in nature. For example, it may be desirable to raise inflation targets either permanently or temporarily (Ball et al. 2016, Kiley and Roberts 2017, Bernanke 2017) or to adopt nominal GDP targeting (Sumner 2012, Beckworth 2017, Frankel 2018).

Those are changes that, while worth discussing, have only a limited probability of being implemented by the next recession. In contrast, a return to QE is highly likely once the next economic downturn arrives. It is therefore surprising that determining the right approach for QE has received little attention relative to these other exploratory policy options. This paper is intended to encourage that discussion and specifically to present a proposal that will maximize the ability of central banks to achieve their economic goals in an environment of sustained low real interest rates.

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