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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 were found to be successful and where the impact remains questionable. We survey the international financial market and macroeconomic effects of UMP both in the economies where these policies were introduced as well as their spillover effects across borders. The paper considers a wider range of UMP rather than the impact of specific policy instruments. We do so by providing a retrospective on the important case of Japan beginning in the later 1990s. We ask whether the Eurozone's experience with UMP is substantively different, given the structure of policymaking. Finally, we ask 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? We conclude that 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 adopt an effective communication strategy. This 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 policy (UMP) became household words. Perhaps for this reason, there are many news headlines questioning the effectiveness and rationale for the continuation of these policies.[1] 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 non interest rate forms of monetary easing.[2] This study examines the empirical literature on the effectiveness of UMP in responding to financial crises and boosting economic activity. In doing so, it considers under what circumstances these policies have been found to be successful and examines cases where the impact remains questionable.

Before the 2007-09 global financial crisis (GFC), that is, until 2006, 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 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.[3] However, as a period of low-growth and low-interest rates settled in advanced economies (AEs), several central banks implemented negative interest rates alongside UMPs. Thus the ZLB expression has been replaced with the term effective lower bound (ELB) in recognition that the article of faith once held by many policymakers has been abandoned (e.g. see Lombardi, Siklos, and St. Amand, *forthcoming*, and references therein).

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[1] QE was coined in Japan following an earlier, but failed, attempt at ending a mild episode of deflation (see section 3.2 below). What follows is a sampling of recent press headlines critical of UMP. There are also academic critics, as we shall see. "Central Banks' Failed Policies", 10-3-2016 *Japan Times*; "Central Banks Double Down on Failed Policies", 9-26-2016 *Market Watch*; "Global Monetary Policy Becoming Less Effective", 10-7-2016 *Bloomberg*; "US and Japanese Central Bankers Are in Denial…" 9-27-2016 *South China Morning Post*; "Cheap Money? I Think We've Had Quite Enough of That", 10-6-2016 *Daily Telegraph*; "Cheap Money Points to More Taper Tantrums", 9-20-2016 *Financial Times*; "It's Not Working, 10-7-2016 *Globe and Mail*; "The Federal Reserve Needs New Thinking", 8-24-2016, *Wall Street Journal*; "Old Tools, New Reality A Struggle for Central Banks", 10-05-2016 *New York Times.*

[2] One need only scan the title of central bankers' speeches to confirm this view. See https://www.bis.org/list/cbspeeches/index.htm?m=7%7C123.

[3] Belongia and Ireland (*forthcoming*) 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 can, in principle, be more effective at stabilizing nominal income than negative interest rates.

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 quelling shocks to the financial system. An unconventional policy need not only be used when the ELB has been reached. It might also be implemented to prevent reaching that threshold or to provide targeted policy support to specific segments of the financial system or economy more generally. In addition, unconventional tools need not be used only to provide monetary stimulus, though there are few examples of their use during tightening cycles. We provide in section 2 a 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 appears to originate, in part, 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 across various segments of the financial markets 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 interest rates and further stimulus through UMP have amplified both domestic and international spillover effects (e.g. Rajan, 2014).[4] 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 attempting to understand how UMP and the ELB have impacted economic outcomes one is also struck by the shifts over time concerning the ultimate aims of these policies. In particular, policymakers argued that using these policy tools was necessary to prevent an even worse contraction in the wake of the GFC, and, once the crisis passed, 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 both in the economies where these policies were introduced as well as their spillover effects across

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[4] Spillover effects existed prior to the last financial crisis. The issue is whether UMPs exacerbate these effects.

borders. This is not the only survey of its kind. However, this survey considers the range of international experiences and implications of UMP, while others have focussed more on the outcomes in specific countries (e.g., 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 (e.g., 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, this survey emphasizes the diversity of experience and outcomes in using UMP. We provide a retrospective on the important case of Japan beginning in the later 1990s. We also consider whether the Eurozone's experience with UMP is substantively different, given the structure of macroeconomic policymaking and of the financial sector.

Finally, we present some new evidence that underscores one of the main claims made by central bankers about UMP: that they were essential in preventing much worse economic outcomes, at least in AEs, after the 2008 financial crisis. We show how the principal benefits of UMPs produced a relaxation of financial conditions that was unprecedented in historical terms. This conclusion is important because it suggests that UMPs should not be considered as part of a 'new normal' but are best thought of as a set of policies to be applied in exceptional circumstances such as in a financial crisis. 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 that have been put in place primarily in Japan, the US, the UK, and the Eurozone—the economies that were most directly implicated by the GFC. We focus mainly on these four economies, tough we also touch upon the implementation of UMP in the small open economies such as Canada, Sweden, and Switzerland, where there experiences were of significance. 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, they have been recurring phenomena throughout history. Yet, at the time their volume was published, UMP had not yet entered the vocabulary of the central bankers.[5]

Was there something fundamentally different about the events that began in 2007?[6] There are at least two notable differences between the GFC and all crises that preceded it, save perhaps for the Great Depression of the 1930s. First, and perhaps most obviously, the crisis began and was centered in AEs. Previously, financial crises were phenomena typically restricted to developing or emerging market economies (EMEs).

Figure 1 shows the incidence of financial crises since 1980. 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.[7] Aggregating all types of financial crises we observe 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 banking crises in EMEs was in the early 1980s.[8] Of course, banking crises were not unheard of in AEs prior to 2007 (e.g. 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 perfect storm of late 2008 and the prolonged economic stagnation that followed.

Second, central banks in the economies most directly affected began with relatively low interest rates, as shown in Figure 2. However, inflation rates were also relatively low. Policy rates for three key central banks began around 5 percent at the beginning of 2007, the Bank of Japan (BoJ) is the exception which had been maintaining its policy rate near zero since the late

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[5] Indeed, the index to their book lists neither UMP nor QE.

[6] The Federal Reserve Bank of St. Louis' crisis timeline begins in February 2007 with the announcement that the Federal Home Loan Mortgage Corporation would cease purchasing the riskiest mortgage-backed securities (MBS).

[7] There is no unique definition of a financial crisis but the ones adopted by Reinhart and Rogoff (2009) are arguably the best known. The data used in Figure 1 are from Bordo and Landon Lane (2013), who build on the earlier work of Bordo et al. (2001), and Laeven and Valencia (2012). There is some disagreement about the incidence of financial crises (see, for example, Bordo and Meissner 2016). The latest addition is due to Romer and Romer (2017) whose chronology for AEs also departs from the one proposed by Reinhart and Rogoff (2009).

[8] Readers need to keep in mind that the Asian Financial Crisis of 1997-1998 is a feature in only one of the countries in the sample of EMEs (viz., Thailand) and, hence, does not affect the median estimate.

1990s. The low starting point may have contributed to some hesitancy in rapidly lowering interest rates, especially before the height of the liquidity crisis when Lehman Brothers went bankrupt. Indeed, the Bank of England (BoE) only lowered its policy rate by 75 basis points from the peak of last tightening in July 2007 until September 2008; then lowered interest rates 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 declined 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 (e.g., see IMF 2003).

Against this background, widespread introduction of UMPs 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 akin to an outlier, that is, more aggressive than its counterparts elsewhere where the shift from price-based monetary policy tools to quantity-based tools took place. Figure 3 shows that this has not been the case. The top portion (Figure 3A) 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 data show a sharp increase in late 2008 the ratio of Fed assets to the size of the US economy rises only modestly thereafter. Indeed, there are similar increases that occur simultaneously at both the ECB and the BoE. Even the BoJ expanded its balance sheet 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 increase sharply once again as the impact of the Eurozone crisis begins to take hold in that part of the world. The most dramatic increase occurs 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 3B it is immediately seen that the largest interventions via the central bank balance sheet takes place in late 2008 and early 2009, at least at the Fed and the BoE where the increases are massive. The rate of accumulation in central bank assets subsides shortly thereafter except, as

noted above, at the BoE and the ECB in 2011 during the Eurozone crisis. While the interventions in Japan after 2013 show steady increases, producing approximately linear growth in the balance sheet to GDP ratio.

Figure 3, however, contains another important message. Well before approaching the ZLB in the two economies most implicated in the GFC, the Fed and the BoE began to shift emphasis away from the policy rate to the composition of their balance sheets as a means of influencing the stance of monetary policy. Balance sheet policies were being used as a way of restoring confidence and easing the flow of credit in the financial sector.

Figure 4 illustrates the sharp deterioration in lending conditions in the four economies being reviewed. A rise in the index (see Lavender and Siklos, 2015; Siklos, 2015) signals that Senior Loan Officers in these economies express a desire to tighten lending standards. The increase is largest in the United States, but is also significant in the euro area and the United Kingdom. Only Japan, mired in a low inflation and growth, seems 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. UMPs were initially intended to ease lending and liquidity conditions in the financial system as well as restore confidence. After the worst of the financial crisis had passed, however, UMP tools began to be used as substitutes for conventional policy to stimulate economic activity. Policymakers concerns shifted to the possibility that AEs were in the throes of secular stagnation, that is, a reduced level of economic growth likely to persist for many years.[9] At the same time, the debate over the advisability of QE and other UMPs as permanent tools in the arsenal of monetary policy instruments became more prominent.

2.2 A Brief Typology of UMP

Space limitations prevent a detailed discussion of different types of UMPs; therefore, we only provide a brief description of UMP tools. For a more extensive account of these policies see, for example, Ball et al. (2016) and IMF (2013).

For 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 quelling shocks to the financial system. An unconventional

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[9] Summers (2016) revives the notion of secular stagnation first proposed by Alvin Hansen in the 1930s in the aftermath of the Great Depression.

policy 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. In addition, UMP tools need not be used only to provide monetary stimulus, though there are few examples of their use during tightening cycles. Table 1 provides a summary of the types of UMP employed in AEs.[10]

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 (viz., the monetary base); therefore, it always involves a change in the central bank's balance sheet. Credit easing (CE) is another balance sheet policy which changes the composition of the central bank's assets. The aim is to improve liquidity conditions in one or more segments of the financial market, but it need not be associated with 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 aims to create incentive 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), ECB (2015) and Stone, Fujita and Ishi (2011) for more detailed discussion and alternative classifications of balance sheet policies.[11]

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. Specifically, forward guidance (FG) is a set of policy tools that use communication to affect policy outcomes. These policies are not new, having been introduced by the BoJ almost two decades ago (see, inter alia, Filardo and Hofmann, 2014). FG has also played an important, if secondary, role in the conduct of monetary policy since the GFC erupted.

FG can take several forms. Qualitative guidance involves clear communication of the central bank's views about future policy actions. Two examples include the US FOMC's statement starting in December 2008 that "weak economic conditions are likely to warrant low levels of the

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[10] Note that we present one of several ways to categorize UMP; there are indeed many different typologies for these policies and there are also no neat separations among policies.
[11] 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.

federal funds rate for some time" and 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". These statements seek to better align market expectations with the central bank's view of the future policy path, but stop short of offering any sort of commitment. 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, however, the distinction between different form of FG is somewhat misleading as central banks may use a mix.

Campbell et al. (2012) suggest an alternative way of thinking about FG, rooted in the potential incentive of policymakers to renege on a promise not to exploit the widely used Phillips curve trade-off. The so-called time inconsistency problem is at the core of macroeconomic analysis, though in practice it is thought to be less influential than theory lets on (e.g. Blinder, 1999). In addition, there are even doubts about the precise nature of the Phillips curve trade-off (e.g. Halls, 2013; alternatively, see Fischer, 2016). For more details on FG policies, refer to Moessner, Jansen and de Haan (2016), 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 continue to persist to this day; see Lombardi, St. Amand and Siklos (2017) and Siklos (2017), and Table 4.2 for an outline of the economies that have introduced negative policy interest rates. 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, 2013). The evidence on the effectiveness of these tools are not discussed within this paper as it remains a conventional policy tool according to our definition.

Two UMP that have yet to be implemented are: helicopter money[12] and changing the inflation objective.[13] The former essentially transfers funds directly into the hands of the public

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[12] The term was coined by Milton Friedman in the same reference where deflation is used to drive nominal interest rates to zero (Friedman 1969).

(e.g., via cash or bank deposits). It has been given serious consideration by scholars (e.g. Buiter, 2014; Turner, 2016, chapter 14); however, there are few indications that any countries are anywhere near considering such an option even if the global economy reverts back into recession. Nevertheless, 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; Rogoff 2016, Camera 2017), 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.[14]

In the 1980s, there was a shift towards monetary policy objective of low and stable inflation. This eventually culminated in the specification of a numerical target for the inflation objective, often set around 2 percent in headline inflation with a tolerance zone of ±1 percent. As inflation targeting spread to EME, the target levels were typically set higher and tolerance zones wider than in AE (see appendix). 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 (e.g. 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 (e.g. Blanchard, Dell'Ariccia and Mauro, 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 (e.g. 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 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

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[13] This would be unconventional for the AEs but not all EMEs. Nevertheless, since the GFC, not even the EMEs have changed their inflation targets. See the Table in the appendix to the paper which traces the history of inflation objectives in countries that are considered to target inflation.

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

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.

Other unconventional tools that may be employed by the central bank in an effort to achieve the monetary policy objective include capital controls and financial repression. As these are policy tools that typically fall under the mandate of agencies statutorily responsible for supervision of the financial system or the maintenance of financial system stability and because it also includes a fiscal policy element, we do not elaborate on these policies. More recently, policymakers have sought to skirt the notion that financial repression should be used as a policy tool by instead appealing to macroprudential regulations.

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

3   The International Evidence to Date: Financial Markets

3.1 Measurement Challenges

There are at least three critical difficulties in evaluating the impact of UMP on financial markets. First, there is usually considerable speculation about an upcoming announcement ahead of the actual announcement. A good example is the announcement of QE in the Eurozone. Beginning in the late fall of 2014 there were a number of clues, based on speeches and other forms of communication, that such a policy was being contemplated. By the end of the year financial markets anticipated that the announcement of QE was imminent; therefore, the announcement in January 2015 had only limited impact.

Next, the fact that the policies surveyed in this paper are considered unconventional implies that, unlike conventional monetary policy that is announced following scheduled policy committee meetings, UMP announcements are infrequent. As a result, the number of available 'observations' is generally small. These features likely explain a preference for relying on event

type studies to investigate the impact of UMP on financial markets. Nevertheless, if each event is taken in isolation then an event 'window' also needs to be defined.[15]

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; e.g. Rogers, Scotti and Wright, 2014). Increasing the sampling frequency, however, confronts a trade-off between the precise measurement of the timing of events against the likely persistent impact and feedback effects across markets and investor types. 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 research that adopt an event study approach includes Aït-Sahalia et al. (2010), Christensen and Rudebusch (2012), Gagnon et al. (2011), Rogers, Scotti and Wright (201 4), Chen et al. (2014), Acharya et al. (2016), and Bastidon, Huchet and Kocoglu (2016). The events investigated can range from the announcement of QE style policies to the whole gamut of UMP since 2008. 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 capture the policy's total impact. Although empirical work has considered a wide array of financial assets, from yields along the term structure to equity prices to exchange rates, in what follows we focus mainly on the impact of UMP on bond yields, especially 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.

Time series approaches have their own challenges but, in principle, they permit before and after comparisons of policies being introduced. Swanson and Williams (2014a, 2014b) argue that to test whether UMPs can be effective at the ZLB, one must first confirm that markets are

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[15] There may also 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.

responsive to surprises. The authors ask whether the responsiveness of financial markets to macroeconomic news surprises changed after GFC relative to the pre-crisis period. If macroeconomic news surprises no longer affect 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, Siklos, and St. Amand (2017, *forthcoming*) also assess the impact of monetary policy surprises and find considerable loss of monetary effectiveness at the short end as well as some loss of effectiveness at the longer end of the yield curve and on exchange rates of reserve currencies. In other words, the ELB can constrain monetary policy.

A significant challenge for time series analysis that, unlike conventional monetary policy which, for well over a decade in AEs and several EMEs, is firmly rooted in changing a single instrument UMP is potentially represented by a vector of different instruments that often overlap over time. A look at the composition of central bank balance sheets, not to mention a list of announcements of different programs to deal with varieties of distress in various parts of the financial system, makes this clear.

Since both event and time series studies have their challenges it is not clear whether one methodology is 'best' under all circumstances. Nevertheless, the reduction in long-term bond yields from various forms of balance sheet policies—specifically, QE and CE policies—in all of these economies is substantial even if the distribution of the various estimates across a sample of studies shows wide variations. Figure 5 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. In the next few sections we will discuss the various policies implemented in each of these countries and how their effectiveness differed. Prima facia, QE does have the desired effect, keeping in mind that, regardless of the estimation technique, most of these studies attempt to control for other factors that might also have affected long-term government bond yields.

3.2 Learning from Japan's Experience

Two aspects of Japan's experience with QE make it an important case study. The BoJ was the first to introduce QE in 2000. And, as shown in Figure 5, the BoJ's QE policies were least

effective at lowering government bond yields. While we may never know conclusively why QE seems to have had a different outcome in Japan than elsewhere it seems that the combination of a lack of commitment to QE and early withdrawal from such programs are key factors in explaining Japan's continuing low-growth, low-inflation economic environment.[16] Koo (2015, p. 64) describes the conflicting views inside and outside the BoJ that potentially 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, as in the US experience of the 1930s, the BoJ did not adequately exploit its balance sheet as a tool to help manage government debt by reducing bond yields and provide the necessary additional stimulus to halt the economic contraction (e.g. McCauley and Ueda, 2009; Ueda, 2011).

In the early 1990s, Japanese equity and property bubbles burst. In response, the BoJ reduced the uncollateralized overnight call rate—key policy interest rate—from a peak of 8.50 percent in 1991 to 0.5 percent in 1995. The call rate hit zero in early 1999. Around the same time Japan began to experience sustained periods of deflation. Since the standard monetary policy tool had been exhausted and was unsuccessful at lifting inflation rates the BoJ 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, meaning the use of communication as a policy commitment device by a major central bank. After a period of economic improvement, ZIRP was lifted in August 2000; however, the 2001 recession led the BoJ to reduce the call rate back to zero percent in March 2001 and adopted QE by changing the key monetary policy instrument to the outstanding balance of the BoJ current accounts and increasing purchases of longer-term Japanese Government Bonds (JGBs). After a period of improvement, the BoJ ended their QE program in March 2006 and began to downsize their balance sheet.

The literature that analyzes the actions of the BoJ after the asset bubble burst in 1991 considers two main questions. First, were the BoJ's monetary policy actions in the early 1990s appropriate given real-time information and the presence of uncertainties? Second, were UMP

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[16] The Japanese example has come to be called a case of a balance sheet recession (e.g., Koo 2008, 2015).

implemented in the late 1990s and early 2000s effective at guiding expected short term interest rates and strengthening financial markets?

On the first question, Harrigan and Kuttner (2004) conclude that deflation could begin to be anticipated around early 1993 and question why the BoJ did not further ease rates prior to 1995. However, a more thorough analysis by Ahearne et al. (2002) suggests that that the deflationary slump was not anticipated until as late as 1995. Estimates of the BoJ's policy rule suggest that although the bank may have acted consistently during the early 1990s, their policy rule may not have been resilient enough in the face of uncertainty in the policy multiplier or demand shock persistence. These results may have to be interpreted with some caution as the literature provides a range of estimates for the policy rule, and often 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 in these studies generally suggest that more aggressive monetary policy in the early 1990s would not have been sufficient to avoid the 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.

On the second question, many researchers have used event studies to capture the effects of monetary policy announcement and asset purchase operations under QE on financial markets. Kuttner and Posen (2004) analyze the behavior of long-term JGB rates before and after a major policy announcement. Recognizing that long-term interest rates can be directly influenced by changes in current short-term interest rates, the authors only analyze changes in long-term JGB rates during periods where short term interest rates were stable in order to capture the influence of changes in expectations on interest rates. They conclude that there is no evidence that various quantitative measures and expansions of eligible assets for open-market operations had an impact on long-term bond rates.

Bernanke, Reinhart, and Sack (2004) also conduct an event study to analyze the effectiveness of BoJ policy announcements from 1998 (when the BoJ gained independence) to 2004 in influencing short- to long-term interest rates, and asset prices. Estimates suggest that announcements by the BoJ influence interest rates through the unexpected component of the announcement as well as via innovations in long-term policy expectations. Their results suggest

that ZIRP and QE may have been effective at decreasing expected future short-term interest rates and therefore yield curves. However, the BoJ's ability to influence 1-year policy expectations is weak relative to similar analyses for other countries that adopted balance sheet policies (see the next section). In addition, surprise easing announcements regarding the path of interest rates (i.e. ZIRP) actually increase long-term rates likely because of an increase in future inflation expectations, while surprise easing announcements concerning JGB purchases decrease long-term rates. Similarly, 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.

Yamaoka and Syed (2010) provide an account of the effectiveness of BoJ's exit from monetary easing in 2006. They suggest that by purchasing short-term assets, placing a cap on JGB holdings, and limiting the purchase of private assets, as well as including termination clauses, the BoJ was able to endure a 'natural' downsizing of its balance sheet. These actions were successful at avoiding inflation, an economic slump, and instability in the financial markets. The introduction of further monetary easing since the 2008 recession (see Figure 3), including a rise in the purchase of private risky assets may, however, pose additional challenges for exit in the future.

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. However, 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; by lowering interest rate spreads for too long, there were few opportunities for profitable investment. The Japanese economy continues to suffer in this trap of low-spreads, low-inflation, and low-growth even after decades of monetary stimulus.

Perhaps for all of the foregoing reasons the BoJ did not immediately follow other large economies back into the fold of implementing UMP once the GFC was underway. While former BoJ Governor Shirakawa lamented that Japan had pioneered some forms of UMP, he remarked that these policies were nevertheless unable to help the country's growth rate reach escape

velocity (Shirakawa, 2010).[17] Still, further monetary easing was warranted, and 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 premia.

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 (e.g. Lam, 2011; Ueda, 2012).

Shirakawa's successor, Governor Kuroda, changed course for the BoJ when he launched Qualitative and Quantitative Easing (QQE) in April 2013 shortly after his appointment. To date, there have been three phases of QQE: a determination to reach a 2 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; and, the ongoing phase of pushing yields along the yield curve to zero through the aggressive purchase of JGBs, which has expanded the BoJ's balanced sheet by an additional 55 percent of Japan's GDP as of the fourth quarter of 2016 (see Figure 3a).

As shown in Table 2, QQE has been estimated to be the most effective of the BoJ's QE policies in lowering long-term JGB yields. As this is written, four years into the experiment, however, there is relatively little evidence that the aggressive policy has been successful beyond the reduction of yields. The bank's own assessment three years into the policy shift acknowledged its failure to shift inflation expectations to toward the 2 percent target (BoJ 2016). It is an article of faith that the formation of expectation based on the policies of a credible, inflation-targeting central bank will be forward looking in nature. Therefore, perhaps the outcome so far reflects the difficulty of the BoJ in restoring credibility, something that may have been eroded while Japan is said to have 'lost' two decades of potentially higher economic growth and inflation.[18]

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[17] 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".

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

Gertler (2017) argues that presumptions about the effectiveness of FG of the kind implemented as part of QQE cannot succeed as theory would predict because expectations are not rational. His model uses a hybrid of forward and backward-looking expectations formation to show that QQE type policies cannot succeed in generating a desired inflation target, at least not in the medium term. He dismisses the role of credibility and largely ignores the role of structural reforms. Central bank credibility, however, took a large hit during the GFC (Bordo and Siklos, 2016b); hence, it is far from clear why alternative explanations of the Japanese experience with QQE so far can be dismissed out of hand. Nishino et al. (2016) show that inflation expectations in Japan are adaptive and highly sensitivity to exogenous factors; however, they do not dismiss the importance of credibility altogether but instead assume the BoJ has a persistent negative credibility shock (see also De Michelis and Iacoviello, 2016).

3.3 The GFC and its Aftermath

In the aftermath of the GFC, the US, UK, and the Eurozone—following the onset of the Eurozone sovereign debt crisis—have all followed in the footsteps of the BoJ in using balance sheet policies (see Table 1 for a chronology of these policies). The US was the first to introduce an outright asset purchase program in November 2008, purchasing agency mortgage-backed securities and agency debt to help stabilised the housing market and underlying financing structure. In March 2009, the size of these purchases was expanded and the program was extended to include Treasury securities in an effort to further ease credit conditions by suppressing interest rates; 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 US treasuries with longer-term yields. The third, the Maturity Extension Program (MEP; also known as Operation Twist), was announced in September 2011. The MEP did not involve the outright purchase of assets, but instead 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 MBS. LSAP3 was announced in September 2012, and asset purchases ceased in October 2014.[19]

The median estimate in the empirical literature of the impact of each of the US Fed's balance sheet policies on government bond yields is provided in Table 2. It is clear that, unlike the experience with the BoJ, the first program (LSAP1) had the largest impact. The literature on the Fed's experience with balance sheet policies indeed suggests that there were diminishing returns to its asset purchases, largely owing to the important role of changing market expectations through the signalling channel (e.g. Ihrig et al., 2012).[20] Similarly, the range of estimates on the impact of LSAP2 is 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 destressed assets affects markets through additional channels (e.g. 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 amounting to a total of $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 6 shows that the UK's experience with QE appears to have been the most effective at reducing long-term yields. Like with the US Fed's asset purchases, the effectiveness of the UK's purchases exhibit diminishing returns, with BQE1 lowering yields by an estimated 80 basis point, and BQE2 lowering yields by an estimated 54 basis points (Table 2). 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 (e.g. Christensen and Rudebusch, 2012; Joyce et al., 2011). The literature suggests that market structure and central bank communication may affect which channels balance sheet policies operate through.

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[19] The focus of this review is on balance sheet interventions that had wide-reaching implications for domestic and global financial markets. Of course, each of the major central banks also engaged in balance sheet policies that were more targeted to specific segments of the market (see Table 1).

[20] 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 areas experience to be discussed below.

A few central banks in small-open economies have also used balance sheet programs, namely the Swedish Riksbank and the Swiss National Bank. The impact of asset purchases in these economies is believed to be smaller, in large part owing to the inability of the central banks in these economies to effect global term premia (e.g. Diez de los Rios and Shamloo, 2017). Kabaca (2016) argues that high substitution between domestic and foreign bonds implies a strong link between global and domestic term premiums; thus, central banks in small-open economies may have limited influence on domestic term premiums. The author concludes that the exchange rate depreciation from large-scale asset purchases would also be small, so QE would be less effective in small-open economies relative to systemically-important economies which can affect global term premiums.

There are a few important elements of these countries UMPs missing in some of the studies used to construct Figure 6; for example, it does not account for the role of central bank communication. As previously noted, UMP includes a shift to using written and verbal announcements to send signals to not only complement current decisions taken by monetary policy committees but also provide an indication of the expected future policy direction. The critical difference in assessing the impact of these policies is that, unlike actions which are observable (e.g. policy rate change or balance sheet policies), words can be subject to more than one interpretation or entail uncertainty because future decisions are conditioned on outturns in financial and economic indicators. This has come to be known as 'data dependence'. Lombardi, Siklos, and St. Amand (2017, *forthcoming*), Bennani (2015), Hansen, McMahon and Prat (2014), Acosta and Meade (2015), Meade, Burk and Josselyn (2015) and Malmendier, Nagel and Yan (2017) 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 to explore their impact on anything from inflation expectations to the stance of monetary policy more generally.

As we discussed in the previous section, the BoJ's ineffective use of FG was owing to its lack of commitment to maintain QE and related inability to convince markets of its resolve (Koo 2015). This was a case of perhaps too much transparency as officials laid bare their concerns over the effects of QE in spite of the fact that the Japanese economy showed little signs of escape velocity in real economic growth nor were there any indication that low and steady deflationary

conditions would be reversed. But FG has been found to be effective in altering market expectations about future interest rates in other cases.

In 2009, as inflation in Canada was showing signs of entering into negative territory, and 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. For the first time, the central bank published a confidence interval for an inflation forecast to demonstrate that it expected this form of FG to result in meeting its two percent inflation objective shortly after the expiry date of the FG period. 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 (e.g. 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 (e.g. 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 employ FG in its arsenal of UMPs in the aftermath of the GFC. It 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.[21] 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 (e.g. Campbell et al., 2016; Raskin, 2013).

Not all scholars are convinced by their effectiveness 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. As the authors point out, for modelling purposes, this distinction may be important. However, in practice, a conditional

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[21] 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.

commitment need not be ironclad to be taken as credible. Still, 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. Event studies of the kind considered above estimate the reduction in government bond yields following the introduction of QE without considering the extent to which any loss of trust or credibility in central banks in the lead up to the policy announcement may partially account not only for the size of the yield reductions but also the duration of any such effects.

For example, both the US and the UK met the economic conditions set by their central banks in their state-contingent FG well-before they decided to tighten policy. Mark Carney introduced this guidance near the beginning of his tenure as governor of the BoE, and was heavily criticized when the economic indicators exceeded expectations only six-months later. When the BoE introduced FG it was always with an eye to achieving the 2 percent inflation target, but when it modified the guidance in 2014 the central bank admitted that FG can "evolve" which is to say that it can be subject to a sliding calendar. Indeed, both the Fed and BoE have since reiterated that a range of economic indicators would be used to gauge the appropriate timing of policy changes. In practice, these noisy signals further raise doubts about whether the effectiveness of such policies came at cost to the credibility of central bank communications.

3.4 Is Europe Different?

The answer is both yes and no. The succession of programs which 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 unravelled, the ECB adopted government bond purchase programs. The first of these programs—the Securities Markets Programme (SMP)—was announced in 2010. Purchases under this programme were aimed at reducing high risk premiums, thereby restoring the smooth functioning of monetary policy transmission throughout the euro area, and the interventions were sterilized through the sale of other assets. The ECB's second government bond purchase program—the Outright Monetary Transactions (OMT) programme—introduced

in the third quarter of 2012 had similar technical features; in addition, purchases were conditional on being part of a financial assistance package through the European Stability Mechanism. It wasn't until January 2015 that the ECB adopted a QE program that included outright purchases of government bonds across euro-area members 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' became used more widely. "We faced severe impairments to the transmission mechanism of monetary policy across the euro area with marked heterogeneity from country to country. This called for unconventional measures tailored to the specific frictions at hand" (Draghi, 2014). While there is one monetary policy for the single currency area, the GFC and 2010-12 sovereign debt crisis had vastly different effects on the financial systems and economies of individual member states. 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 impact of the sovereign debt crisis were clearly asymmetric across the single currency area. Unsurprisingly then, the events since 2008 created a heated debate over how much intervention the ECB was permitted under its legal mandate (enshrined in the Treaty on the Functioning of the European Union) and whether it amounted to favoring some member states over others (e.g. Sinn, 2014).

Beyond these developments which, for a time, were of an existential nature for the euro area as well as creating conflict between the ECB and several members' governments, the interventions in the financial system also reflect a couple of other idiosyncratic elements not present in other economies where UMP were implemented. First, the single currency area did not have institutions that could adequately supervise the financial sector and, although progress has been made since the crisis began, the work is far from completed. Second, bank-centered financial systems dominate in the Eurozone providing an important contrast with the US case (e.g. Cappiello et al., 2010; Hempell and Kok Sørensen, 2010). Indeed, among AEs, the United States has the lowest levels of bank financing at approximately 20 percent.

Although the ECB's UMP actions were criticized as being too little too late (e.g. 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 enacted in the US and the UK (see Table 2). An important caveat is that the ECB's first two government bond buying programs were aimed at reducing risk premia in countries under stress. Considering 2-year yields in Greece escalated to over 300 percent in 2012, a 3.66 percent reduction in short-term yields may indeed have been too-little-too-late; of course, the situation was not nearly as bad in the other periphery countries. In general, it appears the first two programs were successful at depressing yields in targeted member states that were in distress (e.g. Altaville, 2014; Fratzscher, Lo Duca and Straub, forthcoming). Indeed, the SMP and OMT were effective at reducing spreads among euro area member countries (Wafte, 2015), while the PSPP appears to be effective at 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. Unlike Mark Carney's forceful introduction of state-contingent FG at the BoE, 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 reducing market uncertainty in short-term rates (ECB, 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 US and the UK's actions, which were mainly in response to the GFC. But while UMPs have broadly similar financial effects in the Eurozone as in other AEs where similar interventions were undertaken, legal restrictions in future might hamper the ECB's ability of doing "whatever it takes" in the event of a future crisis.[22]

3.5 Does History Repeat Itself?

Some AEs may have, at least partially, repeated the errors committed by policymakers in Japan beginning in the late 1990s by not being persistent in easing policy to combat financial crises and support economic recovery. Figure 6 is a Gantt chart that shows the number of

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[22] 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.

consecutive quarters of monetary policy easing since 1999 for six economies that resorted to some form of UMP over the past decade—Denmark, the euro area, Japan, Sweden, the United States and the United Kingdom.

The wider the bar, the longer the duration of the easing episode. Relying on this metric we find that all six economies shown underwent easing episodes that lasted at least 5 quarters or longer in the early 2000s. Indeed, Denmark, Japan, the euro area, and Sweden recorded periods when monetary policy was eased for at least nine consecutive quarters. When we get to the GFC all six economies undergo policy easing and, while the duration increases for most, there are interruptions. The most aggressive central banks at easing monetary policy when the GFC began were in Denmark (21), the United Kingdom (12), and the United States (11),[23] but monetary policy became less aggressive around 2011-12. Around this time, when the Eurozone crisis reached its peak, central banks were most persistent at easing policy in the euro area (14) and Sweden (12), and joined later by Japan (19).

Taken together Figure 6 points to a reluctance to combat the GFC and Eurozone Crisis with as much monetary policy firepower as might have been at the disposal of central banks. Relying on a different set of arguments this is also the conclusion reached by Ball et al. (2016).

3.6 International Spillovers from UMP

The impact of UMP introduced by major AEs on exchange rates and exchange rate volatility was particularly controversial. Textbook descriptions of the role of the exchange rate generally focus on a two-corner solution, namely fixed versus flexible exchange rates. The latter is supposed to insulate an economy from external shocks. Even before the GFC, doubts were raised about the simple distinction between exchange rate regimes. First, because de facto regimes seemed at variance from the stated exchange rate regimes (e.g. Cook and Devereux, 2016). Second, and most importantly given the preceding discussion, the predicted effects of exchange rates on the trade of goods and services differed from the impact on financial flows (e.g. Ilzetzki, Reinhart and Rogoff, 2017).

Currency fluctuations which improve the balance of trade (e.g., a depreciation) would lead to a tightening of monetary policy assuming that the covered interest rate parity holds and that

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[23] The number of quarters for the longest episode of easing is given in parenthesis.

exchange rate expectations produce expectations of a further depreciation. Even if covered interest rate parity fails to hold in all cases there is at least the possibility that attempts to loosen policy will happen at the expense of a decrease in net exports. Chinn (2013) makes this point both theoretically and empirically and this may help explain the dearth of empirical studies about the impact of QE especially on nominal exchange rate fluctuations. Nevertheless, on balance, it appears that the US dollar did depreciate as a result of the introduction of UMP (also see Neely, 2015; Swanson, 2017). Jones, Kulish and Rees (2016), for example, consider counterfactuals to suggest that FG in the US constrained monetary policy in Canada at the then ZLB by producing a larger appreciation of the currency than might otherwise have been the case.

Overall, however, the evidence linking QE and UMP to exchange rates is far from conclusive (e.g. Gagnon et al., 2017). Figure 7 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) on domestic currencies in EMEs have been identified. The evidence does suggest, however, that the Fed's so-called taper tantrum in the second and third quarters of 2013 caused a depreciation in the domestic currencies of EMEs (e.g. Aizenman, Binici and Hutchison, 2016; Eichengreen and Gupta, 2015; Mishra et al., 2014).

The impact on sovereign bond yields is more clearly in the direction of decreasing yields (Figure 7). In many EMEs, the spillover effects from UMP in AEs created higher equity prices and lower yields on government and corporate bonds. While stronger capital flows during this period can have positive consequences through the provision of financial liquidity, investments and economic growth, strong capital inflows were also associated with rapid credit growth, currency volatility and inflationary pressures (e.g. Chen et al., 2013; Fic, 2013).

The success of QE in putting a floor under a potential economic collapse had the Fed, and other central banks, not taken a "whatever it takes" attitude to the financial crisis on balance helped AEs, but likely did not hurt EMEs. Notice that the previous statement is qualified since the literature is unable to reach a firm conclusion that QE actually harmed EMEs in particular. Furthermore, some empirical evidence suggests that we cannot absolve EMEs altogether because economic fundamentals paly a role in some of the potential adverse effects of UMP (e.g. Aizenman et al., 2014; Chen, Mancini-Grifolli and Sahay, 2014). In any event, we are further away from reaching a consensus on the international spillover effects on EMEs than on the

spillovers within the group of AEs. The bottom line is that QE in the US (and the UK; it is too early to consider the Eurozone or even Japan under QQE), while undoubtedly helpful in loosening policy when persistent economic slack required its implementation, suffers from diminishing returns. Moreover, we have yet to determine whether the persistent application of such policies across several economies over a prolonged period of time produces distortions whose impact has yet to materialize. As Bayoumi et al. (2017) point out, the arithmetic of adding up the costs and benefits remains a work in progress.

4   The International Evidence to Date: Macroeconomic Effects

There remains a critical question about the impact of UMPs: how persistent are they? That is, does the impact on interest rates translate to a change in economic activity—investment and consumption behavior? If the shock from the GFC created a permanent dent in the level of real GDP, then it is reasonable to expect either UMP or perhaps fiscal policy can try to shift real GDP back to its initial trend path. Any investigation of macroeconomic outcomes faces the daunting task of attempting to tease out conclusions over a sample that covers a short span of time. Realistically, any test of the impact and the fallout from the GFC might begin in late 2007 or sometime in 2008 at the earliest, which means that, at most, a decade of macro data are available.

4.1 Can UMP Have Real Economic Effects?

Empirical applications generally specify an econometric model, often some variant of a vector autoregressive (VAR) model, that asks whether and how monetary policy shocks in the period since the GFC have changed or if the introduction of UMP changes any of the relationships under investigation (e.g. Weale and Wiedelak, 2016).[24] Other studies consider how macroeconomic variables such as real GDP growth and inflation responded to QE-like shocks (e.g. Altaville et al., 2014; Bridges and Thomas, 2012). These shocks are often considered to be one-time occurrences and are assumed to have 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.

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[24] Not all tests of the impact of QE rely on such models. Another approach includes cross-sectional studies that rely on microeconomic data (e.g. lending by banks) to investigate the real effects of UMP (e.g. Acharya et al. 2016; Bowman et al. 2015). Alternatively, various macroeconomic models may be used, such as Real Business Cycle variants (e.g. Farmer 2012) or DSGE models (discussed in section 4.3).

Given the potential importance of a shock the size of the GFC, it is reasonable to also raise questions about the structural stability of the parameters of any model. For example, Neely (2014) concludes that while UMP had temporary macroeconomic effects, 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, Neely's study does not provide a clear alternative or, rather, presumes that the models considered in his study are the most appropriate ones under the circumstances. In the meantime, until the relevant econometric lacunae are overcome, it is appropriate to assume that if a cross-section of models and estimates that rely on different identification techniques point in the same direction concerning the impact of UMP then we can have some confidence about the empirical findings to date. Otherwise, we should continue to remain sceptical while generating more robust and reliable estimates.

The empirical evidence indeed points to UMPs having real economic effects, if limited in size and occurring with a significant lag. Indeed, despite ineffectiveness at raising inflation expectations, the BoJ's QE program was found to be effective at addressing commercial bank's liquidity constraints and eventually boosting credit growth five years after asset purchases began (Bowman et al., 2015). 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, Laubach and Reifschneider, 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 (Altaville et al., 2014).

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, a popular alternative is to rely instead on the size of a central bank's balance sheet (as a percent of GDP) and add other macroeconomic and financial variables such as inflation, real GDP growth, interest rates (or spreads), and equity returns to describe the macroeconomy. As noted above, it is unclear a priori how one should identify the structural shocks of interest so a number of alternatives are considered, including imposing sign restrictions (also see Weale and Wieladek 2016). Haldane et

al. (2016) find that QE effects are state dependent but that spillovers across AEs are relatively strong.[25]

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).[26] Chen et al. (2017) is an example that combines data from AEs and EMEs to investigate the global impact of QE. Since UMPs in one form or another have been introduced in a few systemically important economies (viz., US, UK, euro area and Japan) as well as some smaller AEs (Canada, Denmark, Sweden and Switzerland), the relative importance of each, not to mention spillover effects, are readily 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.

An additional difficulty shared by several studies of the kind examined above is that QE-style interventions are treated as if they are homogeneous. But policies vary in purpose. For example, LSAP1, LSAP2, and LSAP3 in the US were aimed at problems in different parts of the financial system (see Section 3.3). Similar arguments can be marshalled to explain differences in QE-style policies in the UK and the Eurozone.

4.2 Additional Evidence of the Macroeconomic Impact of UMP in the United States

Since there is considerable uncertainty about the macroeconomic effects of QE it is worth further exploring the potential impact of UMP style policies. Moreover, since arguably the US was at the epicentre of the events that have unfolded since 2008, we focus exclusively on its experience. When central banks, including the Fed consider the macroeconomic environment they are fond of saying that they look at everything. Hence, one might argue that assessing the results of UMP by focusing only on real GDP growth is unsatisfactory. Instead, suppose that we can summarize

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[25] Both Haldane et al. (2016), and Weale and Wieladek (2016) contain references to several other studies of this kind. Also, see Ball et al. (2016).

[26] 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.

the sources of real shocks to the economy by a vector of variables that includes inflation,[27] forecasts of inflation and real GDP growth in order to capture the forward-looking element of current decisions by households and firms, 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.[28]

The same logic is used to define a monetary policy and a financial factor. The former consists of foreign exchange reserves, changes in the fed funds rate, and the growth in the money supply. For reasons that will become apparent below we also estimate separately a version that includes the size of the Fed's balance 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 in the Wilshire 5000 stock market index, the VIX, the 3 month Treasury bill yield and the yield on 10 year Treasuries, and growth in housing prices.

Figure 8 plots the score based on quarterly data.[29] The top portion of the Figure display all three factors while the bottom graph allows one to determine the impact on the monetary factor scores depending on whether the central bank assets to GDP ratio is included or not. Recall from above that some studies use a central bank balance sheet variable to proxy the QE portion of UMP. Also shown are the recession dates according to the NBER as well as the timing of the three episodes of QE (LSAP1, LSAP2, and LSAP3).

One immediately notices that when monetary conditions loosen, the scores for the monetary factor rise, and the scores for the financial factor decline, an indication that the monetary factor has been used to improve financial conditions. Notice that policy tightens gradually from 2004 to early 2006 before beginning to loosen well before the height of the GFC. Whether the Fed

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[27] In keeping with the Fed's explicit preference for the personal consumption expenditures (PCE) deflator we rely on this series to measure inflation.

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

[29] The full sample estimates are for the period 1994Q1-2016Q4. However, in order to focus on developments since the GFC, only the scores since 2002 are shown. Full estimates are available on request.

tightened monetary policy fast enough or sharply enough in the years leading up to the GFC is unclear but there are some indications that this might be the case.[30]

The improvement in financial conditions is also clearly noticeable in early 2008 and again in early 2009, when LSAP1 is announced. There is a sharp but brief loosening of monetary conditions before they tighten once again just before the end of 2008. Monetary conditions are loosened as a result of LSAP2 and LSAP3 as well. Financial conditions are also seen as improving beginning in 2009. Finally, the evolution of the real factor largely mirrors the NBER business cycle chronology although the scores indicate that the real factor post-crisis never quite reaches levels prior to 2008.

The bottom portion of Figure 8 shows what happens when the proxy for QE is added to the monetary factor by plotting the difference between the factor scores when central bank assets to GDP are included relative to when this summary indicator of the impact of UMP is excluded. The answer is, not surprisingly, not much before the GFC. However, especially in early 2009, the impact is sizeable. Thereafter, differences remain but it is not always the case that the scores that include balance sheet information always yields a looser policy. It is unclear why this might be the case except to note that beyond QE there were also other forms of UMP applied over this period, notably FG.

In Figure 9 we show partial results from the estimation of a VAR model that consist of the real, monetary and financial factors.[31] 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 are 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 incorporate UMP effects (primarily QE) into the monetary factor while the middle set of impulse responses do 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

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[30] Taylor (2007) has long maintained that the crisis might not have been so severe if the Fed had tightened more and earlier than it actually did. Bernanke (2010) provides the opposite view.

[31] 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.

the UMP proxy. All the reasons noted previously apply but perhaps most importantly that the monetary factor can also be said to have prevented a fall in the real factor while monetary policy was, as theory would suggest, largely neutral 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. Equally important, however, is that the size of the impulse response after 1 quarter is almost twice as large when UMP are excluded from the monetary factor than in the case shown at the bottom of Figure 9. Therefore, looser monetary policy may improve financial conditions but not as much as when QE is incorporated. Therefore, QE may have helped to improve financial conditions but the impact has 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.

Next, Figure 10 asks whether the extent to which the scores for the real and monetary factors are influenced by how they are estimated. The lines labelled "no QE" represent forecasts of the real and monetary factors based on the VAR estimated through 2006Q4. The lines labelled "with QE" incorporate UMP in the manner explained above. Even if the real factor was not found to react statistically positively to a shock from the monetary factor the scores for the real factor are persistently higher than if QE is ignored. This means that QE put a floor on the decline in the real economy even if it was unable to generate 'escape velocity'. Similarly, incorporating the impact of QE indicates monetary conditions are considerably looser than if the policy is ignored, at least until the second half of 2011.

Finally, Figure 11 consider a counterfactual of sorts. Suppose that the economy evolved as if the estimates of the VAR until the end of 2006Q4 carried on 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 that is partially offset after the fourth quarter. The improvement or loosening of financial conditions reported earlier remains as in the pre-crisis sample shown in Figure 9 although the effect persists for a little longer (four quarters). Once again it appears that

the policy interventions undertaken after 2008 can be said to have prevented a decline in real activity but not the boost that some expected.

4.3 DSGE Alternative

An alternative to the estimation of VAR-like models is estimation using DSGE (Dynamic Stochastic General Equilibrium) models that are widely used by many central banks. It is well known that these models have been severely criticized not only because they used to ignore a role for the financial system but also by virtue of assumptions made about the rationality of inflation expectations, among other criticisms of this methodology.[32] Nevertheless, the micro-foundations of such models, not to mention their internal consistency, is both a strength and a weakness.

The strength lies in DSGE models' 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. The weakness is the habit of such models to fail to explain macroeconomic facts very well. This is partly due to technical difficulties 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 underappreciate the progress made in less than a decade (e.g. Binder et al., 2018). 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 would not have been observed otherwise. This is only one of many other examples that have shaped DSGE models' ability to explain macroeconomic facts. Nevertheless, there is the risk that such models become too complex and the experience of large scale models of a few decades ago that were eventually discarded as 'incredible', leading to a

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[32] Among the most prominent critics are Buiter (2009), and Krugman (2009) though the criticisms are often leveled 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 (e.g. Siklos, 2017). Binder et al. (2018) provide a good summary of the evolution of DSGE across several generations. Nevertheless, 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.

new generation of more compact and econometrically sensible econometric models, is a reminder of how a once promising research agenda can end.[33]

4.4 Central Bank Credibility and Inflation Expectations

Paralleling studies of the macroeconomic effects of QE and UMP more generally are ones that are concerned with the impact of the crisis on inflation expectations. In AE these have not fluctuated greatly since 2008 and even in many EMEs, such as in the so-called BRICS economies, there has been little apparent fallout from the global financial shock.

An important consideration is whether central bank credibility has taken a hit since the GFC. Bordo and Siklos (2016a, 2016b) and others 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 (2014a) does not find that the ECB's credibility was impacted by the event of recent years. Raynard (201) 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-

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[33] 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.

loose monetary policy is unclear. What is clearer, from the cases of Japan and the US, in particular, is that the success of UMP is not only explained by what actions central banks take but how they exit from extraordinarily loose monetary policy conditions.

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. However, the evidence to date also gives the impression that financial crises of the kind that hit the global economy beginning in 2008 was an exogenous event. Financial crises come in different forms; if their impact and origins are heterogeneous (e.g. Bordo and Haubrich, 2017; Romer and Romer, 2017), so too must be the policy response.

If the Great Moderation was more 'good luck' (Stock and Watson, 2003) than 'good policy', then was the GFC simply bad luck? If luck is the primary factor, this could help explain the recurring habit to follow the advice that: "if it ain't broke, don't fix it". Unfortunately, this also promotes a form of complacency and policymakers have a tendency to insist on a "This Time is Different" mentality, even when it is symptomatic of a larger issue. But not all crises are systemic on a global scale (e.g. the Asian Financial Crisis of 1997-1998); the response to these events should therefore be proportional.

Alternatively, some policymakers have a tendency to insists on a "never again" attitude toward financial crises; 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, who have chosen to live with water and not 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 sequence of events that began in 2007 and continue to impact many economies also teaches 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 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 the uncertainty and skepticism among markets and the public that 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 credibility and confidence in 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? There is, of course, no definitive answer. However, to the extent that the variety of interventions are the product of past failures and greatly complicate 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 with standard monetary policies to deliver not just low and stable inflation but be credible in doing so. This might also prevent future policy makers from asking or expecting too much from their central banks.

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**Figure 1 The Incidence and Dispersion of Financial Crises**
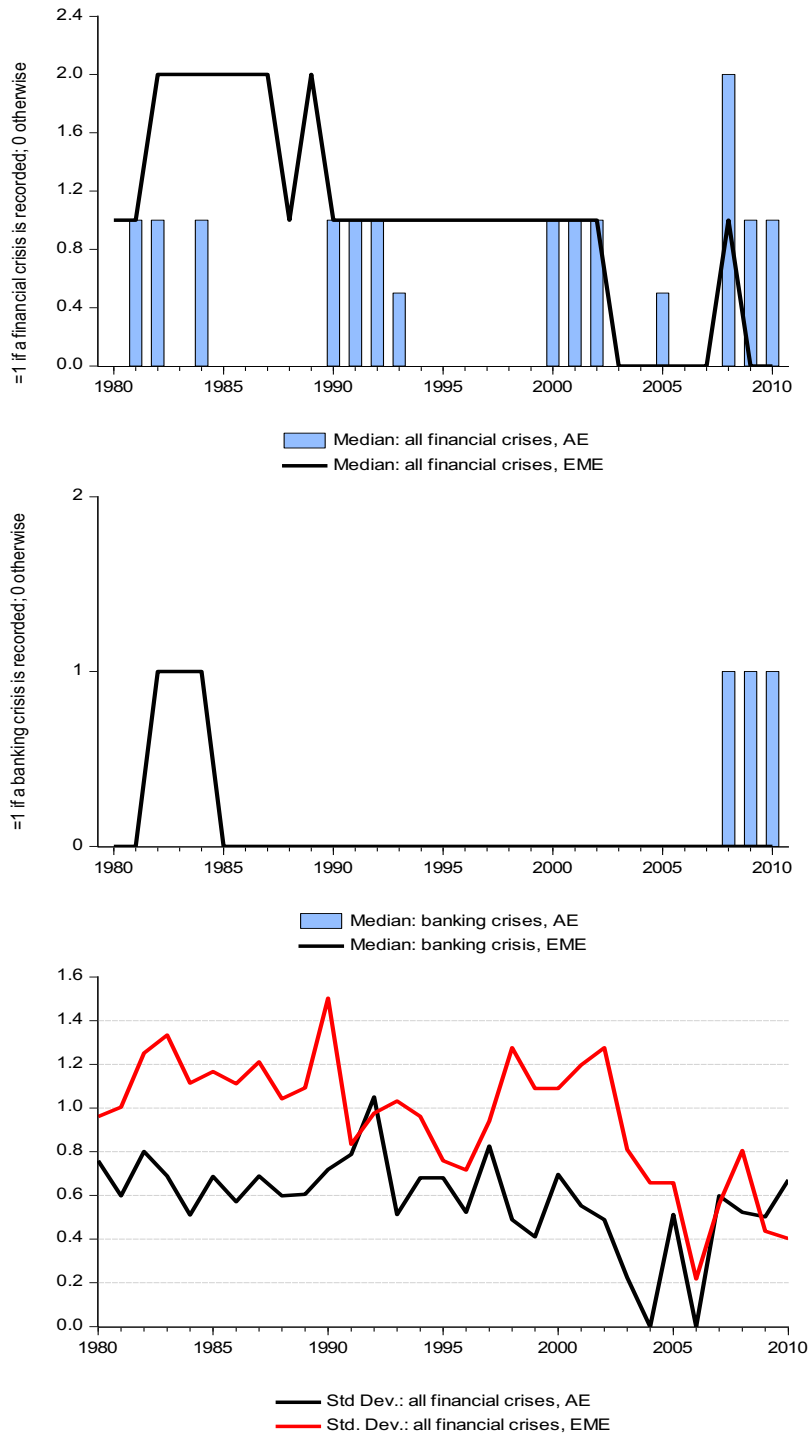
Note: Based on data from Reinhart and Rogoff (2009). Also, see footnote 7 and Siklos (2017).

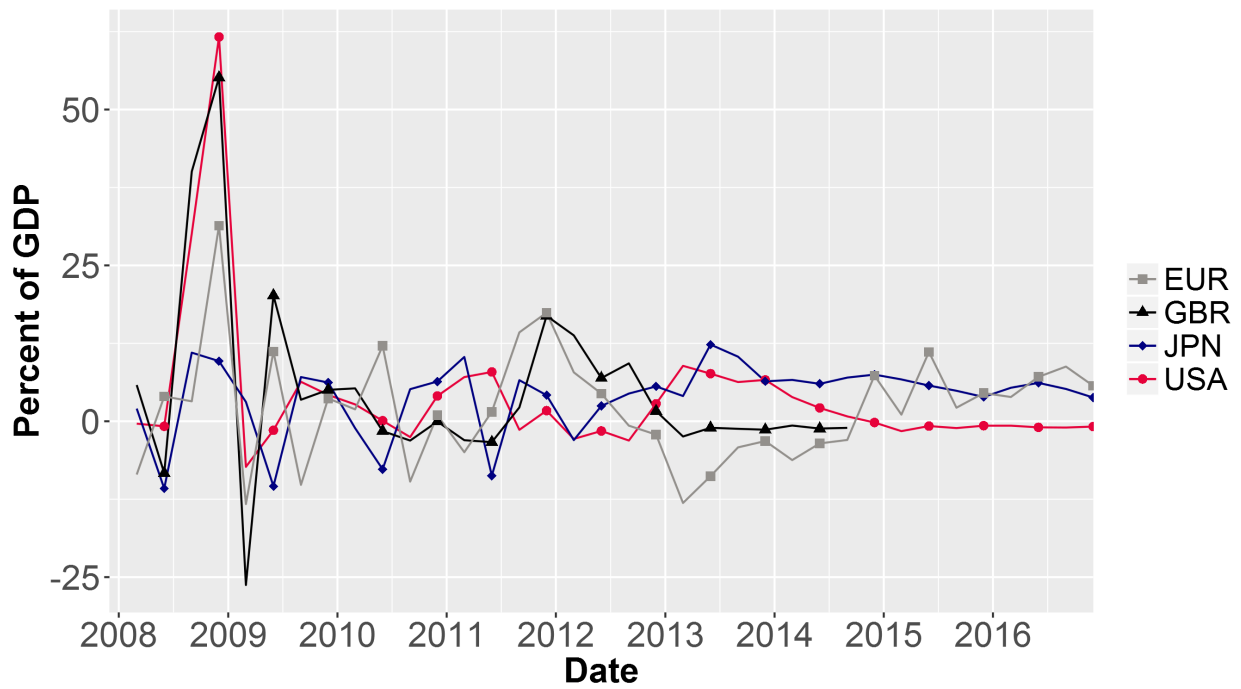**Figure 2 Policy Rates in Major Advanced Economies**
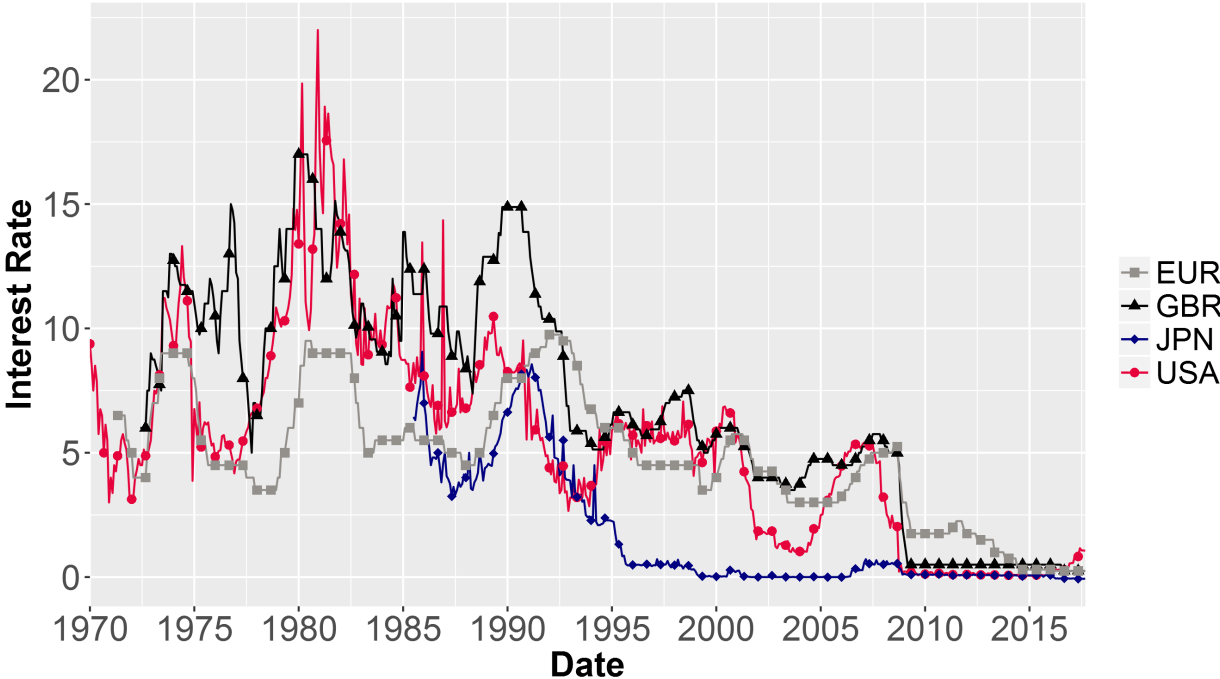
Note: Plotted are monetary policy interest rates of the four major advanced economies: Eurozone (Bundesbank Lombard rate before 1999; ECB marginal refinancing rate thereafter); United Kingdom (bank rate); Japan (call rate); and United States (federal funds rate). Data is from January 1970 to September 2017, where available. Data is from CEIC.

Figure 3A Central Bank Assets as a Percent of GDP
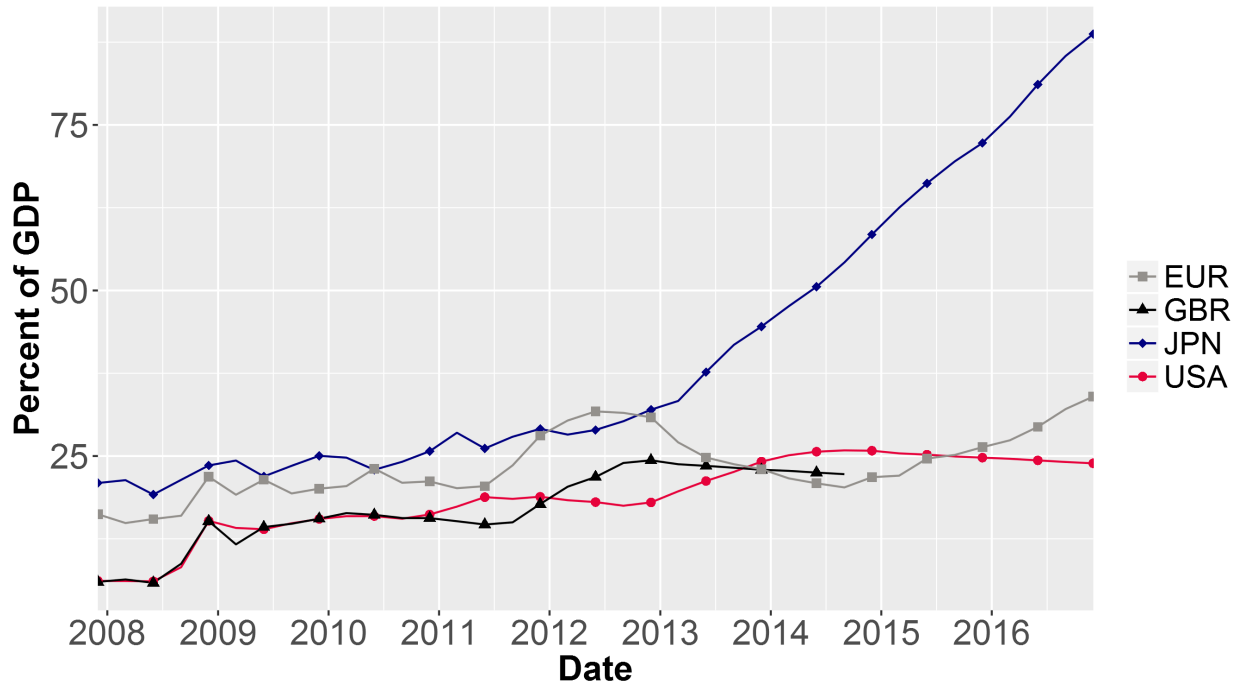
Figure 3B Quarterly Rate of Change in Central Bank Assets as a Percent of GDP

Note: Data Source is CEIC. Sample size is from 2007Q4 to 2016Q4.

Figure 4 Lending Standards in Major Advanced Economies
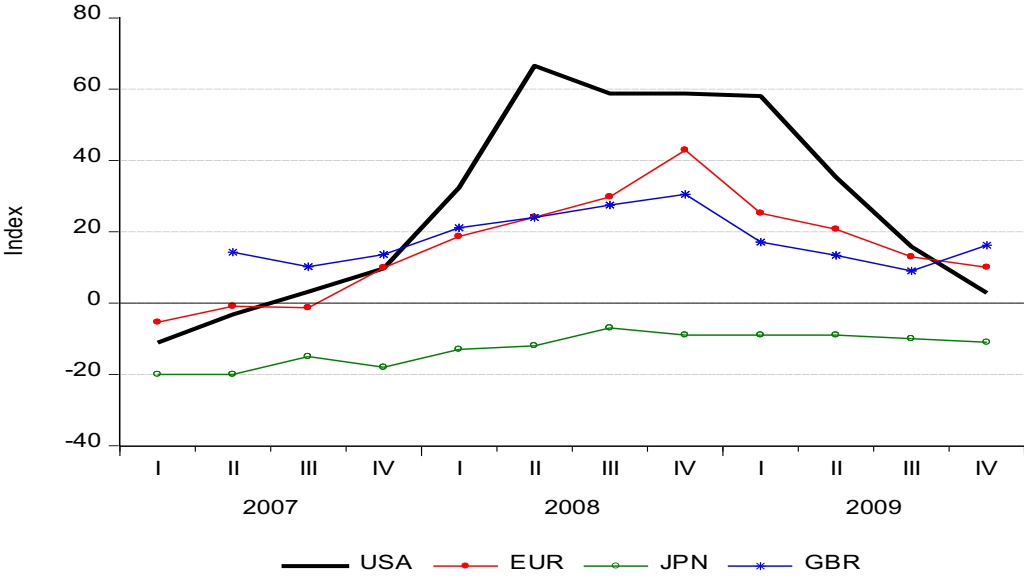
Note: Data from Filardo and Siklos (2017).

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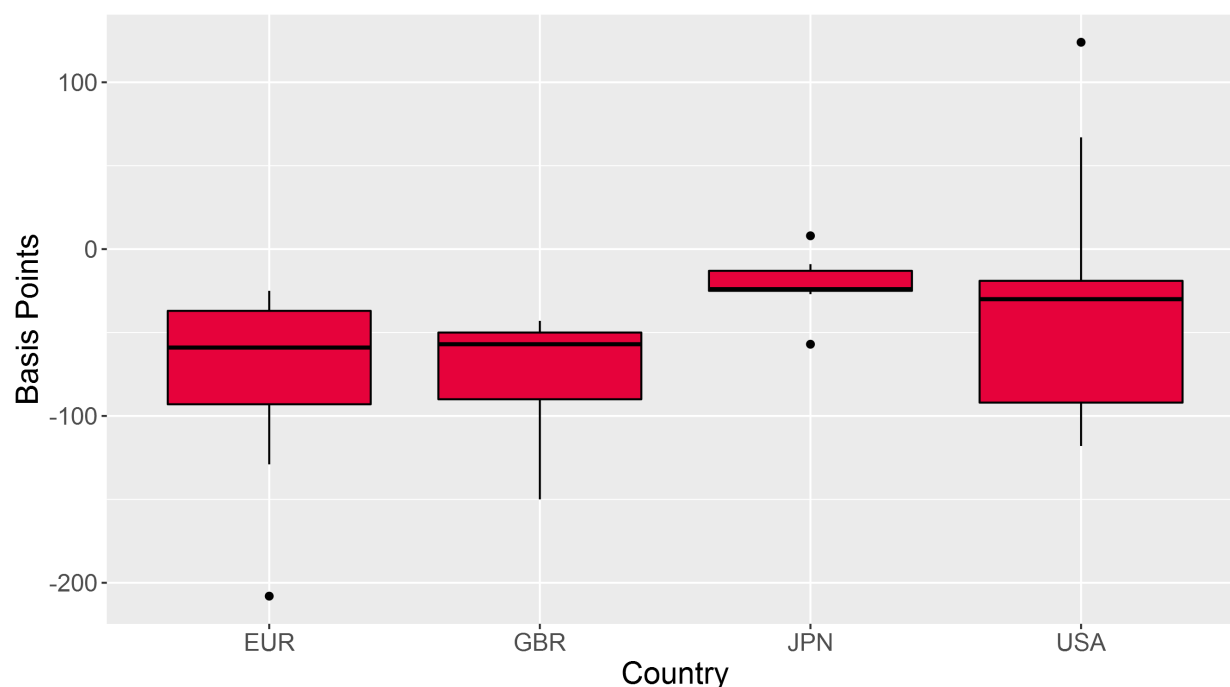
Note: N = 62. Impact on government bonds expressed in basis points. When the study reports several estimates, the minimum and maximum estimates, or estimates using various techniques are recorded.

Euro area (EUR): N = 13. Studies include Altaville, Giannone and Lenza (2016), Andrade et al. (2016), De Santis and Holm-Hadulla (2017), Eser and Schwaab (2016), Fic (2013), Fratzscher, Lo Duca and Straub (2016), Gibson, Hall and Tavlas (2015), Middledorp (2015), Middledorp and Wood (2016).

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

Japan (JPN): N = 9. Studies include Fic (2013), Fukunaga, Kato and Koeda (2015), Gros, Alcidi and Groen (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, Laubach and Reifschneider (2015), Fic (2013), Fratzscher, Lo Duca and Straub (forthcoming), Gagnon et al. (2011), Gros, Alcidi and Groen (2015), Hamilton and Wu (2012), Ihrig et al. (2012), Krishnamurthy and Vissing-Jorgensen (2011, 2013), Li and Wei (2013), Neely (2010), Swanson (2011).

Table 2 Estimate of Impact on Government Bond Yields by Country and Program

Country	Program	Short-term Government Bond Yields (Median Estimate)	Long-term Government Bond Yields (Median Estimate)
EUR	SMP	-366	-60
	OMT	-101	-46
	PSPP	n/a	-61
GBR	APP (2009-10)	-86	-80
	APP (2011)	n/a	-54
JPN	QE1	-11	-11
	CME	-8	-25
	QQE	n/a	-27
USA	LSAP1	-31	-93
	LSAP2	-2	-25
	MEP	0	-17
	LSAP3	n/a	-12

Note: See Notes for Figure 6.

Figure 6 The Persistence of Monetary Easing in Countries that Adopted UMP

18 Years of Monetary Easing: 1999 Q1 - 2016 Q4
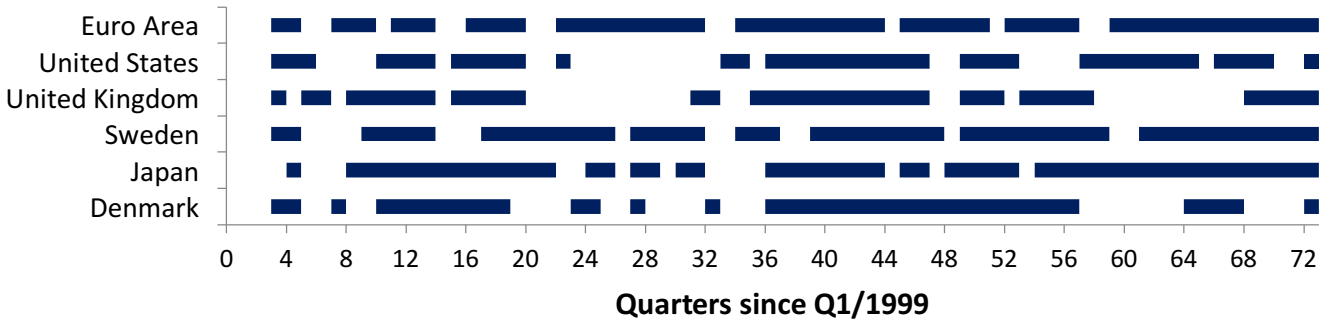
Note: Easing is initiated by two consecutive periods of lower policy rates or higher central-bank asset to GDP, and persists so long as policy rates continue to be low (or are lowered) or central-bank assets to GDP continue to be higher (or increase).

Figure 7 Summarizing Selected Empirical Studies: Spillovers of UMP on EMEs

A) Long-Term Sovereign Bond Yields
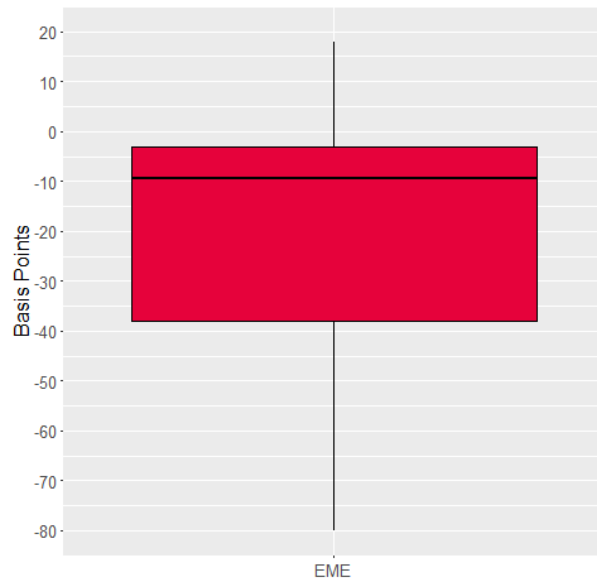
B) Foreign Exchange Rates
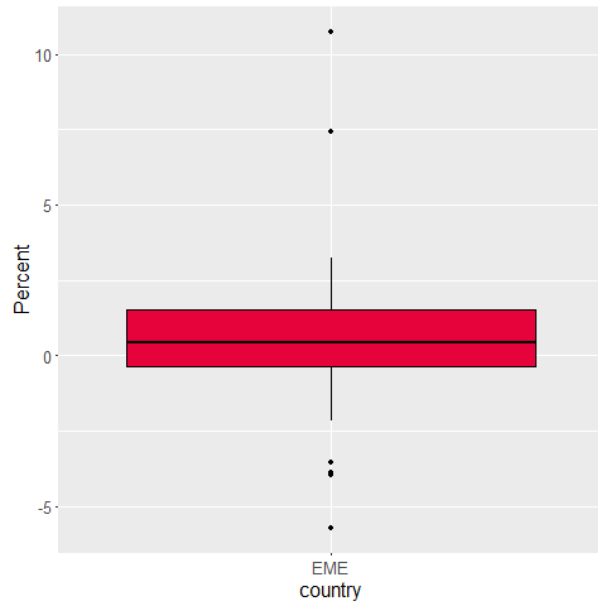
Note: A) N = 31. Impact on government bonds expressed in basis points. B) N = 32. Impact on foreign exchange rates is expressed as percentage change with a positive value referring to a domestic currency appreciation against the benchmark currency (mainly US dollar). Studies include Chen, Filardo and Zhu (2013), Chua et al. (2013), Falagiarda, McQuade and Tirpák (2015), Fic (2013), Fratzscher, Lo Duca and Straub (2016; forthcoming), and Aizenman, Binici and Hutchison (2016).

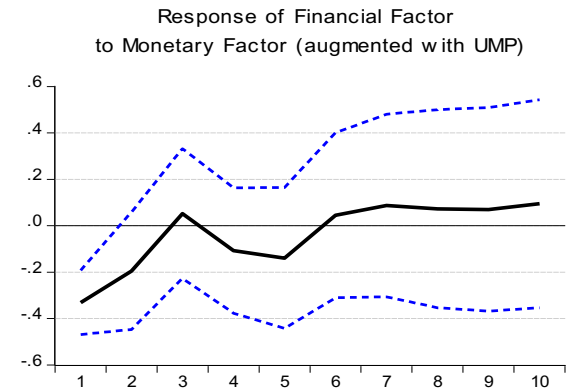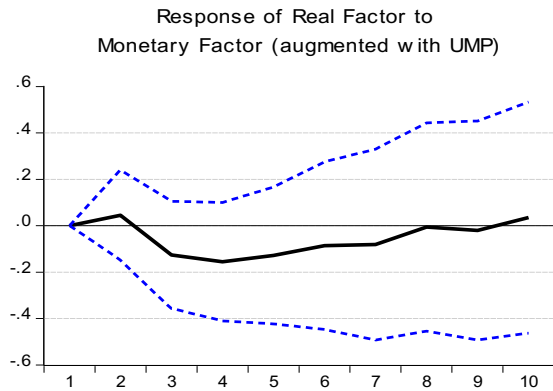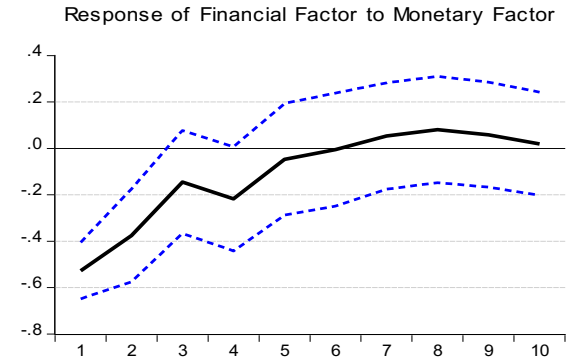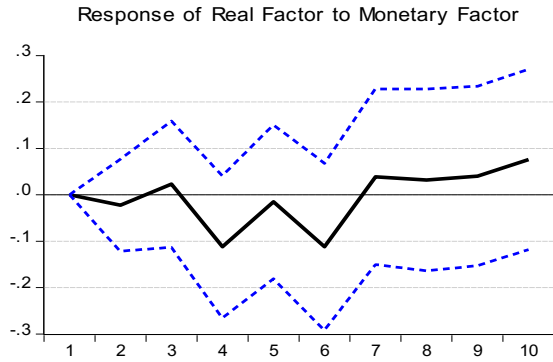**Figure 8 Real, Monetary and Financial Factors: USA**

United States
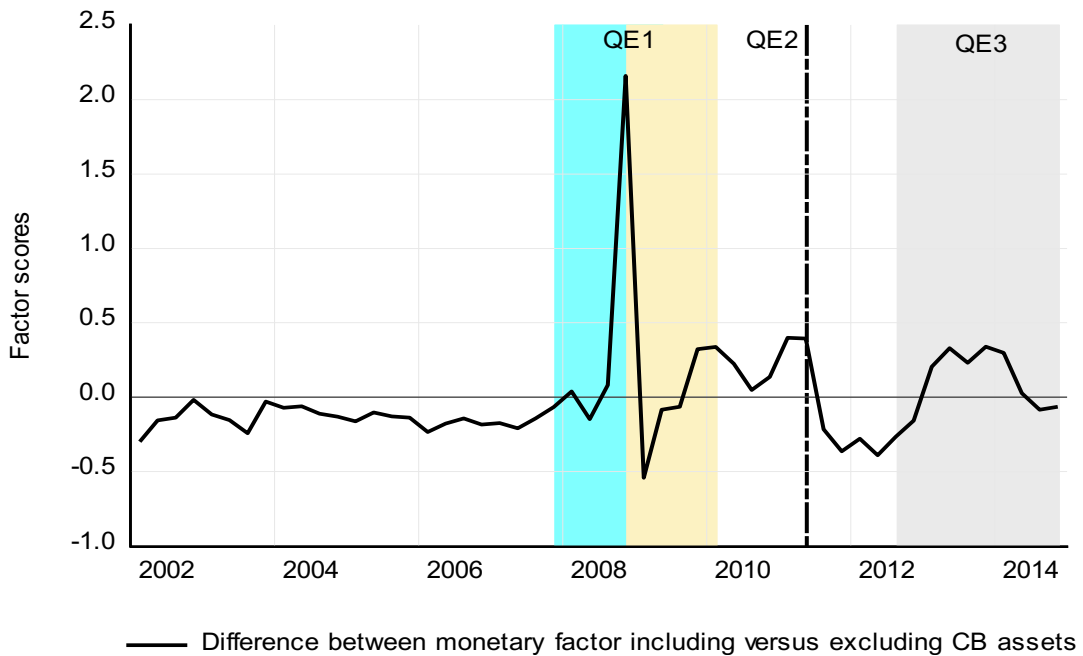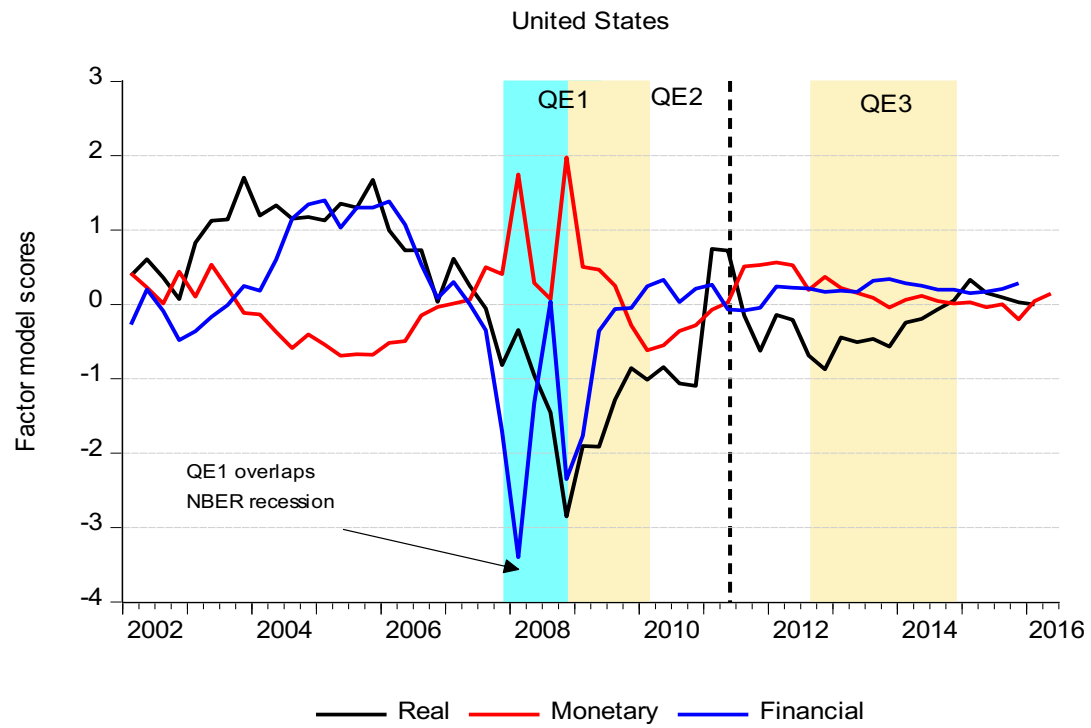
Note: Each factor is estimated by the method of principal components using maximum likelihood estimation. The factors are rotated using the varimax approach. The variables that are included in the real, monetary and financial categories are listed in the main body of the paper.

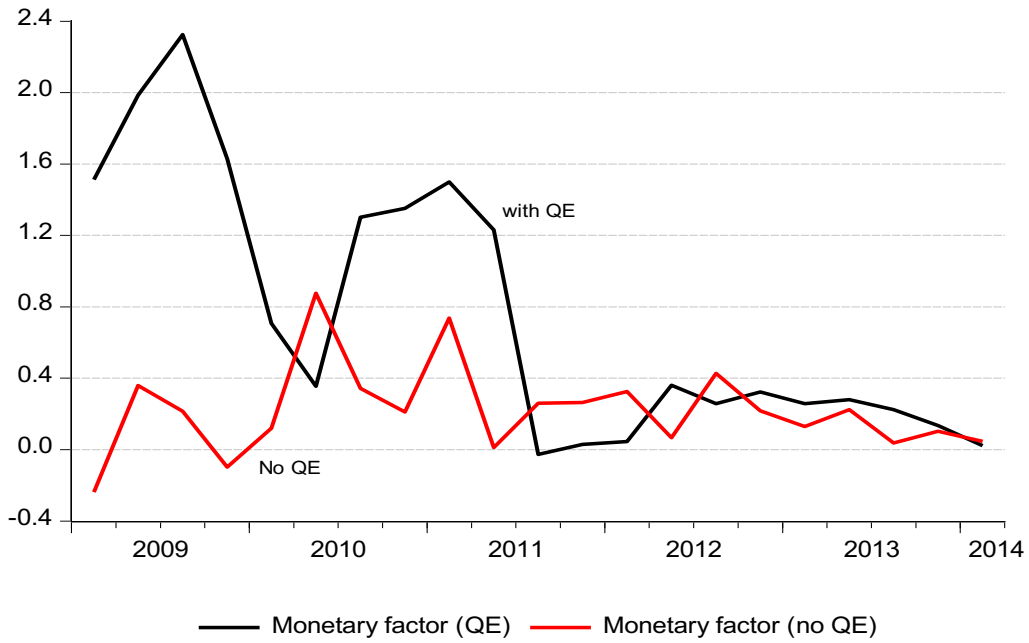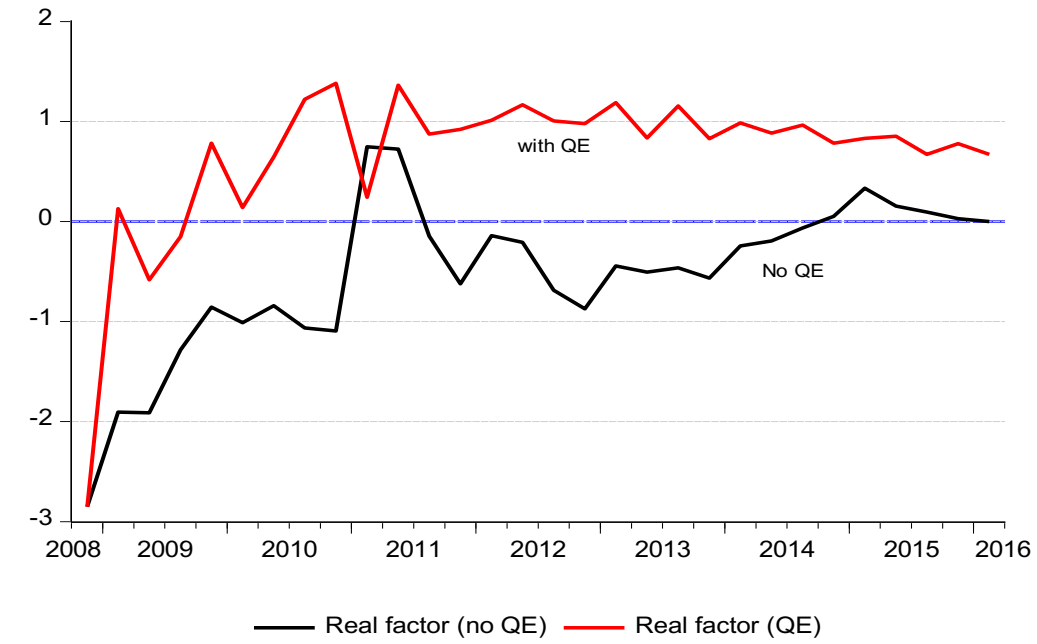## Figure 9 Varieties of Impulse Responses: USA

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)
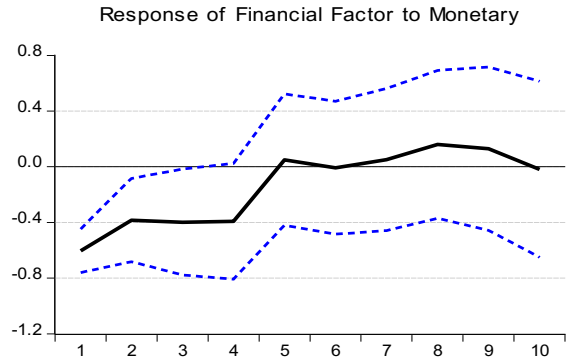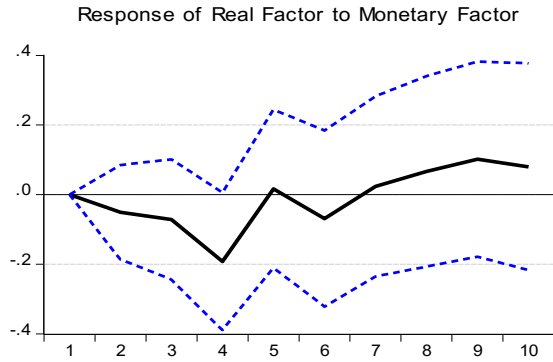
Note: A vector autoregression of order 2 is estimated for the samples shown above. The VAR consists of a real factor, a financial factor, and a monetary factor, in that order. Confidence intervals are estimated via bootstrapping (1000 replications).
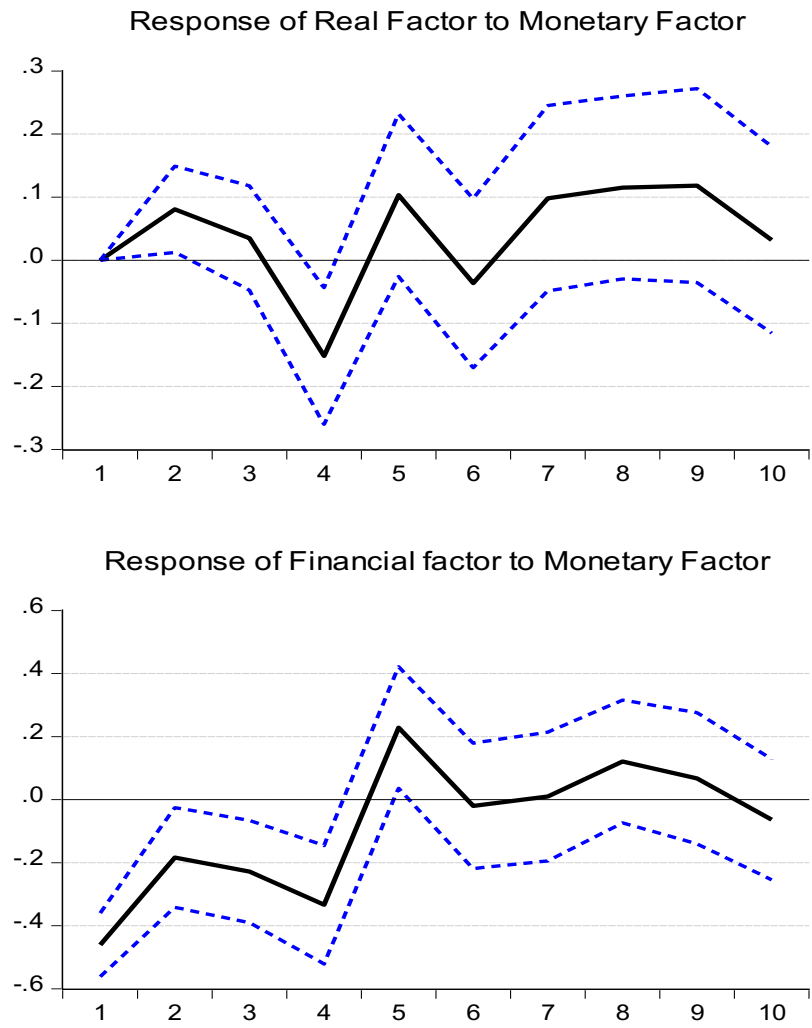
58

Figure 10 Real and Monetary Factors Since the GFC: USA

Note:

See notes to Figure 8.

Figure 11 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 9 for estimation details. The counterfactuals are described in the main body of the paper.