LCERPA

Laurier Centre for Economic Research & Policy Analysis

LCERPA Working paper No. 2018-11

July 2018

A Survey of the International Evidence and Lessons Learned About Unconventional Monetary Policies: Is a 'New Normal' in our Future?

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ABSTRACT

    This study examines the effectiveness of unconventional monetary policies (UMP). It considers whether these policies have been successful and where their effects remain uncertain. We survey both the domestic financial market and macroeconomic effects of UMP in the economies where these policies were introduced and their international spillover effects. The paper considers the impact of a wide range of UMP rather than the effects of specific policy instruments. We also provide a retrospective on the important case of Japan beginning in the late1990s and ask whether the Eurozone's experience with UMP is substantively different given its structure of policymaking. Finally, we ask: if the 'old normal' is not in our future, should the 'new normal' in monetary policy routinely include what we now refer to as UMP? We conclude that UMP can prevent economic collapse but are not designed to promote stronger long-term economic growth. Apart from new communication strategies, the use of UMP under normal circumstances does not appear to be a sound monetary policy strategy. Failure to learn this lesson might also prevent future policy makers from asking or expecting too much from their central banks.

1   Introduction

We are approaching a decade since the expressions quantitative easing (QE) and unconventional monetary policies (UMP) became household words. Central bankers, however, have frequently repeated the need to pursue a "looser for longer" stance in monetary policy,even after years of ultra-low interest rates and noninterest-rate forms of monetary easing. This study surveys the empirical literature on the effectiveness of UMP in responding to financial crises and boosting economic activity. In doing so, it considers the circumstances under which these policies have been found to be successful and examines cases where their impact remains questionable.

Before the 2007-09 global financial crisis (GFC), an increasing number of central banks adopted a short-term interest rate setting as the main, if not sole, instrument of monetary policy. However, owing to the severity of the crisis and its potential implications on the real economy, the central banks that were most directly affected by the crisis quickly lowered their policy interest rates near zero. These policy settings were initially referred to as the 'zero lower bound' (ZLB) because it was argued that interest rates could not, for practical reasons, go below zero.[1] However, several central banks implemented negative interest rates alongside UMPs. Thus the ZLB expression became the 'effective lower bound' (ELB) in recognition that the article of faith once held by many policymakers had been abandoned (see Lombardi *et al.*, *forthcoming*, and references therein).

For the purpose of this analysis an UMP tool is defined as any policy instrument, other than the setting of short-term interest rates, that aims at achieving a stated monetary policy objective either by influencing economic activity or by moderating shocks to the financial system. An unconventional policy need not only be used when the ELB has been reached. It may also be implemented to prevent reaching that threshold or to provide targeted policy support to specific segments of the financial system. In addition, unconventional tools need not be used exclusively to provide monetary stimulus, though there are few examples of their use during periods of monetary tightening. We provide in section 2a listing of UMP tools that have been used in practice or discussed theoretically.

There has been significant scepticism about the economic benefits of UMP type policies. Some of the criticism arises because the ELB and the objectives of UMP seem to differ across central banks and across time, creating uncertainty about what purpose these policies are

supposed to serve. Furthermore, the scale of interventions has been extraordinary, amounting to trillions of US dollars in some economies, and their scope is also unprecedented. This has raised concerns about inducing distortions in financial markets (e.g. Borio and Disyatat, 2010). Similarly, at the macroeconomic level, there are concerns that low policy interest rates and further stimulus through UMP have amplified both domestic and international spillover effects (e.g. Rajan, 2014). As a result, central banks have been accused of risking the loss of their hard-earned credibility in managing inflation expectations (e.g. Taylor, 2014).

In the wake of the GFC, policymakers argued that using these policy tools was necessary to prevent an even worse contraction. Once the crisis passed, they argued that the continued application of such policies could speed up the recovery from crisis conditions. In light of the received macroeconomic wisdom about what monetary policy can (or cannot) accomplish in the medium term, it is important to review the evidence concerning the economic effects of UMP.

The present paper surveys the financial-market and macroeconomic effects of UMP in the economies where these policies were introduced as well as their spillover effects across borders. This is not the only survey of its kind. However, the present survey considers the range of international experiences and implications of UMP, while others have focussed more on the outcomes in specific countries (see Bhattarai and Neely, 2016 for the US experience). It also considers a wider range of UMP, rather than the impact of specific policy instruments (as in Gagnon, 2016; Haldane *et al.*, 2016; and Reza *et al.*, 2015, who focus on QE; and Charbonneau and Rennison, 2015, who focus on forward guidance). Our survey comes closest to Borio and Zabai (2016). However, our survey emphasizes the diversity of experience and outcomes in using UMP. We provide a retrospective on the important but often neglected case of Japan beginning in the late 1990s,where UMP were first attempted and, so far, show few signs of producing the aimed-for economic outcomes. We also consider whether the Eurozone's experience with UMP is substantively different from that of other jurisdictions, given the specific structure of its financial system and its macroeconomic policymaking process.

Finally, we present some evidence that underscores one of the main claims made by central bankers about UMP: that they were essential in preventing much worse economic outcomes after the 2008 financial crisis, at least in advanced economies (AEs). This conclusion is important because it suggests that UMP should not be considered as part of a 'new normal' but are best

thought of as a set of policies to be applied only under exceptional circumstances. We return to this point in the conclusions.

The next section establishes the economic and financial context within which central banks needed to resort to UMP and provides a typology of UMP. Section 3 evaluates the evidence of the short-term impact of UMP on financial markets. Section 4 turns to an analysis of the relatively smaller literature dealing with the macroeconomic impact of UMP. Section 5 concludes.

2   The Transition to Unconventional Policies

2.1 The 2008 Global Financial Crisis

Financial crises are nothing new, as Reinhart and Rogoff (2009) remind us. Yet, at the time their work was published, UMP had not yet entered the vocabulary of the central bankers (indeed, neither term appears in their book's index). Was there something fundamentally different about the events that began in 2007? There are at least two notable differences between the GFC and all the crises that preceded it, save perhaps for the Great Depression of the 1930s. First, the crisis began and was centered in AE. Previously, financial crises were phenomena typically seen as being restricted to developing or emerging market economies (EMEs).

Financial crises have been classified in several ways, including: currency crises (exceptionally large depreciations or devaluations in the nominal exchange rate), inflation crises (persistently high inflation rates that exceed historical norms), sovereign debt crises, stock market crashes and, of course, banking crises.[2] Aggregating all types of financial crises we observe--since the 1980s--that the median frequency of crises in EMEs was at least as high, or higher than, in AEs until the GFC. Similarly, the most recent banking crises erupted in AEs, while the last string of banking crises in EMEs were in the 1980s. Of course, banking crises were not unheard of in AEs prior to 2007 (see Siklos, 2017, chapter 3). However, the shock emanating from systemically important US and UK financial markets, combined with the imbalances in several economies through property-market bubbles or over-leveraged financial institutions, created the conditions for the eventual GFC.

 Second, although central banks in the economies most directly affected by the GFC entered the crisis period with relatively low policy interest rates, their, inflation rates were also relatively

low. Policy rates for three key central banks began at around 5 percent at the beginning of 2007. The Bank of Japan (BoJ) is the exception--its policy rate had been near zero since the late 1990s. The low starting point may have contributed to some hesitancy in rapidly lowering interest rates. Indeed, the Bank of England (BoE) only lowered its policy rate by 75 basis points over the period from the peak of its earlier tightening cycle in July 2007 to September 2008; it then lowered its policy interest rate another 450 basis points to the then ZLB of 0.5% over the subsequent six-month period from October 2008 to March 2009. The European Central Bank (ECB) actually increased interest rates in July 2008 to 4.25 percent, and did not effectively reach the ZLB even two years after the GFC. Only the US fed funds rate was reduced relatively quickly, from 5.25 percent in August 2007 to the mid-point of a range between 0 and 0.25 percent by December 2008. Also influencing central banks may have been their success with lowering policy rates earlier in the decade when the threat of the deflation was on the minds of policy makers in several advanced economies (see IMF, 2003).

Widespread introduction of UMP came shortly after the height of the crisis in the fourth quarter of 2008. Much has been written about the Fed's large balance sheet, and the impression is sometimes given that the Fed has been more aggressive than its counterparts elsewhere. Figure 1 shows that this has not been the case. The top portion (Figure 1A) shows the size of balance sheets of the four major central banks as a percent of GDP during the years surrounding the worst of the GFC. While the US data show a sharp increase in late 2008, the ratio of Fed assets to the size of the US economy rose only modestly thereafter. Indeed, increases of similar magnitude occurred more or less simultaneously at both the ECB and the BoE. Even the BoJ expanded its balance sheet at the time, despite its share of assets being higher than elsewhere, owing to the ongoing legacy of its banking crisis in the 1990s. Finally, notice that by 2012 the share of assets to GDP at both the BoE and the ECB increased sharply once again, as the impact of the Eurozone crisis began to take hold in that part of the world. The most dramatic increase occurred in Japan in 2013 when its program of Qualitative and Quantitative Easing (QQE) was introduced (see section 3.2 below). When we instead examine the rate of change in assets of the same central banks as displayed in Figure 1B, it is immediately clear that the largest interventions via the central bank balance sheet took place in late 2008 and early 2009. The rate of accumulation in central bank assets subsided shortly thereafter except at the BoE and the ECB

in 2011, during the Eurozone crisis. The interventions by the BoJ after 2013 show steady increases, producing noticeable growth in the balance sheet-to-GDP ratio.

Figure 1, however, contains another important message. The Fed and the BoE began to shift emphasis away from the policy interest rate to the composition of their balance sheets *before* they approached the ZLB. Balance sheet policies were being used as a way of restoring confidence and easing the flow of credit in the financial sector. This outcome is also seen in the sharp deterioration of lending conditions in the four economies being reviewed (see Filardo and Siklos 2018; Siklos and Lavender, 2015; Siklos, 2015).The deterioration was largest for the United States, but was also significant in the euro area and the United Kingdom. Only Japan, mired in a low inflation and growth, seemed to escape the trend. Since the potential contraction of loans affects a key element of the transmission of monetary policy the threat to economic activity was potentially large.

2.2 A Brief Typology of UMP

Space limitations prevent a detailed discussion of different types of UMPs. For a more extensive account of these policies see, for example, Ball *et al.* (2016) and IMF (2013).

A UMPis defined as any policy instrument, other than the setting of short-term policy interest rates, that aims at achieving a stated monetary policy objective either by influencing economic activity or by moderating shocks to the financial system. It need not only be used when the ELB has been reached; it might, for example, be implemented to prevent reaching that threshold or to provide targeted policy support to specific segments of the financial system or economy. Table 1 provides a summary of the types of UMPs employed in AEs. Note that we present one of several ways to categorize UMP; there are many different typologies for these policies and there are also no neat separations among policies.

The term QE is often used to refer to any policy decision that aims to change the size and/or composition of the balance sheet. But these policies can take several forms. With QE, the central bank targets the liabilities side of its balance sheet by changing the level of reserves held by financial institutions. The aim is to change the money supply via the monetary base. Credit easing (CE) is another balance sheet policy that changes the composition of the central bank's assets. The aim is to improve liquidity conditions in one or more segments of the financial system, but it need not lead to a change in the size of the central banks' balance sheet (i.e. asset

purchases may be sterilized by the sale of other types of assets). A third balance sheet policy creates incentives for the recipients of funds from central bank operations, namely commercial banks, to increase loan activity in an effort to stimulate economic activity. Readers are referred to Borio and Zabai (2016), European Central Bank (2015), and Stone *et al.* (2011), for more detailed discussions and alternative classifications of balance sheet policies. For example, excluded from this analysis are foreign exchange interventions or the provision of foreign exchange liquidity, which are included in other classifications of balance sheet policies.

While balance sheet policies involve direct intervention in the monetary system, another set of UMP tools aim to change expectations by sending signals about the future policy path. Forward guidance policies (FG) use communication to affect policy outcomes. They were introduced by the BoJ almost two decades ago (see, inter alia, Filardo and Hofmann, 2014). FG can take several forms. Qualitative guidance involves communicating the central bank's views about future policy actions but stops short of offering any sort of commitment. Two examples include the US FOMC's statement, starting in December 2008, that "weak economic conditions are likely to warrant low levels of the federal funds rate for some time" and the ECB Governing Council's guidance, introduced in July 2013, that they "expect the key ECB interest rates to remain at present or lower levels for an extended period of time". The other two types of FG link a commitment to a certain policy path—usually promising to keep interest rates low—during a specified time period (calendar-based FG) or at least until a specified economic threshold is reached (state-based FG). In practice, the distinction between different forms of FG is somewhat arbitrary, as central banks may use a mix. For more details on FG policies, refer to Moessner *et al.* (2017), who examine whether central banks actually make commitments in practice, and Charbonneau and Rennison (2015).

There are several other policy actions that might be classified as 'unconventional'. Until the GFC the possibility of negative interest rates was regarded as an interesting possibility, but unlikely to be seen in practice. But the GFC ushered in negative interest rates that persist to this day. Significantly, the US Fed and the BoE have explicitly ruled out allowing their policy rates to turn negative for fear of distorting capital markets in a manner that would not offset the potential benefits of the further easing brought about by such a strategy (e.g. Burke *et al.*, 2010; Turner, 2014). The evidence on the effectiveness of this tool is not discussed below, as it remains conventional according to our definition.

Two UMPs that have yet to be implemented are: helicopter money and changing the inflation objective.[3]The term 'helicopter money' was coined by Milton Friedman (1969), and essentially involves the transferring of funds directly into the hands of the public (e.g., via injections of cash or bank deposits). It has been given serious consideration by scholars (e.g. Buiter, 2014; Turner, 2016, chapter 14) and, in some circumstances, QE and helicopter money are fiscally equivalent (Cohen-Setton, 2015; Reichlin *et al.*, 2013).However, there are few indications that any countries are anywhere near considering such an option even if the global economy reverts to recession. Since some countries (e.g. China, India, Sweden) are already exploring a future where the central bank issues digital money (see, inter alia, Engert and Fung 2017; Camera, 2017; Rogoff, 2016a), this could open up the possibility of helicopter money being more readily available as an additional instrument of monetary policy, though only as a last resort.[4]

In the 1980s there was a shift towards the adoption of explicit inflation targets. As inflation targeting spread to EMEs, the target levels were typically set higher and tolerance zones wider than in AEs. In light of the near miss with the ZLB in the early 2000s when some AEs--notably the US-- faced the possibility of a protracted deflation, it became apparent that hitting the ZLB was becoming more likely with sustained low inflation rates (see Chung *et al.*, 2012). This spurred largely theoretical work to investigate, among other issues, the economic consequences of the ZLB and its implications for the financial system (Williams, 2014, and references therein).

On the presumption that the ZLB should be avoided if possible, some scholars made the case for raising inflation targets (Blanchard *et al.*, 2010). Others argued that if inflation was below target for an extended period of time, then a credible commitment to letting inflation rise above target during the recovery could help prevent a liquidity trap (Woodford, 2012). See Ball *et al.* (2016) for an extensive discussion of the benefits and costs of raising the inflation rate.

More recently, Bernanke (2017) has suggested that a future monetary policy regime could combine some of the virtues of price-level targeting and inflation targeting. In normal times inflation targeting has proved successful, while price-level targeting promises to overshoot a future price level in case current prices evolve too slowly. In this fashion central banks have an argument for maintaining policy rates lower for longer when they are near or at the ZLB. How one might credibly switch from one type of inflation control regime to another remains unclear.

In what follows we do not discuss the potential financial system and economic implications of financial repression or macroprudential policy strategies, occasionally also thought of as unconventional, so as to retain focus on UMPs with more direct central bank involvement. See, however, Edison *et al.* (2004), Lombardi and Siklos (2016) and Reinhart *et al.* (2011), and references therein.

3 The International Evidence to Date: Financial Markets

3.1 Measurement Challenges

There are at least two challenges in evaluating the impact of UMP on financial markets. First, there is usually considerable speculation about an upcoming announcement ahead of the actual announcement. Next, UMP announcements are infrequent. As a result, the number of available 'observations' is generally small. These features likely explain a preference among researchers for relying on event-type studies to investigate the impact of UMP on financial markets.[5]

Since there are potentially many news items that can take place simultaneously with an announcement of an UMP action, identifying the isolated impact of, for example, the launch of a QE program is not straightforward. In part for this reason a growing number of studies rely on ultra-high frequency data (intra-daily or even tick by tick; see Rogers*et al.*, 2014). The finely chosen timing of events also ignores the real possibility that agents, even those in financial markets, are rationally inattentive or do not react to news at the very moment an event takes place. Such a possibility could bias estimates from even the most careful event study. MacKinlay (1997) is a well-known survey of the advantages and limitations of event studies.

Empirical contributions that adopt an event study approach include Aït-Sahalia *et al.*(2012), Acharya *et al.* (2017), Bastidon *et al.*(2016), Chen *et al.*(2014), Christensen and Rudebusch (2012), Gagnon *et al.* (2011), and Rogers *et al.* (2014). The events investigated can range from the announcement of QE-style policies to the whole gamut of UMP. This methodology treats policy announcements and/or interventions as events whose effects can be individually measured and the cumulative response to events associated with a specific policy captures the policy's total impact. In what follows we focus mainly on the impact of UMP on bond yields, especially those of long-term government bonds, since these are the main target of large-scale asset purchases made by central banks under the aegis of QE policies.

Swanson and Williams (2014a, 2014b) argue that in order to test whether UMPs can be effective at the ZLB one must first confirm that markets are responsive to surprises. The authors ask whether the responsiveness of financial markets to macroeconomic news surprises changed after the GFC, relative to the pre-crisis period. If macroeconomic news surprises no longer effect interest rates along the yield curve, then monetary policy may also be unable to impact markets, thereby losing its effectiveness. Data for the U.S., the U.K. and Germany suggest that market responsiveness has diminished at the short end of the yield curve. However, monetary policy is found to remain effective at the longer end of the yield curve. Lombardi *et al.* (2017, *forthcoming*) concur, relying on a wider array of countries, more recent data, as well controlling for the verbal and written communication of central banks.

Figure 2 shows the distribution of estimates of the impact of balance sheet policies on long-term government bond yields in the Eurozone, Japan, the United Kingdom and the United States across both time series and event studies. While the range of estimates across a large number of studies can be large it is almost unambiguously negative, implying that UMP could be successful in reducing bond yields even at the longer end of the term structure.

3.2 Learning from Japan's Experience

Two characteristics of Japan's experience with QE make it a particularly important case study: theBoJ was the first central bank to introduce QE in 2000;and, as shown in Figure 2, the BoJ's QE policies were the least effective at lowering government bond yields. We may never know conclusively why QE seems to have had a different outcome in Japan than elsewhere, but it seems that the combination of a lack of commitment to QE and early withdrawal from such programs were key factors.[6] Koo (2015, p. 64) describes the conflicting views inside and outside the BoJ that limited the effectiveness of QE. Policymakers were concerned about a "QE trap", that is, the economic and financial risks of exiting from a massive expansion of the balance sheet. A somewhat related argument is that the BoJ did not adequately exploit its balance sheet by providing the necessary additional stimulus to halt the economic contraction (McCauley and Ueda, 2009; Ueda, 2011).

In the early 1990s, Japanese equity and property bubbles burst, putting intense deflationary stress on the domestic financial system. In response, the BoJ reduced the uncollateralized overnight call rate— the key policy interest rate—from a peak of 8.5 percent in 1991 to 0.5

percent in 1995. Subsequently the call rate was reduced to zero in early 1999. Around the same time, Japan began to experience sustained periods of consumer price deflation. The BoJ then began adopting UMP. In April 1999, the BoJ committed to maintaining a zero-interest rate policy (ZIRP) "until deflationary concerns are dispelled." This was the first use of forward guidance. ZIRP was lifted in August 2000,only to be reintroduced in March 2001.The BoJ then adopted QE and increasing purchases of longer-term Japanese Government Bonds (JGBs) but it ended the QE program in March 2006 and began to downsize its balance sheet.

Harrigan and Kuttner (2004) conclude that deflation was anticipated around early 1993 and question why the BoJ did not further ease interest rates prior to 1995. Ahearne *et al.* (2002) suggest that deflation was not anticipated until as late as 1995. Given Japan's circumstances it is not surprising that the literature provides competing recommendations for the BoJ (see, inter alia, Ahearne *et al.*, 2002; Fujiwara *et al.*, 2007; Harrigan and Kuttner, 2004; Leigh, 2010). Counterfactual simulations suggest that more aggressive monetary policy in the early 1990s would not have avoided a deflationary slump, but setting a higher inflation target, combined with a stronger emphasis on output stabilization or following a price level targeting rule might have been successful at avoiding deflation and improving output.

The results from a variety of event studies suggest that ZIRP and QE may have been effective at decreasing expected future short-term interest rates and therefore yield curves (Bernanke *et al.*, 2004; Kuttner and Posen, 2004). Baba et al. (2005) find that ZIRP was effective at decreasing the expectation component of future short-term interest rates, but had little impact on risk premiums.

The foregoing only scratches the surface of studies that explore Japan's early experience with QE. Nevertheless, there is evidence that by becoming avant-garde in the use UMP the BoJ was able to at least cushion the blows from the bursting of the 1990s asset price bubble. Nevertheless, in a review of the BoJ's early efforts with UMP, Ueda (2012) concludes that entrenched deflationary expectations underpinned the failure to secure an economic recovery. By acting either too slowly or too cautiously, or a combination thereof, Japanese monetary policy failed to stifle the recession.

Perhaps for all of the foregoing reasons the BoJ did not immediately follow other large economies by implementing UMP once the GFC was underway in 2007-8. Former BoJ Governor

Shirakawa lamented that Japan had pioneered some forms of UMP but that these policies were unable to help the country's growth rate reach escape velocity (Shirakawa, 2012).[7] Still, the BoJ introduced a new program—comprehensive monetary easing (CME)—in October 2010.This program not only included purchases of long-term JGBs but also more risky assets such as exchange-traded funds and Japan real estate investment trusts, in an effort to reduce risk premiums. The CME program was found to be effective at reducing interest rate spreads and risk premiums, as well as raising equity prices, consumer and business confidence, and corporate bond issuances. However, the policy was ineffective at influencing inflation expectations or foreign exchange rates (Lam, 2011; Ueda, 2012).

Shirakawa's successor, Governor Kuroda, launched Qualitative and Quantitative Easing (QQE) shortly after his appointment in April 2013. To date, there have been three phases of QQE: a determination to reach a two percent inflation target together with a massive expansion of the BoJ's balance sheet (see below); the breaching of the ZLB into negative short-term interest rate territory; and the ongoing phase of pushing yields along the yield curve to zero through the aggressive purchases of JGBs, which had expanded the BoJ's balance sheet by an additional 55 percent of Japan's GDP as of the fourth quarter of 2016 (see Figure 1a). The BoJ's own assessment three years into the policy shift acknowledged its failure to shift inflation expectations to toward the two percent target (Bank of Japan, 2016). Gertler (2017) argues that presumptions about the effectiveness of FG under QQE cannot succeed as theory would predict because expectations are not rational. Nishino *et al.* (2016) show that inflation expectations in Japan are adaptive and highly sensitive to exogenous factors. They do not dismiss the importance of credibility altogether, but instead assume the BoJ has experienced a persistent negative credibility shock (see also De Michelis and Iacoviello, 2016). The current state of play may indeed reflect the erosion of BoJ credibility (Bordo and Siklos, 2016b) while Japan is said to have 'lost' two decades of potentially higher economic growth and inflation.[8]

3.3 The GFC and its Aftermath

The US first introduced an outright asset purchase program in November 2008, purchasing agency mortgage-backed securities and agency debt to help stabilise the housing market and the underlying financing structure. In March 2009 the program was extended to include Treasury securities; this program is referred to as the first Large-Scale Asset Program (LSAP1), and asset

purchases totalled around $1.75 trillion. The US Fed later embarked on three other major balance sheet programs. The second (LSAP2) was announced in November 2010 and consisted of the purchase of $600 billion in longer-term US treasuries with the objective of reducing their yields. The third, the Maturity Extension Program (MEP; also known as Operation Twist), was announced in September 2011. The MEP swapped the US Fed's holdings of Treasuries with shorter residual maturities for Treasuries with longer maturities. The final program (LSAP3) had no ex-ante determination of the duration or total size of asset purchases, with pre-announced monthly purchases of Treasuries and mortgage-backed securities. LSAP3 was announced in September 2012, and asset purchases ceased in October 2014.

Based on median estimates in the empirical literature, and unlike the BoJ's experience, LSAP1 had the largest impact. All in all, the literature on the Fed's experience with balance sheet policies suggests that there were diminishing returns to its asset purchases, largely owing to the important role of changing market expectations through the signalling channel (Ihrig *et al.*,2012).[9] Similarly, the impact of LSAP2 was quite large, and there is some debate over whether purchasing non-treasury securities (specifically, mortgage-backed securities) is more effective at lowering yields because the purchase of scarce and/or distressed assets affects markets through additional channels (see Krishnamurthy and Vissing-Jorgensen, 2011, 2013).

In the UK, the Government established the Asset Purchase Facility in January 2009, providing a framework for the BoE to purchase assets, which the central bank began doing in March 2009. The first round of asset purchases (BQE1) occurred in 2009, and totalled $200 billion of mostly medium- and long-term gilts, but also included the purchase of some commercial paper and corporate bonds. The second round of purchases (BQE2) occurred in the background of the neighbouring euro area crisis from 2011 to 2012, and included an additional $175 billion of gilt purchases. Figure 2 suggests that the UK's experience with QE appears to have been the most effective at reducing long-term yields. As is the case with the US Fed's asset purchases, the effectiveness of the UK's purchases exhibited diminishing returns. Evidence suggests that while the reduction in US Treasury yields operated mainly through the signalling channel (i.e. changing market expectations about future short-term interest rates), the dominant channel in the UK was through portfolio rebalancing (Christensen and Rudebusch, 2012; Joyce *et al.*, 2011).

A few central banks in small open economies, such as the Swedish Riksbank and the Swiss National Bank, have also used balance sheet programs. The impact of asset purchases in these economies is believed to be smaller, in large part owing to their inability to affect global term premiums (Diez de los Rios and Shamloo, 2017). Central banks in small open economies may have limited influence on domestic term premiums (Kabaca, 2016).

There are a few important elements of these countries' UMP that are missing in some of the studies used to construct Figure 2, namely a role for central bank communication. Acosta and Meade (2015), Bennani (2015), Hansen *et al.* (2014), Lombardi *et al.* (2017, *forthcoming*), Malmendier *et al.* (2017), and Meade *et al.* (2015) are examples of studies that apply different algorithms and techniques to quantify the content of central bank policy statements, minutes, speeches, and other central bank written publications. These studies explore the impact of written communications on anything from inflation expectations to the stance of monetary policy more generally. All of these efforts are also at the core of the FG approach to policy.

In 2009, with the Bank of Canada's (BoC's) policy rate was near the ZLB, the BoC altered course by forcefully announcing in the April 2009 Monetary Policy Report that it would promise to leave the overnight rate at the ZLB for a year unless conditions warranted removing the promise. The BoC removed the promise and raised the policy rate in April 2010, one meeting before FG was due to expire. Although subsequent empirical investigations suggest that the removal of the conditional commitment by the BoC was successful (He, 2010; Siklos and Spence, 2010) based on financial markets' reactions, one must wonder whether the success may have been short-lived. It has been suggested that the success of the BoC's policy at changing market expectations is related to the fact that FG was used as an unorthodox policy, that is, communicating information the BoC typically does not provide, which may have made the conditional commitment more credible (He, 2010; Woodford, 2012). Indeed, the current Governor of the BoC, Stephen Poloz, came to believe that FG should only be used in crisis conditions (Poloz, 2015).

The United States was also quick to add FG to its arsenal of UMPs in the aftermath of the GFC. The Fed is the only major central bank to use qualitative, calendar-based and state-contingent FG in the aftermath of the GFC, thus making it a good case for comparative analysis.[10] The use of date-based guidance was found to significantly reduce the volatility of

interest rate expectations and may have changed expectations about the US Fed's policy reaction function (Campbell *et al.*, 2016; Raskin, 2013).

Not all scholars are convinced about the effectiveness of FG beyond the near-term (e.g. Filardo and Hofmann, 2014; Kool and Thornton, 2012). Moessner *et al.* (2017) suggest that central banks do not make commitments of the kind that is discussed in theory. Precisely because of the conditionality of the language used by central banks, there have been concerns that UMP may impair any hard-won credibility that central banks had prior to the GFC. For example, event studies do not consider the extent to which there was any loss of trust or credibility in central banks in the lead up to these policy announcements.

3.4 Is Europe Different?

The answer is both yes and no. The succession of programs that began in October 2008 with the fixed-rate full allotment, long-term financing operation (LTRO), followed by the purchases of debt securities held by banks (covered bond purchases or CBPP) in 2009, were akin to the operations to ease liquidity that other central banks also introduced around that time. Of course, the details of these programs reflected some of the specific financial problems that some individual euro area member states faced after 2008.

As the Eurozone crisis unfolded the ECB adopted government bond purchase programs. The first of these programs—the Securities Markets Program (SMP)—was announced in 2010. Purchases under this programme were aimed at reducing high risk premiums. The ECB's second government bond purchase program—the Outright Monetary Transactions (OMT) program— introduced in the third quarter of 2012--had similar technical features. It was not until January 2015 that the ECB adopted a QE program which included outright purchases of government bonds across euro-area member states, and debt instruments issued by international or supranational institutions located in the euro area.

The ECB initially referred to these undertakings as 'non-standard' policies (Coeuré, 2013) although, by 2014, the expression 'unconventional' was more widely used. The strictures imposed by the Maastricht Treaty, at least in principle, forbade a bailout of individual member governments via monetary policy actions. This meant that the ECB had to be scrupulous in not favoring some euro-area member states over others even if the effects of the sovereign debt crisis were clearly asymmetric across different countries in the single currency area. Unsurprisingly

then, the events since 2008 created a heated debate over how much intervention the ECB was permitted and whether it amounted to favoring some member states over others (e.g. Sinn, 2014).

Although the ECB's UMP actions were criticized as being 'too little, too late' (see Kang *et al.*,2016; Wyplosz, 2011),the evidence shows that the ECB's policies were just as effective at lowering long-term yields and more effective at lowering short-term yields than the policies implemented in the US and the UK (see Figure 2). An important caveat is that the ECB's first two government bond purchase programs were aimed at reducing risk premiums in countries under stress (Altavilla, 2016; Fratzscher*et al.*, forthcoming). Indeed, the SMP and OMT were effective in reducing spreads among euro area member countries (Wafte, 2015), while the PSPP appears to have been effective in reducing yields across the euro area (De Santis and Holm-Hadulla, 2017).

Similar delays in policy action were observed in the ECB's use of communication as a policy tool: FG was first introduced in July 2013. The ECB proceeded cautiously by using qualitative guidance. The purpose was to better align financial markets, specifically money market rates, with the ECB's policy stance. It has been deemed successful both at aligning market expectations with the Governing Council's policy intentions and at reducing market uncertainty in short-term rates (European Central Bank, 2014).

Generally, it appears that Europe took a slightly different approach to implementing UMP than other major AEs. In particular, the timeline differed from the actions of the US and UK, which were mainly in response to the GFC. However, legal restrictions in future might hamper the ECB's ability to do "whatever it takes" in the event of a future crisis.[11]

3.5 International Spillovers from UMP

The impact of UMPs introduced by major AEs on exchange rates and exchange rate volatility was particularly controversial. It seems difficult to ignore the cross-border effects of UMP on economies that needed to react to shocks emanating from AEs in crisis. Textbook descriptions presume that flexible exchange rates insulate an economy from external shocks. However, even before the GFC doubts were raised about this conclusion, because de facto regimes seemed at variance from the stated exchange rate regimes (Cook and Devereux, 2016). Moreover, the predicted effects of exchange rates on the trade of goods and services differed from the impact on financial flows (Ilzetzki *et al.* 2017).

Overall, however, the evidence linking QE and UMP to exchange rates is far from conclusive (see Gagnon *et al.*, 2017). Figure 3 shows the range of estimates in the literature on the impact of spillovers from QE to exchange rates and sovereign bond yields. Both positive (appreciation) and negative (depreciation) effects on the exchange rates of domestic currencies in EMEs have been identified. The evidence suggests that the Fed's so-called 'taper tantrum' in the second and third quarters of 2013 caused a depreciation in the currencies of EMEs (Aizenman *et al.*, 2016; Eichengreen and Gupta, 2015; Mishra *et al.*, 2014). In contrast, as also shown in Figure 3, the impact on sovereign bond yields was relatively more consistent in that UMP in AEs lowered yields in EMEs.

The success of QE appears to have put a floor under a potential economic collapse in AEs, and likely did not hurt EMEs. Nevertheless, the literature is unable to reach a firm conclusion that QE actually harmed EMEs in particular. As Bayoumi *et al.* (2017) point out, the arithmetic of adding up the global costs and benefits of UMP remains a work in progress.

4   The International Evidence to Date: Macroeconomic Effects

4.1 Can UMP Have Real Economic Effects?

Many tests of the impact of QE on real economic outcomes rely on some variant of a vector autoregressive (VAR) model, which we will evaluate in this section. Another approach is to use cross-sectional studies that rely on microeconomic data (e.g. lending by banks) to investigate the real effects of UMP (Acharya *et al.* 2017; Bowman *et al.* 2015). Alternatively, various macroeconomic models may be used, such as Real Business Cycle variants (Farmer 2012) or dynamic stochastic general equilibrium (DSGE) models (discussed in section 4.2).

Empirical applications of a VAR model generally ask whether and how monetary policy shocks in the period since the GFC have changed, or whether the introduction of UMP has changed any of the relationships under investigation (see Weale and Wieladek, 2016). Other studies consider how macroeconomic variables such as real GDP growth and inflation responded to QE-like shocks (Altavilla*et al.*, 2016; Bridges and Thomas, 2012). These shocks are often considered to be one-time occurrences and are assumed to exert only transitory effects on the macroeconomy. In any case, the investigator must take a stand not only on the exogeneity of UMP-style interventions, but also concerning the restrictions needed to identify the structural parameters of interest.

Neely (2014) concludes that the likelihood of parameter instability over any sample that includes the GFC implies serious reservations about the reliability of estimates based on these kinds of econometric models. Unfortunately, no clear alternative is provided.[12] Until the relevant econometric lacunae are overcome, if a cross-section of models and estimates that rely on different identification techniques points in the same direction concerning the impact of UMP then we can have some confidence about the macroeconomic impact of QE.

The empirical evidence to date suggests that UMPs have real economic effects, but that these are limited in size and occur with a significant lag. Monetary policy shocks in the form of QE are found to increase real GDP growth and inflation in the US and UK; with the peak impact estimated to occur between two and six years after these central banks first introduced UMPs (Bridges and Thomas, 2012; Engen *et al.*, 2015). In the euro area, targeted government bond buying programs during the sovereign debt crisis increased credit and economic growth in the countries under stress (Altavilla *et al.*, 2016).

An illustration of the VAR approach to examining the effects of QE is Haldane *et al.* (2016). Eschewing the use of dummy variables to identify QE episodes, they rely instead on the size of a central bank's balance sheet (as a percent of GDP). Haldane *et al.* (2016) find that QE effects are state dependent but that spillovers across AEs are relatively strong; see Ball *et al.* (2016), Haldane *et al.* (2016) and Weale and Wieladek (2016) for references to several other studies of this kind. While most VAR models are for single economies, some of the VARs are of the global variety wherein VARs for individual economies are 'stacked' to create a global VAR(GVAR).[13] Chen et al. (2017) is an example that combines data from AEs and EMEs to investigate the global impact of QE. Spillover effects can then readily be estimated from such models. The authors conclude that US-style QE had the largest impact, while the adverse spillover effects on EMEs claimed by some policymakers are exaggerated.

Since there is considerable skepticism about the macroeconomic effects of QE it is worth further exploring the potential impact of UMP style policies. To illustrate, we focus exclusively on the US experience. Suppose that we can summarize the sources of real shocks to the economy by a vector of variables that includes inflation (we use the personal consumption expenditures (PCE) deflator), forecasts of inflation and real GDP growth, real GDP growth, the unemployment rate and oil price inflation. We then reduce the dimensionality of the problem of

evaluating the effects of UMP by estimating the first principal component of these variables. The resulting scores, essentially a linear combination of the variables described above, define the evolution of the real economy in the U.S.[14]

The same logic is used to define a monetary policy factor and a financial factor. The former consists of foreign exchange reserves, changes in the Fed funds rate, and the growth in the money supply. We also estimate separately a version that includes the size of the Fed's balance sheet as a percent of GDP. Finally, the vector that is used to generate scores that define the evolution of financial conditions in the economy includes: credit growth, the return on the Wilshire 5000 stock market index, the VIX, the three-month Treasury bill yield and the yield on 10-year Treasuries, and growth in housing prices.

Figure 4 shows partial results from the estimation of a VAR model that consists of real, monetary and financial factors.[15] We then apply a shock to the monetary factor equivalent to one standard deviation to identify how the real and financial factors respond. In estimating these relationships we consider three variants. The top set of impulse responses is for estimates that end in 2006Q4, that is, before the onset of the GFC. The next two sets are for the full sample that ends in 2016Q4. The difference between the two estimates is that the bottom set of impulse responses incorporates UMP effects (primarily QE) into the monetary factor while the middle set of impulse responses does not.

Two conclusions emerge from the set of impulse responses. First, monetary shocks do not appear to have exerted any real effects either before or after the crisis, whether or not we include the UMP proxy. All the reasons noted previously apply. However, perhaps most importantly, the monetary factor can also have prevented a fall in the real factor while monetary policy was, as theory would suggest, largely neutral in real economic terms during the Great Moderation.

Turning to the financial factor we observe, as noted above, that an improvement or loosening of financial conditions is associated with a loosening of monetary policy. While the impulse responses become insignificant after three quarters for the pre-crisis sample, the effect disappears after two quarters when the monetary factor excludes the central bank assets to GDP ratio and only after one quarter when the UMP proxy is incorporated. Therefore, QE may have helped to improve financial conditions, but the impact deteriorated over time. This result broadly parallels

some of the findings discussed earlier about the size and duration of QE effects using data sampled at a much higher frequency.

Finally, Figure 5 considers a counterfactual. Suppose that the economy evolved as if the estimates of the VAR until the end of 2006Q4 remained unchanged until the end of the available sample (2016Q4). How would real and financial factors respond to a monetary shock? We observe that a positive monetary shock produces a small but statistically significant temporary boost to real activity that lasts two quarters and partly reversed after the fourth quarter. The improvement or loosening of financial conditions reported earlier remains as in the pre-crisis sample shown in Figure 5, although the effect persists for a little longer (four quarters). Once again, it appears that the policy interventions undertaken after 2008 may have prevented a decline in real activity but did not provide the boost that some expected.

4.2 DSGE Alternative

An alternative to the estimation of VAR-like models is estimation using DSGE models that are widely used by many central banks. They have been criticized because they used to ignore a role for the financial system and were based on stringent assumptions about the rationality of inflation expectations, among other issues.[16]

The strength of DSGE models lies in their ability to provide a coherent explanation for what might happen under certain economic conditions when the channels through which monetary policy is thought to operate are clearly spelled out. Their weakness is that such models typically fail to explain macroeconomic facts very well. This is partly due to the technical difficulties that DSGE models face when the ELB is breached. However, each failure with such models spurs a search for improvements, and critics of the DSGE methodology often do not fully appreciate the progress made in less than a decade (Binder *et al.*, *forthcoming*). Jones (2015), for example, overcomes DSGE model difficulties in the presence of the ZLB by treating the economy as subject to a sequence of contractionary shocks that can ostensibly be overcome with FG. On this basis, FG does produce benefits for output and inflation that otherwise would not have been observed. This is only one of many other examples that have led to improvements in DSGE models' ability to explain macroeconomic facts. Nevertheless, there is the risk that such models become too complex; the experience of large scale models of a few decades ago that were eventually discarded as 'incredible', led to a new generation of more compact and

econometrically sensible econometric models--a reminder of how a once promising research agenda can be transformed.[17]

4.4 Central Bank Credibility and Inflation Expectations

An important consideration is whether central bank credibility has taken a hit since the GFC. Bordo and Siklos (2016a, 2016b) have noted that there is no consensus on how to measure central bank credibility. Nevertheless, there is an expectation that actual inflation performance ought to be closely associated with a broad set of inflation expectations. Bordo and Siklos (2016b), relying on a large panel of countries, conclude that central bank credibility was adversely affected by the GFC. However, monetary authorities with strong institutional features (e.g., countries with an inflation target, central banks with greater transparency and autonomy) fared much better.

Other studies that focus on particular events or economies have reached somewhat different conclusions. Moessner (2014) does not find that the ECB's credibility changed by the events of recent years. Raynard (2012) indicates that if QE is supposed to raise inflation expectations, in part to avoid a deflationary outcome, the data suggest that the GFC has not changed the relationship between money growth and inflation. Campbell et. al (2012) highlight a role for FG in influencing inflation expectations and conclude that private sector forecasters did respond to central bank communication policies.

Monetary policy rules also play an important role in Engen *et al.*'s (2015) study that examines U.S. Blue Chip forecasts. While the Fed's FOMC was found to successfully influence inflation expectations, the continued delay in the economic recovery tempered the potential real economic impact of QE. Whether this outcome can be linked to Orphanides' (2015) claim that the Fed "procrastinated" when it reversed course away from continuing to implement an ultra-loose monetary policy is unclear.

5   Conclusions: Lessons Learned, the Exit, and the 'New Normal'

The body of evidence that seeks to measure the economic and financial repercussions of the GFC has accumulated very quickly. There is already considerable evidence that UMPs can be powerful tools to blunt the negative economic effects of a financial crisis. Financial crises come

in different forms; if their impact and origins are heterogeneous (Bordo and Haubrich, 2017; Romer and Romer, 2017), so too must be the policy responses.

Some policymakers have a tendency to insist on a "never again" attitude toward financial crises; but this approach is unrealistic. Perhaps we should instead borrow from the Dutch, most of whom live at or below sea level and face infrequent but potentially devastating floods they have chosen to live *with* water, not to fight it. In other words, we should abandon the thought that we can prevent all manner of financial crises and learn instead to live with smaller crises--a common occurrence in history as Reinhart and Rogoff (2009) have clearly demonstrated--while seeking to avoid crises of the kind that produced the Great Depression or the Great Recession of 2008-2009.

The events that began in 2007 also teach us that any successful monetary policy response should be forceful (see also Geithner, 2016), that a joint response from both the fiscal and monetary authorities is essential, and that the policy response should be persistent until confidence and the conditions for full recovery are in place. Moreover, depending on the size and the spread of the financial crisis, a premium ought to be placed on a mechanism that allows for a rapid and at least cooperative, if not coordinated, international response.

It remains in the realm of a counterfactual to ask whether a faster and more aggressive easing of policy might have restored confidence more quickly. Even more intriguing is whether this kind of approach might have made the exit back to normal conditions less time-consuming and difficult. Clearly, complicating the exit is not the technical element in removing policy accommodation. Instead, it is how the accumulated loss of credibility and trust in central banks may have affected public uncertainty and skepticism about whether economic activity has returned to normal. UMP has demonstrated that it can reduce the economic costs of a financial crisis. However, the monetary authorities have been reluctant to claim that it can restore growth to pre-crisis conditions unless other policies, in the realm of fiscal and structural policies, are also enacted. As a result, they are caught in a trap where their policies may actually contribute to delaying a return to more normal conditions. The fact that some central banks are beginning to reverse course on policy rates in spite of inflation rates that remain below target may well be an indication that they are aware of the dilemma they face.

Finally, it is worth asking, if the old normal is not in our future, whether the new normal in monetary policy should routinely include the panoply of instruments and interventions that make up what are now referred to as UMP? To the extent that the wide variety of interventions is a product of past failures and greatly complicates the task of monetary policy, the answer should be in the negative. Using a wide range of instruments that can prevent economic collapse, but are not designed to promote adequate economic growth, does not appear to be a sound monetary policy strategy. Far better to utilize new communication devices together with standard monetary policies to deliver not just low and stable inflation but to do so in a credible fashion. This might also prevent future policy makers from asking--or expecting--too much from their central banks.

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[1]Belongia and Ireland (2017) remind us that reverting to alternative monetary rules—for example, targeting the monetary base or monetary aggregates, as opposed to an interest rate rule—avoids the zero bound and, in principle, can be more effective at stabilizing nominal income than negative interest rates. Other studies in this monetarist vein also support the view that monetary policy around this time helped cushioned the blow from the GFC (e.g., Beckworth, 2017; Congdon, 2010; Hetzel, 2009; Sumner, 2011).

[2] There is no unique definition of a financial crisis but the ones adopted by Reinhart and Rogoff (2009) are arguably the best known. Our interpretation on data from Bordo and Landon Lane (2013), who build on the earlier work of Bordo *et al.* (2001) and Laeven and Valencia (2012). There is disagreement about the incidence of financial crises (see Bordo and Meissner, 2016). The latest addition is due to Romer and Romer (2017). Their chronology for AEs also departs from the one proposed by Reinhart and Rogoff (2009).

[3] This would be unconventional for the AEs but not all EMEs. Nevertheless, since the GFC, not even the EMEs have changed their inflation targets.

[4] Paralleling this development is the suggestion that, except for small denominations, cash should be removed altogether especially in AE. See, for example, Rogoff (2016b).

[5] There may also be a problem with identifying the timing of certain events. Should one date the event when an intention to do something is announced as opposed to when the action is taken? For example, Draghi's "whatever it takes" pronouncement in London in July 2012 caused a major market reaction, but the actual OMT policy details were announced September 6th.

[6] The Japanese example has come to be called a case of a balance sheet recession (Koo 2015).

[7] The term 'escape velocity' was coined by BoE Governor Mark Carney (2014) and refers to "the momentum necessary for an economy to escape from the many headwinds following a financial crisis".

[8] After factoring in demographic factors, Borio *et al.* (2015, Box 2) argue that only the 1990s can be characterized as a lost decade, as growth in GDP per capita exceeded that of the US after 2000.

[9] Of course, as elaborated by Haldane *et al.* (2016), asset purchases are likely to have a larger effect during times of market turmoil; a feature we also observe for the euro area's experience to be discussed below.

[10] The BoJ used a combination of calendar-based and state-contingent FG as part of its QQE program; but the discussion in Section 3.2 shows why it may not be the best case for analyzing the effectiveness of FG.

[11]The ECB may not be the only central bank that suffers from a potential loss of flexibility in a future crisis. The Dodd-Frank reforms of 2010 also placed new limits on the Fed. Geithner (2016) argues that a future crisis will reduce the margin of the Fed to ease financial conditions in the manner it did in 2008 and 2009.

[12] A referee suggested that a time-varying estimation approach is preferable. This is undoubtedly true. However, time-varying VARs of various kinds (whether of the Bayesian variety or not) are unlikely to be conclusive at this point because existing sample spans provide a limited number of time-varying coefficients that can be estimated with reasonable precision especially when quarterly data are employed.

[13]Chudik and Pesaran (2016) is a recent survey of the GVAR technique. This modeling approach consists in attempting to estimate a model for N economies in the VAR framework for the express purpose of recognizing that macroeconomic linkages exist between the countries in a dataset. It is ideally suited to explore questions of financial integration and cross-country spillover effects. Nevertheless, since the technique requires a large number of

restrictions GVARs can be difficult to estimate and the identification of some shocks may not always have a readily available economic interpretation. Another alternative is the panel VAR approach.

[14] Statistical testing (not shown) reveals that the first principal component accounts for the overwhelming proportion of the total variation across the estimated principal components.

[15] Six lags are specified based on several lag selection criteria. The results are largely unaffected if we reverse the order of the monetary and financial factors.

[16] Among the most prominent critics are Buiter (2009), and Krugman (2016), though the criticisms are often levelled at earlier generations of such models. A more recent critique by Romer (2016) raises broader criticisms of central bank modeling strategies. In all of these cases there is insufficient recognition that judgment still plays a dominant role in central bank decision-making (Siklos, 2017). Some of the criticisms of this approach, especially the difficulty of modeling heterogeneity across firms, financial institutions and individuals, does continue to have some resonance.

[17] Blanchard (2016) also offers a sharp critique of DSGE modelling while defending its usefulness. Interestingly, given the importance central banks place on communication, one of his chief concerns is how such models fail in this regard.

Acknowledgments

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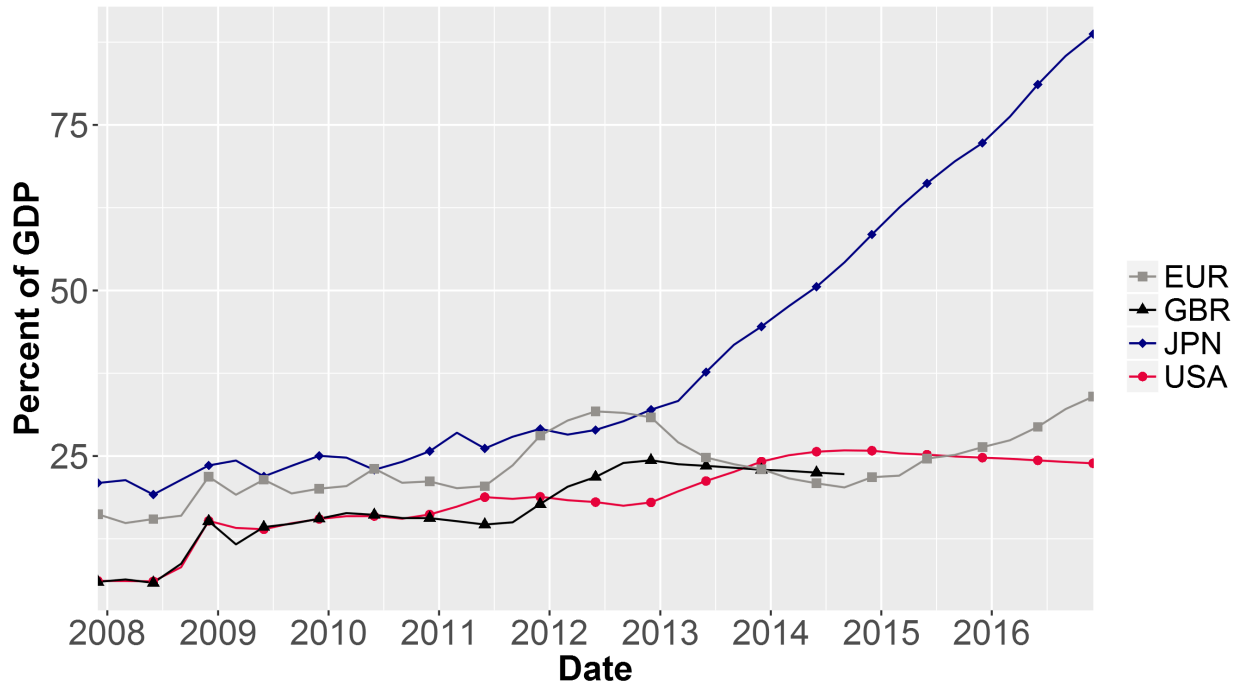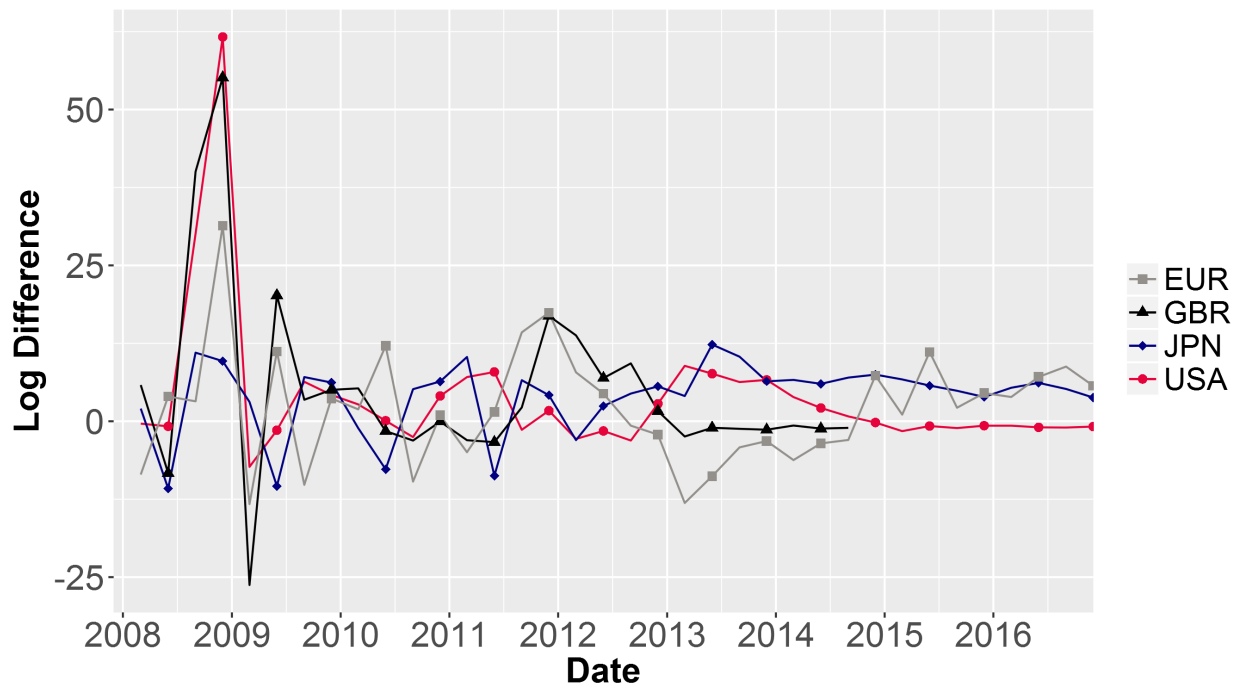**Figure 1A Central Bank Assets as a Percent of GDP**

Figure 1B Quarterly Rate of Change in Central Bank Assets as a Percent of GDP

Note: Data Source is CEIC. Sample size is from 2007Q4 to 2016Q4. The Bank of England changed its methodology for reporting its balance sheet in October 2014; the series therefore ends 2014Q3.

Table 1 Unconventional Monetary Policies in Advanced Economies (Chronological by Type)

Policy Type	Economy	Policy Name	Time Period
Forward Guidance[1]			
Qualitative	Japan	zero interest rate policy (ZIRP)	April 1999 to August 2000
	United States	n/a	August 2003 to December 2005
	United States	n/a	December 2008 to July 2011
	Euro area	n/a	July 2013 to present[2]
Calendar-Based	Canada	n/a	April 2009 to March 2010
	United States	n/a	August 2011 to November 2012
State-Based	Japan	n/a	March 2001 to March 2006
	Japan	n/a	October 2010 to March 2013
	United States	n/a	December 2012 to February 2014
	Japan	n/a	April 2013 to present[2]
	United Kingdom	n/a	August 2013 to January 2014
Balance Sheet Policies			
Quantitative Easing	Japan	Quantitative Easing (QEJ)	March 2001 to March 2006
	United States	Large Scale Asset Purchase Program (LSAP1)	January 2009 to March 2010
	United Kingdom	Asset Purchase Facility – Gilt (BQE1)	January 2009 to February 2010
	Japan	Comprehensive Monetary Easing (CME)	October 2010 to March 2013
	United States	Large Scale Asset Purchase Program (LSAP2)	November 2010 to June 2011
	United Kingdom	Asset Purchase Facility – Gilt (BQE2)	October 2011 to October 2012
	United States	Large Scale Asset Purchase Program (LSAP3)	September 2012 to October 2014
	Japan	Quantitative and Qualitative Monetary Easing (JGB purchases)	April 2013 to present[2]
	Euro area	Public Sector Purchase Programme	January 2015 to present[2]
	United Kingdom	Asset Purchase Facility – Gilt (BQE3)	August 2016 to present[2]
	Switzerland	Expansion of Sight Deposits (Reserves)	August 2011
	Sweden	Government bonds	February 2015 to present[2]
Credit Easing	United States	Commercial Paper Funding Facility	October 2008 to February 2010
	United States	Mortgage-Backed Securities Purchases (see also LSAP1)	November 2008 to March 2010
	Switzerland	Private Sector Bond Purchases	March 2009 to July 2009
	United Kingdom	Asset Purchase Facility –	March 2009 to November 2011

|		Commercial Paper	
	United Kingdom	Asset Purchase Facility – Secured Commercial Paper and Corporate Bond Secondary Market Scheme	March 2009 to August 2016
	United States	Operation Twist	September 2011 to June 2012
	Euro area	Securities Markets Programme	May 2010 to September 2012
	Euro area	Outright Monetary Transactions Programme	September 2012 to present[2]
	Euro area	Asset Backed Securities Purchase Programme	September 2014 to present[2]
	Euro area	Covered Bond Purchase Programme	July 2009 to June 2010; November 2011 to October 2012; October 2014 to present[2]
	Japan	Quantitative and Qualitative Monetary Easing (ETF and J-REIT purchases)	April 2013 to present[2]
	Euro area	Corporate Sector Purchase Programme	June 2016 to present[2]
	United Kingdom	Asset Purchase Facility – Corporate Bond Purchase Scheme	September 2016 to April 2017
Subsidized Lending to Banking System	Euro area	Longer-term refinancing operations (LTRO)	6 month: March 2008 to March 2010; August 2011 12 month: May 2009 to December 2009; October 2011 3 year: December 2011
	United States	Term Asset-Backed Securities Loan Facility (TALF)	November 2008 to June 2010
	Japan	Loan Support Program	June 2010 to present[2]
	United Kingdom	Funding for Lending Scheme	July 2012 to present[2]
	Euro area	Targeted longer-term refinancing operations (TLTRO)	September 2014 to March 2017
	United Kingdom	Term Funding Scheme	September 2016 to present[2]

1.Forward guidance only refers to the ad-hoc use of central bank communication of future policy path during crises or periods of high market uncertainty. The release of conditional forecasts (e.g. at the Reserve Bank of New Zealand, Norges Bank and Riskbank) are not included in this analysis (see, e.g. Kool and Thornton, 2012).

2.As of 31 October 2017.

Source: Individual country central banks accessible via the BIS's Central Bank Hub (https://www.bis.org/cbanks.htm).

Figure 2 Summary of Selected Empirical Studies:
The Impact of UMP on Long-Term Government Bond Yield
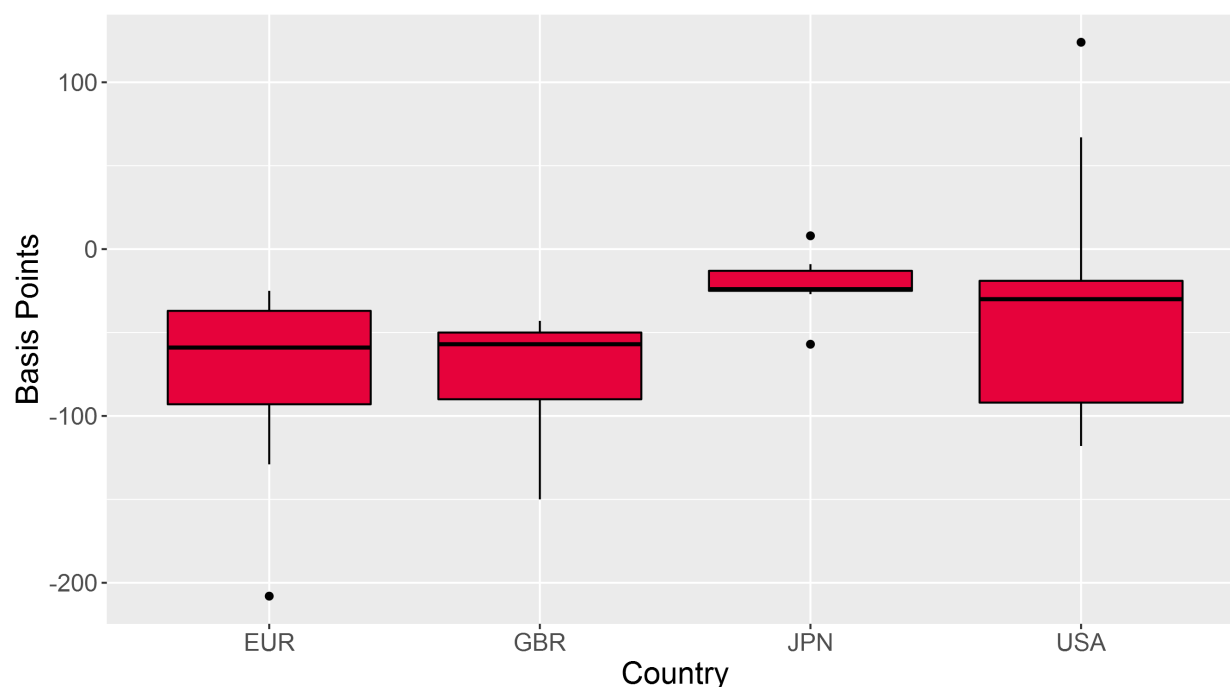
Note: N = 62. Impact on government bonds expressed in basis points. When the study reports several estimates, the minimum and maximum estimates, or estimates using various techniques are recorded.

Euro area (EUR): N = 13. Studies include Altavilla *et al.* (2016), Andrade *et al.* (2016), De Santis and Holm-Hadulla(2017), Eser and Schwaab (2016), Fic (2013), Fratzscher *et al.*(2016), *et al.* (2015), Middledorp (2015), Middledorp and Wood (2016).

United Kingdom (GBR): N = 11. Studies include Breedon *et al.*(2012), Bridges and Thomas (2012), Caglar *et al.* (2011), Christensen and Rudebusch (2012), Churm *et al.* (2015), Fic (2013), Gros *et al.*(2015), Joyce *et al.* (2011).

Japan (JPN): N = 9. Studies include Fic (2013), Fukunaga *et al.*(2015), Gros *et al.*(2015), Lam (2011), Ueda (2012).

United States (USA): N = 29. Studies include Bauer and Rudebusch (2014), Christensen and Rudebusch (2012), D'Amico and King (2013), Engen *et al.*(2015), Fic (2013), Fratzscher *et al.*(forthcoming), Gagnon *et al.* (2011), Gros *et al.*(2015), Hamilton and Wu (2012), Ihrig *et al.* (2012), Krishnamurthy and Vissing-Jorgensen (2011, 2013), Li and Wei (2013), Neely (2010), Swanson (2011).
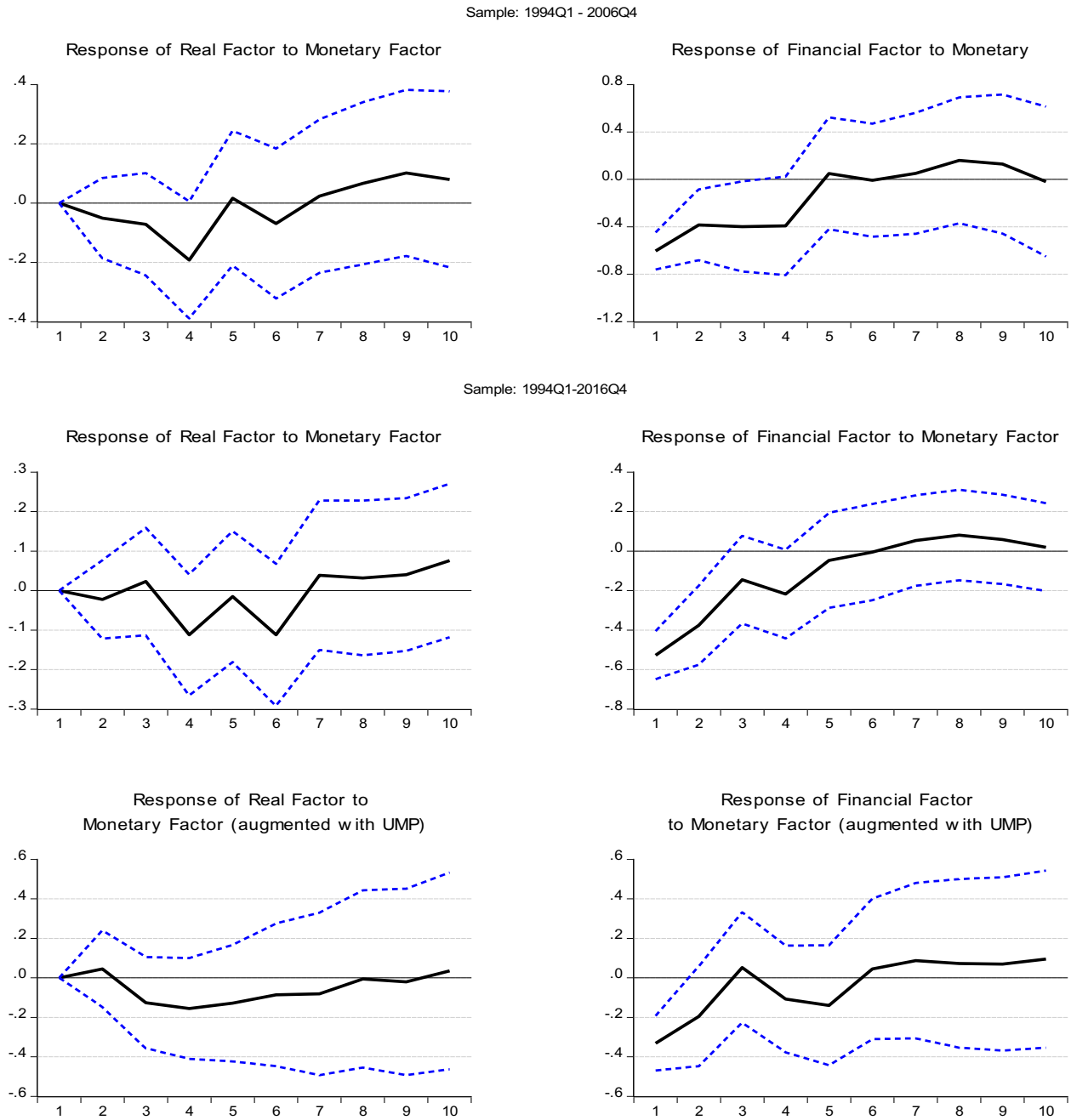
Figure 3 Summary of Selected Empirical Studies: Spillovers of UMP on EMEs

**A. Long-Term Sovereign Bond Yields B. Exchange Rates**
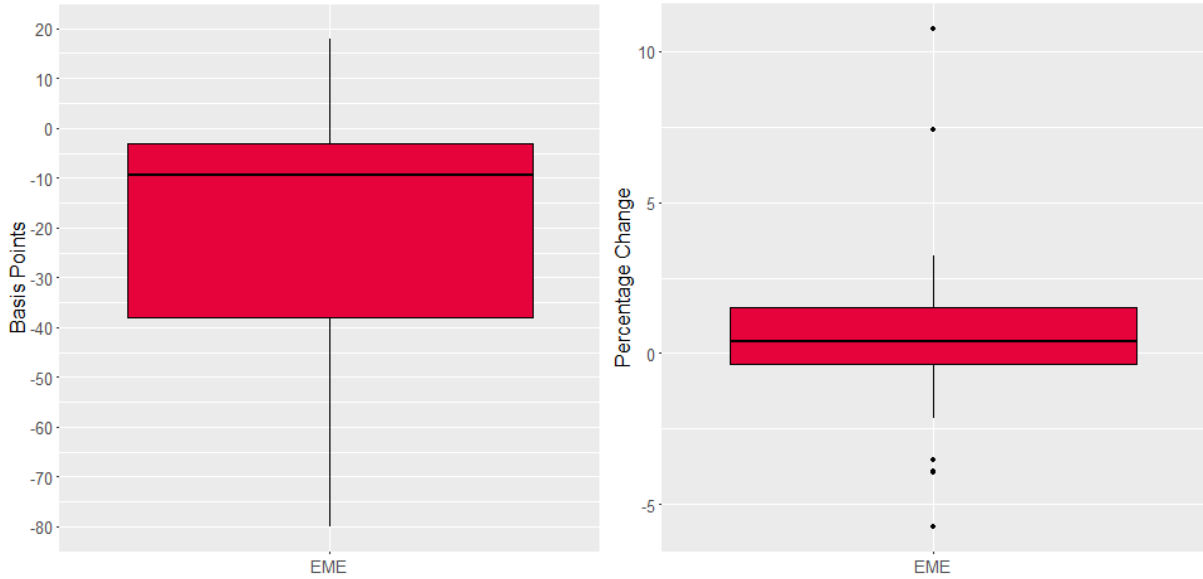
Note:NForex = 25; N Long-term yields = 24. Impact on government bonds expressed in basis points, and impact on foreign exchange rates is expressed as percentage change with a positive value referring to a domestic currency appreciation against the benchmark currency (mainly US dollar). Studies include Aizenman *et al.* (2016), Chen *et al.* (2013), Chua *et al.* (2013), Falagiarda *et al.* (2015), Fic (2013), Fratzscher *et al.*(2016; forthcoming).

Figure 4 Varieties of Impulse Responses: USA

Sample: 1994Q1 - 2006Q4

Response of Real Factor to Monetary Factor

Response of Financial Factor to Monetary

Sample: 1994Q1-2016Q4

Response of Real Factor to Monetary Factor

Response of Financial Factor to Monetary Factor

Response of Real Factor to Monetary Factor (augmented with UMP)

Response of Financial Factor to Monetary Factor (augmented with UMP)

Note: A vector autoregression of order 2 is estimated for the samples shown above. The VAR consists of a real factor, a financial factor, and a monetary factor, in that order. Confidence intervals are estimated via bootstrapping (1000 replications).

Figure 5 Counterfactual Experiment: What If the Crisis Never Happened?

Response of Real Factor to Monetary Factor

Response of Financial factor to Monetary Factor
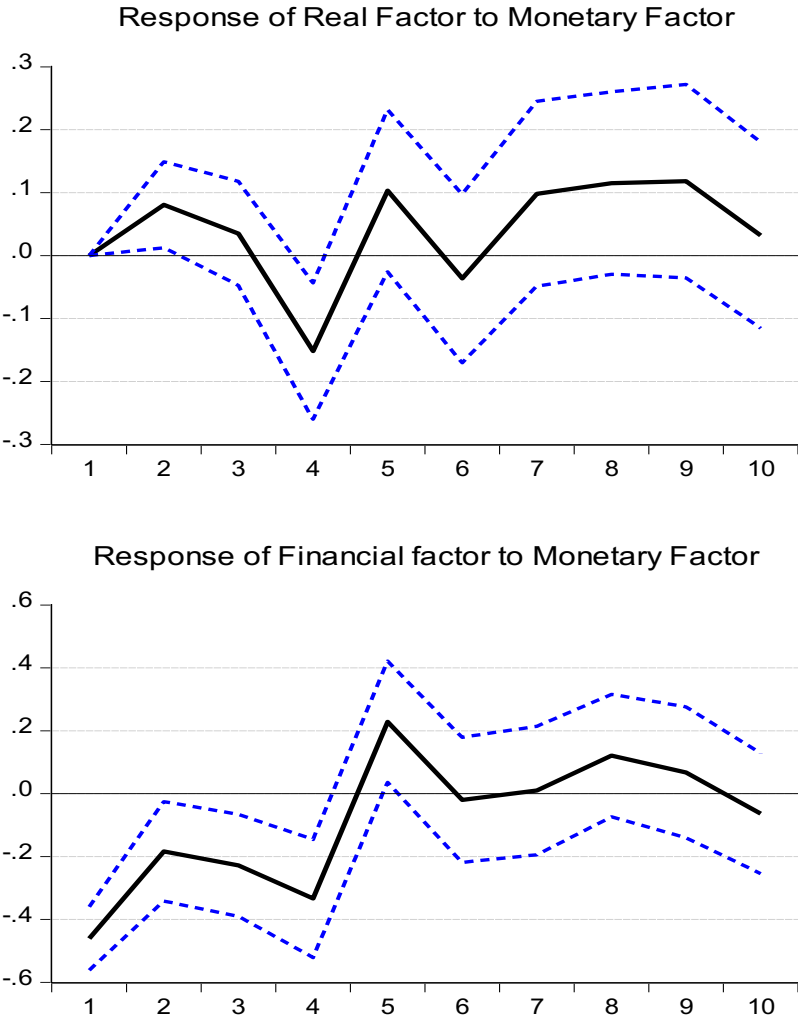
Note: See the notes to Figure 4 for estimation details. The counterfactuals are described in the main body of the paper.