

Economics

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Empirical and Thematic Perspectives

Escaping the Zero Lower Bound—Are Bulging Central Bank Balance Sheets a Good Substitute for Rate Cuts?

- This essay assesses the economic stimulus provided by the expansion of central bank balance sheets in recent years. Our key finding is that these policies have provided significant monetary accommodation, driving down long-term interest rates in the United States, the euro area, and the United Kingdom by roughly 100 basis points and providing an economic effect in each of these economies equivalent to several hundred basis points of policy rate cuts. For Japan, the estimated effects have been more modest, roughly one-quarter of the size elsewhere, but still significant.
- We find that on average across these countries, a generic 1 percent of GDP increase in the central bank's balance sheet reduces long-term interest rates by more than 6 basis points on average and generates an easing in financial conditions equivalent to a 23 basis point policy rate cut. But the effects of balance sheet expansion are more powerful if the increase is reflected in the monetary base, and most powerful if the increase is registered in bank reserves. On the asset side, we find that securities purchases have a more stimulative impact on long rates than a generic increase in central bank assets. Consistent with this observation, our work indicates that the Fed's Operation Twist has had significant effects on U.S. long-term interest rates.
- Adjusting for the effects of stimulus from balance sheet policies, we find that the monetary policy stances of the Federal Reserve, the European Central Bank, and the Bank of England correspond to nominal policy rates that are deeply into negative territory. We also find that the current settings of monetary policy (including the stimulus from balance sheet expansion) are now at—or below—the prescriptions of standard Taylor rules, which serve as a guidepost for the appropriateness of monetary policy. Our broad conclusion is that aggressive balance sheet policies have helped loosen the constraints of the zero lower bound on nominal interest rates.
- This conclusion, however, requires two qualifications. First, the setting of policy rates in Japan—even adjusting for the central bank's balance sheet expansion—remains far tighter than what a Taylor rule prescribes. Whether this reflects structural constraints on Japanese monetary policy, as the Bank of Japan (BoJ) has argued, or a reluctance by the BoJ to aggressively reflate the economy remains very much an open issue.
- Second, we recognize that bulging balance sheets could over time impose meaningful costs on the central bank and the economy. For example, such policies may be politically controversial and raise public concerns regarding the legitimacy of the central bank's actions; balance sheet policies may require the central bank to become enmeshed in the process of credit intermediation, which could bring a range of unintended consequences; and exiting toward a more normal-sized balance sheet is likely to be a challenging and uncertain process.

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See Appendix A-1 for Analyst Certification, Important Disclosures and non-US research analyst disclosures.

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Escaping the Zero Lower Bound—Are Bulging Central Bank Balance Sheets a Good Substitute for Rate Cuts?

In a previous essay, we examined the broad evolution of the balance sheets of major central banks since the eruption of the financial crisis in mid-2007.¹ We documented the remarkable growth of these balance sheets in recent years and also sketched out some challenges that central banks may face once the time (eventually) comes to exit from extraordinarily stimulative policies.

This essay complements our previous work by putting forward some empirical estimates of how much economic stimulus these bulging balance sheets have actually provided. Our key finding is that the effects of these policies has been substantial, driving down long-term interest rates in the United States, the euro area, and the United Kingdom by something on the order of 100 basis points and providing monetary accommodation in each of these economies equivalent to several hundred basis points of policy rate cuts. For Japan, the estimated effects have been more modest, roughly one-quarter of the size, but still significant.

As a conceptual matter, central bank balance sheet policies—depending on their exact structure and the features of the economic environment more generally—may stimulate the economy through a variety of channels. The following are three that we see as particularly significant:

- *Adding liquidity.* Balance sheet policies have the capacity to significantly increase the amount of liquidity in the economy. As we have seen with the ECB's recent three-year LTROs, the higher levels of liquidity may reduce funding risks facing financial institutions and, on the margin, incentivize banks to increase their holdings of other assets (such as government securities) and perhaps even boost the flow of credit to households and firms.
- *Removing duration.* The Federal Reserve has emphasized that its purchases of long-term risk-free securities take duration out of private hands. This in turn motivates investors to purchase other (potentially more risky) assets, thus driving down term and risk premiums and, equivalently, raising asset prices. The lower level of such premiums should encourage borrowing in the economy, while higher asset prices should stimulate spending through positive wealth effects.
- *Underscoring a commitment to stimulative policies.* An expanding central bank balance sheet, in our view almost regardless of the exact composition of the program, tends to be interpreted by market participants as a deepening commitment by the central bank to reducing the amount of slack in the system, fighting deflationary pressures, and keeping policy rates at low levels. To the extent that balance sheet policies are accompanied by an explicit communications strategy also committing to stimulative policies, this channel is likely to become even more powerful. In this sense, we see balance sheet and communications policies as strong complements, with each reinforcing the other.

With this brief background, the remainder of our essay is structured as follows. First, we compare the policy rates set by four major central banks—the Federal Reserve (Fed), the European Central Bank (ECB), the Bank of England (BoE), and the Bank of Japan (BoJ)—to the prescriptions from simple Taylor rules. Second, we document the evolution of the balance sheets of these central banks, looking at

¹ "Prospects for Central Bank Balance Sheets," *Global Economic Outlook and Strategy*, March 21, 2012.

both the overall size of the balance sheet and the behavior of several key balance sheet components, including the monetary base, bank reserves, and securities holdings. Finally, we estimate empirical relationships that enable us to map moves in central bank balance sheets into changes in long rates and equivalent moves in policy rates. This methodology allows us to directly compare the policies of these central banks and sheds important light on the extent to which the zero lower bound on nominal interest rates has constrained policy in recent years.

The Evolution of Conventional Monetary Policy: A Comparison to Taylor Rules

As a first step in this discussion, we calculate standard “Taylor rules” for the Fed, the ECB, the BoE, and the BoJ. The key question is—given the path of inflation and output in each of these economies—was the evolution of monetary policy more or less in line with conventional policy prescriptions? As shown in **Figure 1**, we compare the actual stance of policy against the stance prescribed by Taylor rules for the period 1999:Q1 to 2012:Q1, but we are particularly interested in the reaction of monetary policy once the financial crisis erupted in mid-2007.

More specifically, these Taylor rules reflect the following relationship:

$$\text{Policy rate}(t) = i^* + \gamma \cdot (\text{Inflation}(t) - \text{Inflation goal}) + \beta \cdot (\text{Output gap}(t))$$

Thus, the Taylor rule assumes that moves in the policy rate over time are determined by the performance of inflation relative to the central bank’s inflation goal (“the inflation gap”) and the size of the output gap. If inflation runs above the goal, the central bank tends to tighten. And as output falls below potential, pushing the output gap into negative territory, the central bank tends to ease policy. Finally, i^* can be interpreted as the policy rate that prevails when both the output gap and the inflation gaps have closed.

Following Taylor, we assume that the coefficient on the inflation gap (γ) equals 1.5. This means that the central bank moves its policy rate more than one-for-one with moves in inflation, or equivalently, that the central bank responds to a rise in inflation with an increase in both its nominal and real policy rates. We consider two versions of this rule: One with the coefficient on the output gap (β) equal to 0.5 and another that is more responsive to slack, with β equal to 1.0.² Finally, we set i^* equal to the average policy rate in each economy since 1999.³

The Taylor rules that we report focus on “core” inflation (i.e., headline inflation less food and energy) for each of these economies.⁴ We calculated rules that were driven by headline inflation and found them to imply implausibly large whipsaws in policy rates in recent years, given the wide swings in oil and other commodity prices that have occurred. We interpret this evidence as suggesting that central banks have generally looked through these lurches in commodity prices. In

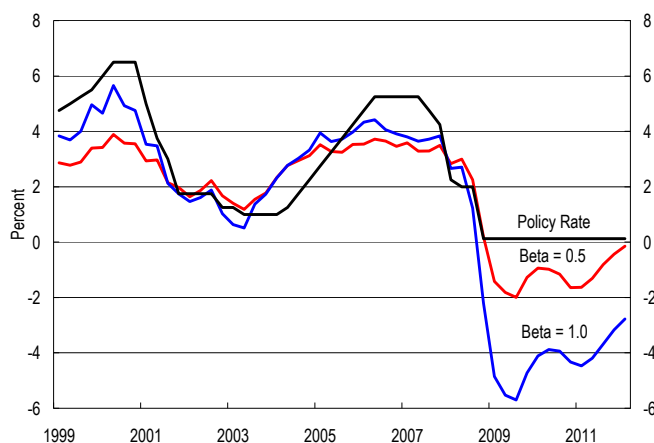
² These rules follow Taylor 1993 and 1999. (See “Discretion versus Policy Rules in Practice,” *Carnegie-Rochester Conference Series on Public Policy*, vol. 39, December 1993; and “A Historical Analysis of Monetary Policy Rules,” in *Monetary Policy Rules*, University of Chicago Press, 1999.)

³ This choice is admittedly imperfect but, we believe, balances two offsetting potential biases. On the one hand, as we show below, average core inflation since 1999 has been a little below the assumed target, and output has typically been somewhat below potential. This suggests that the average policy rate that has actually prevailed perhaps understates i^* . On the other hand, the zero-lower bound on nominal interest rates has constrained actual policy rates from responding fully on the downside to shifts in economic conditions. As such, the *desired* policy rate through the cycle has at times likely been well below the policy rate that has actually prevailed, and this suggests that the average rate that has prevailed may be biased upward relative to the desired rate.

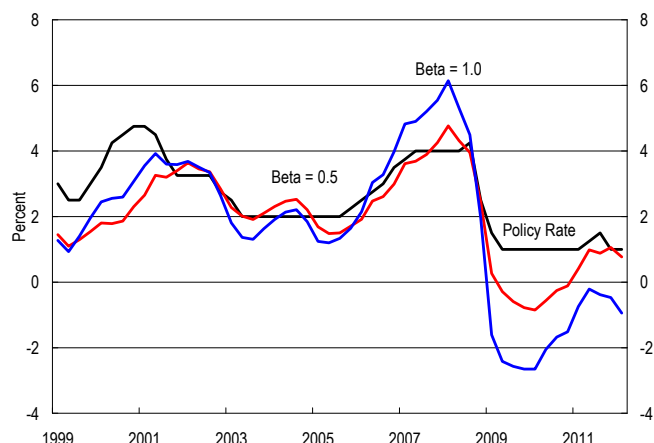
⁴ We use core PCE inflation for the United States (consistent with the spirit of the Fed’s recently announced inflation target and the expressed preference of Fed policymakers over the past decade), and core CPIs for the other three countries.

Figure 1. Taylor Rules*

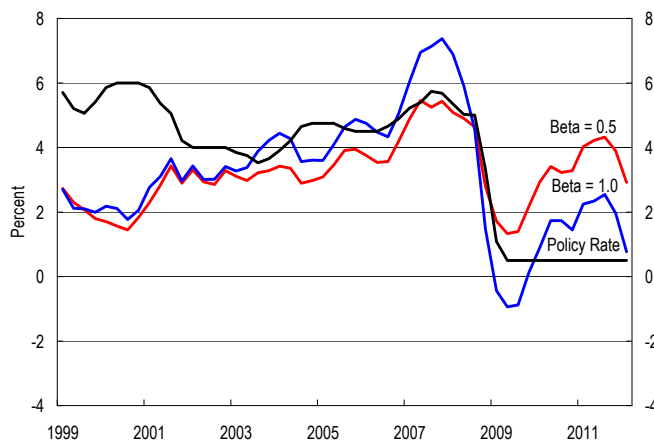
Federal Reserve



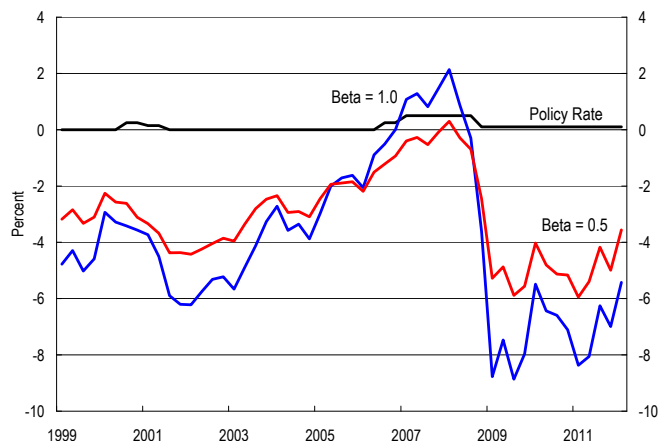
European Central Bank



Bank of England



Bank of Japan



*Beta is the coefficient on the output gap (i.e., the actual level of GDP relative to its estimated potential).

Sources: National Central Banks and Statistical Agencies, Haver Analytics, and Citi Investment Research and Analysis.

calculating the Taylor rules, we have assumed that the core inflation objectives for the Fed, the ECB, and the BoE are all equal to 2 percent, while the objective for the BoJ is 1 percent.⁵ Data on output gaps come from the CBO for the United States and from the OECD for the other three economies.

As a first step, **Table 1** compares the average observed inflation and interest rates for these economies over the 1999 to 2012:Q1 period. Inflation performance for the United States, the euro area, and the United Kingdom is remarkably similar, with core inflation running at roughly 1¼ percent over this period and headline inflation averaging between 2 and 2¼ percent.⁶ Similarly, the average setting of the policy rate for the Fed and the ECB has been essentially identical, while the average output gap for the United States has been somewhat larger. In contrast, the

⁵ These are now the explicit objectives for *headline* inflation in each of these economies, but strike us as a reasonable point of departure for examining the trajectory of policy over the past decade.

⁶ U.S. inflation as measured by the CPI has been somewhat higher than PCE inflation, with headline CPI inflation running at 2.5 percent on average and core CPI inflation at 2.0 percent.

Table 1. Average Central Bank Policy Rates: 1999:Q1-2012:Q1 (Percent)

	Average Policy Rate	Inflation Rate		Real Policy Rate		Output Gap
		Headline	Core	Headline	Core	
(1) Federal Reserve	2.6	2.2	1.8	0.4	0.8	-1.1
(2) European Central Bank	2.6	2.1	1.7	0.5	0.9	-0.4
(3) Bank of England	3.8	2.2	1.7	1.6	2.1	-0.1
(4) Bank of Japan	0.1	-0.3	-0.6	0.4	0.7	-1.7

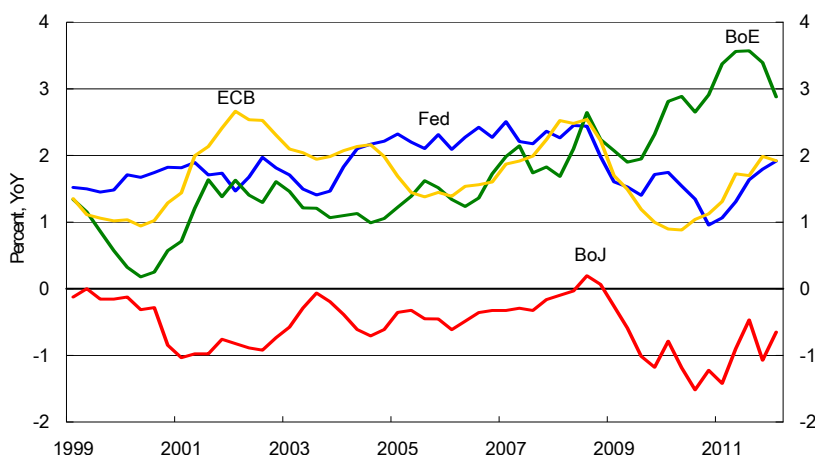
Sources: National Central Banks and Statistical Agencies, OECD, CBO, Haver Analytics, and Citi Investment Research and Analysis.

average setting of the policy rate in the United Kingdom has been more than a full percentage point higher than in the United States and the euro area.

Japan's economy has struggled through the entirety of this period, recording a sizable output gap and weak performance more generally. However, with BoJ policy rates trapped at the zero lower bound and ongoing deflation, real policy rates in Japan have remained positive, at levels similar to those recorded in the United States and the euro area.

We now turn to our Taylor rule estimates for these four economies. For the United States, the Taylor rules broadly tracked the contours of Federal Reserve policy until the Fed funds rate slammed into the zero lower bound in late 2008. Specifically, the peak in policy rates in 2000-01 and 2006-07 was somewhat above the Taylor rule prescriptions, and the timing of the tightening cycle in the middle of the decade seems just a bit delayed relative to the recommendations of the Taylor rule. However, none of these divergences strike us as a first order. Rather, the most important observation is that through the depths of the financial crisis, the zero-lower bound on nominal interest rates has significantly constrained the Fed's scope for conventional policy accommodation, with an observed gap of roughly 200 to 400 basis points (depending on the rule) between actual Federal Reserve policy and the recommendations from the Taylor rule. Notably, with the recent rise in U.S. inflation (**Figure 2**), the Taylor rules now see a somewhat less stimulative policy rate as being appropriate than was the case a year or two ago.

Figure 2. Core Inflation*



*Headline inflation excluding food and energy.

Sources: National Statistical Agencies, Haver Analytics, and Citi Investment Research and Analysis.

For the ECB, these Taylor rules prescribed a policy rate during the depths of the crisis that was roughly 100 to 300 basis points lower than the rate set by the ECB. That said, as with the United States, an upshift in actual inflation over the past year or so has closed much of this gap. Clearly, however, these simple rules do not account for the full set of considerations that shape central bank policies, including the euro area's mounting financial stability stresses and deteriorating growth prospects, which have prompted the ECB recently to double down on its unconventional stimulus efforts.

The Taylor rules for the Bank of England fit the trajectory of U.K. policy fairly well through much of the last decade, including broadly matching the timing and magnitude of the sharp cut in policy rates during 2008. That said, the persistently high level of U.K. inflation has subsequently kept the prescription of the Taylor rule in generally positive territory. In contrast, the BoE has fully looked through these price rises, committed to the view that the underlying weakness of the economy will eventually feed through into lower U.K. inflation. And the recent decline in inflation now seems to be vindicating this view.

Finally, the Taylor rules for Japan recommended a significantly negative policy rate during both the QEP period and during the global financial crisis. Only for the brief period from 2005 through 2007 was the Taylor rule recommendation anywhere in the neighborhood of positive territory. By these metrics, the Japanese economy remains deeply mired in a deflation trap, with conventional policy constrained by the zero lower bound.

Documenting the Expansion of Central Bank Balance Sheets

Of course, these assessments—which focus on the stance of conventional monetary policy—significantly understate the extent to which central banks have provided monetary stimulus. Once rates approached the zero lower bound, all four of these central banks significantly expanded their balance sheets as an additional instrument of policy. In **Figure 3**, we show four related measures of the balance sheet expansion that has occurred.

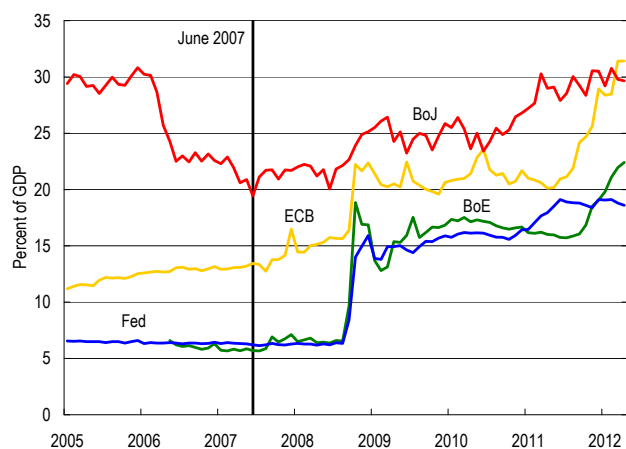
The first of these figures reports the total size of central bank balance sheets relative to GDP. All four of these central banks have recorded significant balance sheet growth since the financial crisis erupted. The Fed and the BoE saw most of the growth of their balance sheets in the year or so after the Lehman collapse. In contrast, more than half of the growth of the ECB's balance sheet has occurred over the past year, as the central bank has taken increasingly aggressive measures to fight the region's fiscal and financial crisis. The expansion of the BoJ's balance sheet has occurred more gradually over the past five years, with the balance sheet now returning to the levels seen during the QEP period.

But not all balance sheet growth is likely to be equally stimulative. The following is just one example: of the ECB's balance sheet expansion, roughly 3 percent of GDP corresponds to revaluation gains on gold, foreign exchange reserves, and other assets. Such items are unlikely to be as stimulative as 3 percent of GDP of additional LTROs or securities purchases.

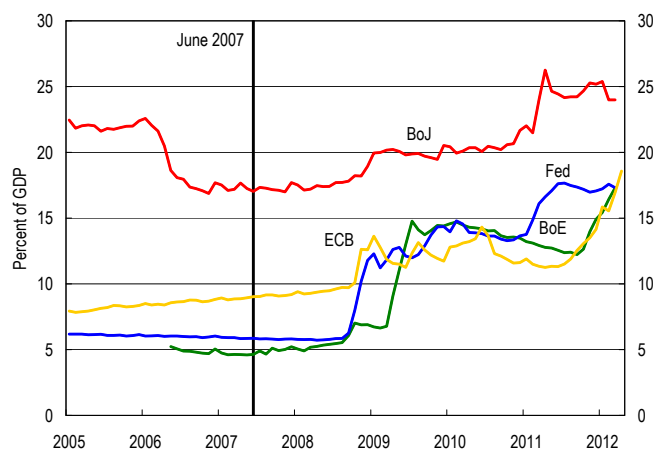
More generally, there are many dimensions along which the impact of central bank balance sheet policies may differ. For example, looking at the asset side of the balance sheet, the stimulative effects of balance sheet expansion may vary depending on whether the central bank purchases long-term securities, provides loans to liquidity-constrained firms, or buys other types of assets. On the liability side, the stimulus to the economy may differ depending on whether the counterpart to this balance sheet growth is an expansion of the monetary base or if the central

Figure 3. Central Bank Balance Sheets

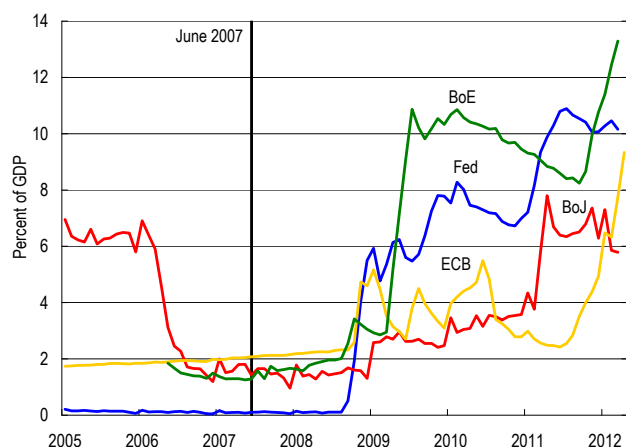
Total Assets



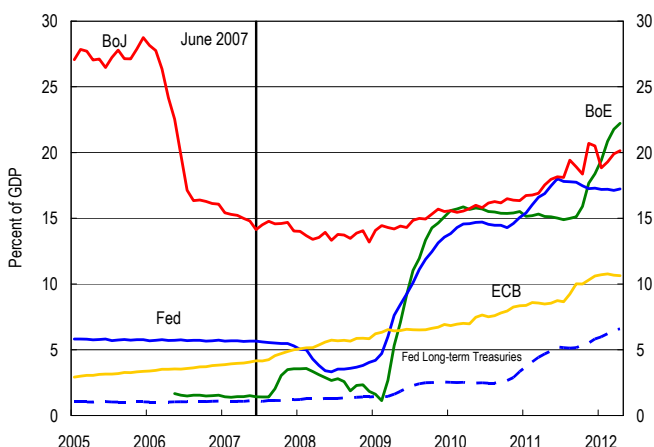
Monetary Base



Bank Reserves



Securities Holdings



Sources: National Central Banks and Statistical Agencies, Haver Analytics, and Citi Investment Research and Analysis.

bank instead drains the liquidity. Similarly, if the base is in fact allowed to grow, the stimulus may vary depending on whether the increase in the base reflects rising bank reserves or increased currency holdings.

All this said, we are hesitant to broadly assert that any particular type of balance sheet expansion is necessarily more stimulative than any other. For example, in some situations an expansion of bank reserves could be extremely stimulative, but in other instances—for example, when the system is already flush with reserves—the associated stimulus might be limited. Moreover, even if there are systematic differences in the stimulus associated with different configurations of balance sheet composition and expansion, we see the extent of these differences as being primarily an empirical issue. With this discussion in mind, the next several figures look at key components of central bank balance sheets, i.e., the monetary base, bank reserves, and securities holdings.

Each of these four central banks has seen a significant increase in its monetary base since mid-2007. For the Fed, the BoE, and the ECB, the base is now at roughly 17-18 percent of GDP and is somewhat higher, at around 25 percent of GDP, for the BoJ. As with the overall balance sheet, the trajectory of the monetary

base in each of these economies has differed notably. In the United States and the United Kingdom, the base moved up sharply during the six months or so after Lehman's collapse. Thereafter, the U.S. base bulged further during late 2010 and early 2011 during QE2, and the U.K. base has been on an upward trajectory in recent months as the BoE has restarted its asset-purchase program. The monetary base in the euro area increased more modestly on net through early 2011, but has since shot up as the ECB has intensified its crisis-fighting efforts. Japan's monetary base expanded slowly from the beginning of the financial crisis through early 2011, but then increased markedly last spring as the BoJ provided substantial liquidity in the aftermath of the earthquake and tsunami; these operations pushed the monetary base above the levels registered during QEP.

The next panel of **Figure 3** subtracts currency from the monetary base and, thus, focuses on bank reserves. Our view is that currency holding is a relatively slow moving variable, showing some reaction to shifting economic conditions but unlikely to move in a sharp or dramatic fashion. Rather, bank reserves have the greater potential to provide significant stimulus to economic activity and, in addition, may pose the greater risk at the time of exit. Here, the Fed and the BoE have been more aggressive than the ECB and the BoJ; indeed, bank reserves in the United States were hovering at \$10 billion when the crisis erupted, but have since surged to roughly \$1.5 to \$1.6 trillion. That said, the ECB has recently closed a large share of this gap with the bank reserves created through its sizable three-year LTROs.

The final panel looks at the evolution of securities holdings, an important component of the asset side of these balance sheets. Central bank securities purchase programs have in various instances focused on unclogging the monetary transmission mechanism, jump-starting market functioning, and removing long-term risk-free assets from private hands (in hopes of motivating portfolio rebalancing into other classes of assets). Clearly, asset purchases have been a more prominent feature of the crisis-fighting efforts of the Fed and the BoE, although the ECB and the BoJ have purchased meaningful quantities of assets as well. Given that the Federal Reserve has emphasized the view that its purchases of long-term risk-free securities provide meaningful stimulus to the economy, we also include on this graph the Fed's holdings of Treasuries with maturity greater than five years; such holdings have increased by 5½ percent of GDP since the onset of the financial crisis.

Quantifying the Effects of Central Banks' Balance Sheet Policies

Now, in an effort to measure the stimulus associated with the evolution of these balance sheets, we estimate a simple empirical relationship. Specifically, we posit that the level of the long-term interest rate (which we take as the 10-year government securities yield) is a function of the policy rate and the evolution of the central bank's balance sheet. Specifically, for each of the four economies, we estimate a relationship of the following form, using monthly data from January 1999 to March 2012:

$$\text{Long-term rate}(t) = \text{Constant} + a \cdot \text{Policy rate}(t) + b \cdot (\text{Balance sheet}/\text{GDP})(t)$$

For each economy, we consider four different measures of the size and composition of the balance sheet—total assets, monetary base, bank reserves, and securities holdings. For the Federal Reserve, we also separately consider a measure of long-term Treasury holdings (i.e., securities with longer than five-year remaining maturity), which aims to capture the effects of Operation Twist. Remarkably, by selling short-term Treasuries and buying long-term Treasuries, Twist leaves all four of the other measures of balance sheet size unchanged.

As one other important point, this specification takes a strong view that it is the *stock* of central bank assets and liabilities—and not the *flow* of new purchases—that has the most potent effect on long-term interest rates and, hence, on the economy. (We explicitly tested this hypothesis in preliminary work with the data, and the results for the corresponding flows were not statistically or economically significant.)

This regression framework allows us to address two kinds of questions: First, how have central bank balance sheet policies influenced long rates? The coefficient “b” gives us an answer to this question. This coefficient captures the direct effect on long-term interest rates of balance sheet expansion, holding the policy rate constant. Second, by comparing the respective effects on long rates, this framework also allows us to translate balance sheet growth into an equivalent amount of policy rate easing. Specifically, suppose a 100 basis point decrease in the policy rate lowers the long-term rate by 30 basis points, and a 1 percentage point increase in the balance sheet decreases the long rate by 7½ basis points, this implies that 1 percentage point of balance sheet is equivalent to 25 basis points of policy rate easing (in terms of its impact on the long rate). With these estimates in hand, we are able to assess how much policy rate easing central bank balance sheet expansion has actually delivered.

That said, a pivotal assumption in our analysis is that the reaction of long-term interest rates is a reliable gauge of the overall economic effects of monetary policy easing, whether that easing is achieved by conventional rate cuts or balance sheet expansion. To the extent that monetary policy influences the economy through channels that are independent of long-term interest rates, our estimation framework will miss important aspects of monetary policy transmission. With this in mind, our work could usefully be extended in a number of directions, including the possibility of considering other variables—such as equity prices or intermediate-maturity bond yields—as the dependent variable.

Table 2 provides a brief summary of our results for various types of balance sheet expansion. We find that on average across these countries a generic increase in the balance sheet does in fact have significantly stimulative effects on long rates and the economy, with a 1 percent of GDP expansion reducing long-term interest rates by more than 6 basis points on average and generating an easing in financial conditions equivalent to a 23 basis point cut in the policy rate. But the effects of balance sheet expansion are more powerful if the increase is reflected in the monetary base, and most powerful if the increase is allowed to pass through into bank reserves.

Table 2: Impact of Balance Sheet Expansion (Basis Points)

	Decline in Long Rates	Equivalent Cut in Policy Rate
<i>1% of GDP change in...</i>		
(1) Total Assets	6.2	23.4
(2) Monetary Base	8.3	27.1
(3) Bank Reserves	10.7	33.8
(4) Securities	6.8	21.7

Source: Citi Investment Research and Analysis

As for the asset side of the balance sheet, securities purchases have a more stimulative impact on long rates than does a generic increase in central bank assets, but the differing effects on the asset side do not seem to be as significant as those on the liability side. That said, as discussed below, we do find that the Fed's long-term Treasury purchases have had significant effects on U.S. interest rates.

We note one possible objection to our work is that we are capturing the correlation between central bank balance sheets on the one hand and movements in long-term interest rates on the other, but this correlation does not necessarily imply causation. It is possible that other factors have driven the decline in long rates. Even so, we see solid analytical reasons to believe that the expansion of central bank balance sheets has influenced the incentives facing commercial banks, investors, and other economic agents and has thus left an imprint on long-term interest rates. In addition, much of the previous empirical work on this topic has relied on "event study" methodologies, which focus on the response of financial markets over very short windows following the announcement of these programs. Our methodology examining the month-to-month co-movement between key balance sheet variables and interest rates over a longer horizon strikes us as a useful complement to this previous work.

Estimated effects on long-term interest rates. We now turn to the issue of how central bank balance sheet policies have influenced long-term interest rates. Our major results on this score are reported in **Figure 4**. For expositional simplicity, these panels show the average estimated effect on long rates across the four measures of central bank balance sheets that we have discussed—total assets, monetary base, bank reserves, and securities holdings.⁷

We find that the cumulated impact of Federal Reserve balance sheet policies on U.S. long-term interest rates amounts to roughly 100 basis point (excluding the effects of Operation Twist). Specifically, if various measures of the Fed's balance sheet had remained unchanged at their pre-crisis levels, U.S. 10-year Treasury yields would be at around 3 percent at present, rather than at 2 percent. Our work suggests that the impact of balance sheet policies on U.S. long-rates has gone through three distinct phases: first, a period of stimulus during the second half of 2008, as the Fed significantly eased liquidity conditions; second, a gradual further increase in stimulus during the period of QE1 from late 2008 through early 2010; and third, another ramping up of stimulus during late 2010 and early 2011 as QE2 came on line.

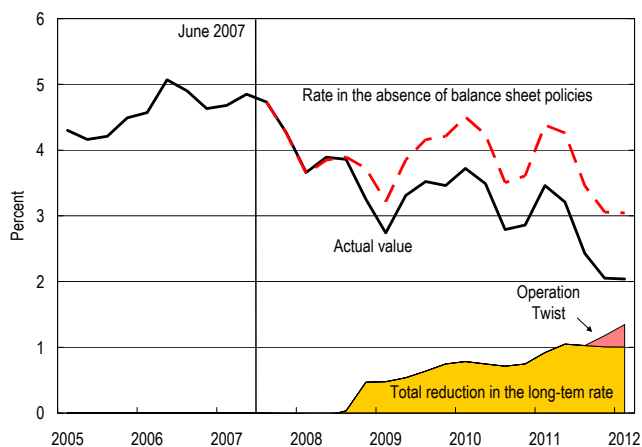
An additional measure of balance sheet growth, which focuses on the Fed's holdings of long-term Treasuries, suggests that Operation Twist may have reduced U.S. long-term interest rates by a further 35 basis points. Taken together, these estimates suggest that the total effect on long rates of the Fed's balance sheet policies may be on the order of 135 basis points.

These assessments for the United States are subject to an important qualification, however. The Fed has often coupled its balance sheet announcements with strong forward guidance regarding the future path of monetary policy. Since we have not controlled for such announcements explicitly, it is possible that our estimates also capture, at least to some extent, the effects of the Fed's communications efforts.

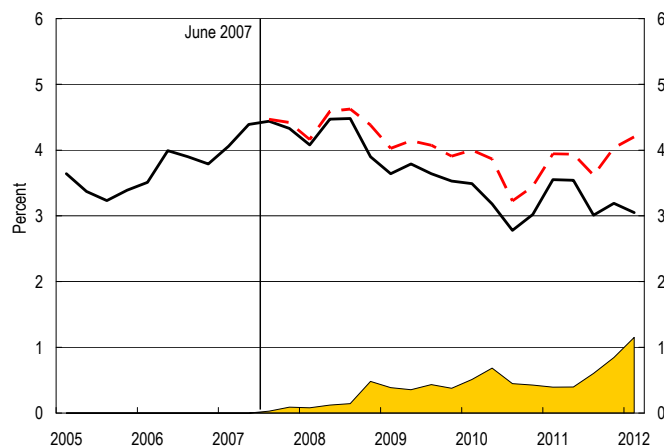
⁷ Given that these measures of balance sheet have tended to move in similar ways for a given central bank, we see these estimates as providing broad signals regarding the *overall* stimulative effects of central bank balance sheet expansion, rather than precise estimates of the impact of specific components of the balance sheet. This view—along with the desire for expositional clarity—has prompted our decision to report only the averages of the estimated interest rate effects across these four measures of the size and composition of the balance sheet. That said, we would be quite happy to discuss this work in greater detail with interested readers.

Figure 4. Long-term Interest Rates

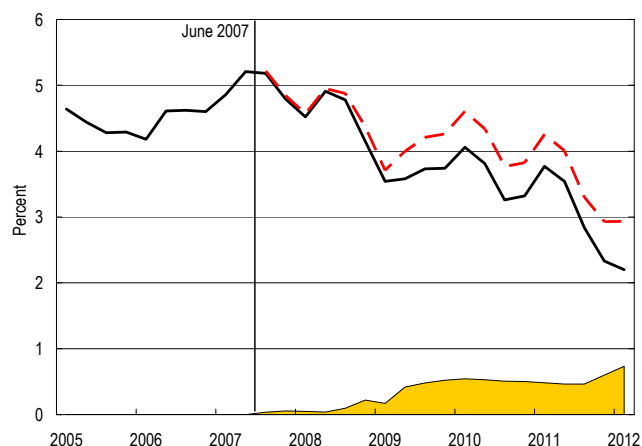
United States



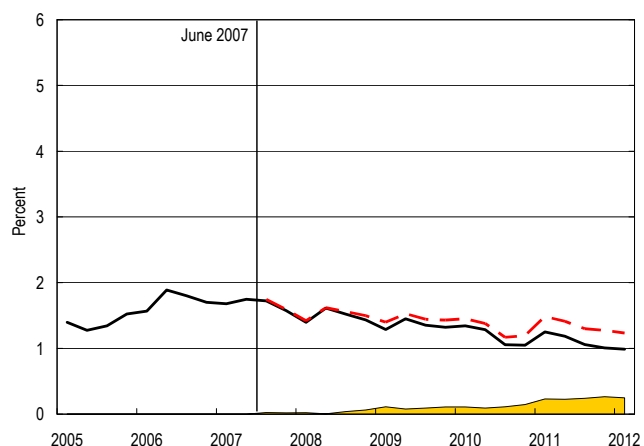
Euro Area



United Kingdom



Japan



Sources: National Statistical Agencies, Haver Analytics, and Citi Investment Research and Analysis.

This may particularly be the case for our estimated effect for Operation Twist, which has been ongoing during a period in which the Fed has taken steps to beef up its communication framework, including an extension of the (conditional) commitment to keep rates at exceptionally low levels.⁸

The results for the United Kingdom are qualitatively similar, with the BoE's policies putting sustained downward pressure on long-term rates between mid-2008 and mid-2009, and then a further downward push on rates during the second half of 2011 as the Bank launched its second round of asset purchases.⁹ All told, we see

⁸ In our review of the academic literature, we have not found a comprehensive estimate of the effects of the Fed's various balance sheet programs. Gagnon, Raskin, Remache, and Sack (Federal Reserve Bank of New York Staff Reports, March 2010) find that QE1 reduced the 10-year term premium "somewhere between 30 and 100 basis points" with most of their work pointing to estimates "in the lower and middle thirds of this range." Grossing up these estimates for QE2 would suggest a range of roughly 40 to 140 basis points. Our estimate of 100 basis points (excluding Operation Twist) is within—but above the center—of this range. As for Operation Twist, Meaning and Zhu (*BIS Quarterly Review*, March 2012) estimate that Twist could reduce Treasury yields by up to 85 basis points by the time of its completion.

⁹ The BoE reformed its money market operations in May 2006, altering the size and composition of its balance sheet. As a result, balance sheet data before the change are not directly comparable to the current data.

the Bank of England's efforts as trimming long-term gilt rates by about 75 basis points.¹⁰

Our estimates for the euro area are plagued by a challenging methodological problem. The shifting risk premiums associated with the region's ongoing fiscal and financial stresses make it difficult to tease out the effects of ECB policies on long rates. Specifically, German long-term rates have been driven down by safe haven inflows, while the rates of many other euro-area countries reflect mounting risk premiums. As an admittedly imperfect compromise, we take as our proxy for euro-area long rates the simple average of the German and French rates. With German rates driven down by safe haven inflows and French rates lifted by risk premiums, we see this average as providing a reasonable baseline for evaluating the effects of ECB policies. Using this measure, we find that the ECB's balance sheet policies have reduced long rates in the euro area by slightly more than 110 basis points.¹¹ Notably, much more than half of this effect has come over the last year, as the ECB has kicked its crisis-fighting efforts into high gear.

Finally, the effects of the BoJ's policies on Japanese long-term interest rates have been more modest, amounting to roughly 25 basis points. However, Japanese rates started the period already at exceptionally low levels, which has likely limited the scope for further declines.

To what extent have central banks escaped the constraints of the zero lower bound? Drawing on the framework sketched out above, we now use our regression results to adjust the path of policy rates to reflect the stimulus that has accrued from central bank balance sheet expansion.

As shown in **Figure 5**, our work suggests that for the United States, the effects of balance sheet expansion have been worth about 340 basis points of Federal funds easing. By this measure, the monetary easing currently in the system is now well beyond the prescription of a Taylor rule with a weight of 0.5 on the output gap and, with the uptrend in inflation in recent quarters, even perhaps slightly more than is prescribed by a Taylor rule that weights the output gap with a coefficient of one. This analysis provides very useful context for interpreting recent statements from the Federal Reserve indicating that, given the stimulus currently in place, the Committee would need to see a decline in inflation or a deterioration in economic activity to justify a further round of asset purchases. Our analysis suggests that current economic conditions do not necessarily require additional stimulus.

The Bank of England, in gearing the stance of its monetary policy, is clearly looking well beyond the variables in this simple Taylor rule. The central bank injected several hundred basis points of stimulative balance sheet policies at a time when the Taylor rule was recommending a tightening of policy to tame the effects of rising inflation. The BoE's policy through this period has been firmly forward looking: The ongoing stimulus has reflected the view that in the presence of meaningful slack

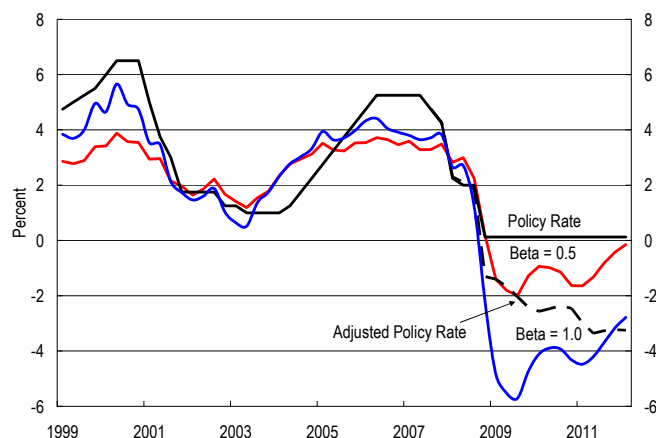
Accordingly, in estimating our regression models for the United Kingdom, we held balance sheet variables constant at their May 2006 level (as a share of GDP) for observations prior to the change in balance sheet.

¹⁰ Joyce, Tong, and Woods (BoE *Quarterly Bulletin*, 2011:Q3) find that the first round of the BoE's assets purchases, which amounted to £200 billion, pushed down long-term gilt yields by about 100 basis points and were equivalent to policy rate cuts of 150 to 300 basis points. With the second round of QE adding another £100 billion of purchases through March (the end of our sample), this would suggest total effects—assuming that the second round of purchases was equally effective—of 150 basis points on long rates and 225 to 450 basis points on policy rates. Our estimate of the effect on long rates is smaller—only about half this size—but (as shown in Figure 5) our assessment of the equivalent easing of the policy rate is broadly similar, at about 320 basis points.

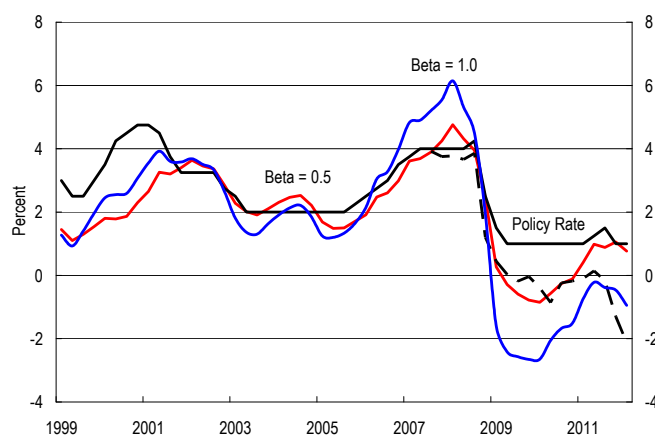
¹¹ If we expanded this measure to include long-term interest rates for the peripheral countries, the estimated effects of ECB policy would be much smaller. But for these countries, the effects of ECB policies are being masked by a roughly contemporaneous increase in risk premiums.

Figure 5. Policy Rates Adjusted for Balance Sheet Effects

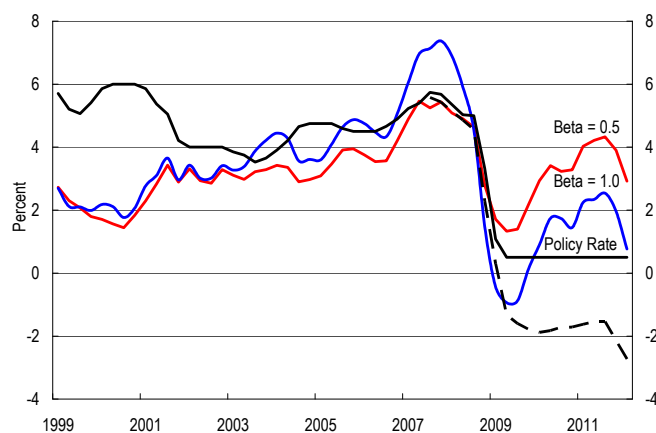
Federal Reserve



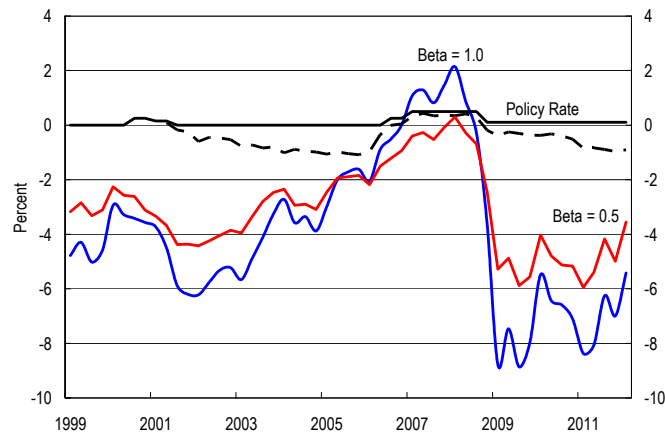
European Central Bank



Bank of England



Bank of Japan



Sources: National Central Banks and Statistical Agencies, Haver Analytics, and Citi Investment Research and Analysis.

inflation would eventually fall. Moreover, given the country's ongoing fiscal retrenchment and vulnerability to spillovers from stresses in the euro area, as well as the headwinds from domestic private-sector deleveraging, the risks to economic activity (and ultimately to prices) have been seen as firmly on the downside. The recent decline in inflation now seems to have ratified key premises of the BoE's policy.

Our results for the ECB indicate that through the first several years of the crisis the ECB's policies, including the stimulus from balance sheet expansion, closely tracked the more conservative Taylor rule (which puts a weight of just 0.5 on the output gap). However, over the past year, the amount of stimulus that the ECB has injected has increased significantly, and now exceeds the prescriptions of both Taylor rules. As with the Bank of England, this marked shift in the stance of ECB policy highlights that central banks formulate their policies taking into consideration a broad set of factors, including concerns about financial stability and the economic outlook, many of which are not well accounted for in a simple Taylor rule.

Finally, the results for the BoJ strike us as discouraging. In the face of Taylor rule recommendations for substantially negative policy rates, the BoJ's balance sheet

policies have had some modest stimulative effects, but much less pronounced than those of the other central banks. The BoJ has made only limited headway in its efforts to stamp out deflationary pressures and support a closing of the output gap. Whether the economy's poor performance reflects the constraints of Japan's very low interest rate environment (and other structural problems) or the reluctance of the BoJ to act with sufficient aggressiveness remains very much an open issue.

Some Concluding Thoughts

Our work suggests that the balance sheet policies that central banks have employed have generally been powerful, driving down long-term interest rates and effectively loosening the constraints of the zero lower bound on nominal interest rates. These results point to a broadly eclectic view regarding the appropriate structure of such programs. For example, we have found evidence that the Fed's Operation Twist—which leaves the size of the balance sheet, the monetary base, bank reserves, and the central bank's total securities holdings all unchanged—has nevertheless had significant effects on the trajectory of long-term U.S. interest rates. But we also find evidence that the ECB's three-year LTROs, which have operated mainly by expanding the monetary base and bank liquidity, have also placed significant downward pressures on long-term interest rates.

Our broad impression is that faced with differing economic circumstances various types of balance sheet policies may have significant effects. A related conjecture is that market participants may view balance sheet policies—however they are structured—as an implicit commitment to maintain a stimulative monetary policy stance until economic conditions become more normal.

On balance, we would characterize these results as casting a broadly affirmative vote in regards to the effectiveness and power of these balance sheet policies. Central banks have been able to ease well beyond the constraints of the zero lower bound. However, our work also indicates that the gearing of central bank policy takes into account a whole range of current and prospective economic and financial developments that are not necessarily captured by simple Taylor rules. This suggests that during periods of economic uncertainty or financial stress, it may be quite appropriate for central banks to be far more stimulative than a Taylor rule would prescribe. As such, our finding that balance sheet expansion has allowed central banks to bring policy into line with Taylor rule prescriptions does not mean that central banks have escaped the zero lower bound entirely—in an unconstrained world, they might have chosen to be *substantially below* the Taylor rule given present circumstances.

The discussion in this essay has admittedly focused more on the benefits, rather than on the costs, of balance sheet policies. As the central bank becomes more enmeshed in the process of credit intermediation, there is an inevitable risk of unintended consequences and distortions. This is the case if the central bank becomes more involved in the allocation of liquidity (as with the LTROs) or if the central bank significantly steps up its purchases of assets in financial markets (as with the Fed's securities purchase programs). In either event, financial institutions may focus on central bank actions rather than on underlying fundamentals in formulating their investment decisions and may take actions to game the central bank.

Also, balance sheet policies—even if they operate broadly through the same channels as conventional monetary policy—can be politically controversial and may raise public concerns about the merits and legitimacy of the central bank's actions.

Such adverse public reaction could, in principle, feed back into reduced economic sentiment and undercut the effectiveness of the central bank's policies.

Finally, this essay has focused on the effects that balance sheet policies have had to date. We have not examined the issue of what the exit will look like or what the attendant risks might be. We also have not looked at the potential interactions and sequencing between monetary and fiscal exits. How might the constraints of mounting public debt in these countries influence, and perhaps even constrain, the path of monetary policy as it attempts to unwind unconventional policies? We plan to take up these important issues in future essays.

Appendix A-1

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