

QUANTITATIVE EASING AND UNCONVENTIONAL MONETARY POLICY – AN INTRODUCTION*

Michael Joyce, David Miles, Andrew Scott and Dimitri Vayanos

This article assesses the impact of Quantitative Easing and other unconventional monetary policies followed by central banks in the wake of the financial crisis that began in 2007. We consider the implications of theoretical models for the effectiveness of asset purchases and look at the evidence from a range of empirical studies. We also provide an overview of the contributions of the other articles in this Feature.

On the eve of the financial crisis of 2007–8, the intellectual and empirical foundations of monetary policy appeared secure and its implementation robust. The aim of monetary policy was to achieve low and stable inflation, the policy framework was inflation targeting, the instrument was a short-term interest rate at which the central bank provided funds to banks or the interbank market and the impact of this official rate on market rates and the wider economy was reliably quantified. Within this framework, the setting of interest rates was done judgementsally using a wide variety of macroeconomic signals but in a manner that could be approximated with reference to so-called Taylor rules, whereby interest rates responded more than one for one to changes in inflation and also responded to fluctuations in the output gap. This effectively summarises what constituted conventional monetary policy amongst the mature economies. Its operation led to an effective and predictable use of monetary policy and a largely successful pursuit of low inflation.

The financial crisis and its aftermath of the worst global recession since the 1930s poses a number of challenges for monetary policy and central banks. While conventional monetary policy achieved low and stable inflation, it did not prevent asset market bubbles from occurring. Pre-crisis, a significant literature examined the role of monetary policy in containing asset market bubbles. An influential line of thought suggested that the main aim of monetary policy should be to contain inflation, that *ex ante* it is far from clear that bubbles can be identified or dealt with by monetary policy and that it may be more effective to use monetary policy to mop up the aftermath of a burst bubble than use it to tackle its build-up.

This view has been widely challenged since the financial crisis. Central banks now have a much greater focus on financial stability in addition to targeting inflation. But by Tinbergen's Law, if an authority has N policy targets it needs at least N policy instruments, so we have seen central banks augment their arsenal of policy instruments with macroprudential tools (see for instance in the UK, the creation of a Financial Policy Committee to run macroprudential policy alongside the Monetary Policy Committee)

* Corresponding author: David Miles, Bank of England, Threadneedle Street, London EC2R 8AH. Email: david.miles@bankofengland.co.uk

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and a strengthening of capital adequacy and liquidity rules through Basel III. The aim of these policies is to achieve financial stability and prevent or at least moderate asset market bubbles.

The other main challenge to this pre-financial crisis consensus has been the ability of conventional monetary policy to mop up in an aftermath of a financial crisis and stimulate the economy into sustainable recovery. There is a variety of issues to be considered here. The first is that of the zero lower bound on nominal interest rates. The depth of the recession in many countries meant that Taylor rules would recommend negative nominal interest rates but market interest rates are effectively bounded by zero (or close to zero) because agents can always hold non-interest bearing cash. With the interest rates that central banks can set at or close to zero, other interest rates or forms of monetary policy needed to be considered. The second problem occurred due to the disruption of the financial system itself. Given the scale of losses incurred in the aftermath of the bubble bursting, the solvency of many banks and borrowers were called into question. The result was that the usually reliable relationship between changes in official interest rates and market interest rates broke down, again leading central banks to consider other forms of intervention. Related to this were fears that banks were holding onto funds to improve their viability rather than on-lending to the private sector, requiring some central banks to intervene with the direct provision of credit.

The result was that conventional monetary policy proved ineffective – the usual official rate could not be changed in line with the Taylor rule; it did not impact market rates in the expected way and problems with financial intermediation meant that the usual monetary transmission mechanism was not working. While central banks hold onto the belief that when recovery occurs, conventional monetary policy and macroprudential tools will achieve price and financial stability jointly, the challenge is to aid the economy in its recovery so as to reach that point. This is the challenge facing central banks and why they have turned to unconventional monetary policy.

Unconventional monetary policy takes many forms, as it is defined by what it is not rather than what it is. In some cases (for instance Denmark), it involves the use of negative interest rates. Some commentators advocate suspension or changes to inflation targets. The more common forms of unconventional monetary policy involve massive expansion of central banks' balance sheets (see Figure 1) and attempts at influencing interest rates other than the usual short-term official rates. For instance, the Federal Reserve implemented policies known as 'credit easing' when they purchased mortgage-backed securities. The purchase of these securities meant that the Fed now held more assets and so its balance sheet expanded. The purchase of these assets also provided liquidity to a market that had dried up in the wake of the financial crisis and helped lower mortgage interest rates directly and provided credit lines to an important part of the economy. The Federal Reserve has also implemented 'Operation Twist'. In this case the size of the balance sheet of a central bank is not affected but the central bank tries to influence non-standard interest rates. In Operation Twist, the Fed sells short-term government bonds and uses the proceeds to buy long-term bonds. Because its sales and purchases are of equal amount, the balance sheet of the central bank is unaffected but through its purchase of long-term bonds, it drives up their price and lowers long-term interest rates.

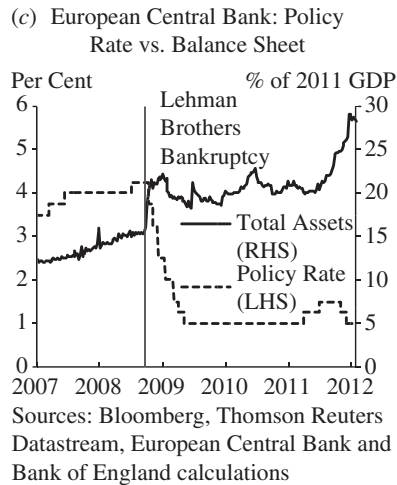
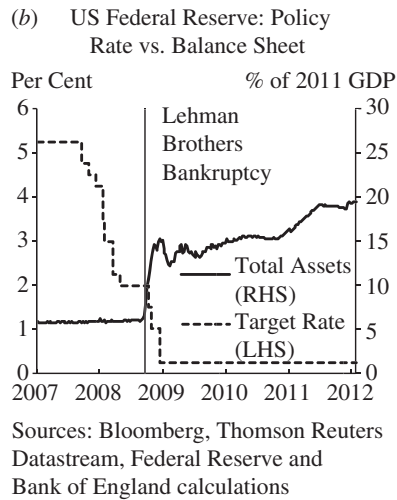
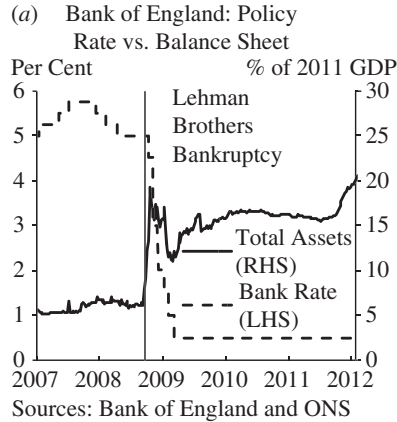


Fig. 1. Central Bank Balance Sheets During the Crisis

The most high-profile form of unconventional monetary policy has been Quantitative Easing (QE). The phrase was first applied to Japan as it dealt with the bursting of a real estate bubble and the deflationary pressures that followed in the 1990s. Conventional monetary policy operates by affecting short-term interest rates through open market operations. By either buying or selling securities from the banking system, they influence the level of reserves that banks hold in the system. In normal times, these fluctuations in the volume of reserves are merely a by-product and are not a focus or target of policy itself. Instead, fluctuations in reserves are a means to achieve desired changes in interest rates. The phrase 'Quantitative Easing' was introduced to signal a shift in focus towards targeting quantity variables. With interest rates at their Zero Lower Bound, the Bank of Japan aimed at purchasing government securities from the banking sector and thereby boosting the level of cash reserves the banks held in the system. The hope was that by targeting a high enough level of reserves, eventually this would spill over into lending into the broader economy, helping drive asset prices up and remove deflationary forces.

The central banks of the US, the Euro area and the UK have all followed Japan in adopting policies that have led to substantial increases in their balance sheets, although there are significant differences both amongst themselves and with Japan in terms of how they have implemented QE and other unconventional policies. The Bank of England has overwhelmingly bought UK government bonds from the non-bank private sector through its QE operations; the Fed has bought US Treasuries but also large quantities of agency debt and agency-backed mortgage backed securities. The differences between the assets bought by the Fed and the Bank of England are in fact not so great, because the bulk of the mortgage-backed securities are guaranteed by the US agencies, which are in effect government agencies. The expansion of the European Central Bank (ECB) balance sheet has come about largely through repo operations – that is, the provision of loans (many long term) in exchange for collateral (much of which are bank loans and not government bonds).

The ECB operations are different from the central bank purchases analysed in most of the literature on QE and credit easing. Indeed, in many ways, they are a response to a different problem than that faced by the Fed in the US and the Bank of England. Stresses within the euro area, particularly in 2011 and into 2012, led to a steady and very substantial outflow of euro deposits from banks in some of the peripheral countries and into banks in other euro-area countries. That caused a major imbalance within the euro-area banking system – essentially a form of bank run on many institutions. The magnitude of these imbalances became reflected in the so-called Target system imbalances operated by the ECB (Sinn and Wollmershauser, 2011). The ECB long-term repo operations were designed to alleviate the acute funding difficulties that were generated.

The Bank of England and the Fed asset purchase operations were not designed to handle a liquidity problem within the banking system. Rather, they were designed to affect the yields (or prices) on a wide range of assets – particularly on bonds issued to finance lending to companies and households. Many of the empirical articles in this volume assess the success or otherwise of those operations in affecting yields. The focus of many of the articles is on the impact of central bank asset purchase on government bond yields – although the ultimate objective of central banks has been as much (if not more) upon the yields and prices of private sector assets.

Understandably the efficacy of unconventional monetary policy is a subject of intense interest to central banks. Conventional monetary policy was firmly based on theoretical foundations, perhaps best articulated in Woodford (2003). However, precisely because of its novelty and the fact that its creation was due to a practical response to circumstances rather than driven by intellectual developments, we lack a clear agreed framework on how unconventional monetary policy impacts the economy. In Section 1, we therefore review possible transmission mechanisms for QE and the conditions under which it may, or may not, affect the macroeconomy.

Conventional monetary policy was also based on substantial evidence on how short-term official interest rates affected the economy. Knowledge of that transmission mechanism meant that the setting of interest rates could be done with an awareness of what quantum of interest rate changes were necessary to deliver an appropriate response. No such evidential basis yet exists for unconventional monetary policy. Exactly because it is unconventional, it has been rarely used so historical evidence is limited. Therefore, central banks need to learn from the past few years since the crisis unfolded and examine closely, whether the differences in implementation across them can give guidance about the optimal form and setting of non-conventional monetary policy. The brief summary of the emerging empirical literature on this topic, including many of the articles contained in this Feature, which we provide in Section 2 is hopefully helpful in that regard.

To shed light on these topics and the efficacy of its own QE the Bank of England organised a conference on QE and unconventional monetary policy in November 2011. A wide range of high-quality articles were submitted to the conference and a selection of the articles presented are included in this Feature. These articles reflect a wide range of methodologies used to construct a counterfactual (case study analysis, vector autoregressions (VARs), dynamic stochastic general equilibrium (DSGE) models) and assess the impact of unconventional policies, consider a wide range of countries and focus on the impact of QE on both financial markets and the wider economy. Given the continued weakness of the economic recovery it is possible that unconventional monetary policy will be with us for several more years. Although this is undesirable from a policymakers' perspective, it will give us further evidence with which to learn more about the impact of unconventional policies. For the time being, however, we hope that the articles pulled together for this volume give an accurate reflection of the academic state of knowledge currently available to policymakers.

1. Unconventional Monetary Policy in Theory: The Transmission Mechanism

Woodford (2003) is a comprehensive articulation of the theoretical foundations of what is still considered conventional monetary policy. Optimal monetary policy is essentially boiled down to rules for setting a short-term nominal interest rate. While the mechanisms through which central banks influence interest rates usually involve some form of market operations, the quantities of such transactions were seen as almost irrelevant. Monetary policy was therefore seen as all about the decision by policy committees on policy rates, whereas implementation of these decisions was seen as just plumbing.

But as explained above, a zero lower bound on interest rates and a disconnection between official rates and market rates meant that conventional monetary policy ceased to be effective in the aftermath of the financial crisis. For both these reasons, monetary policy became about much more than setting a price – the policy rate – and focus turned to the size of central bank balance sheets.

By purchasing assets, the central bank can expand its balance sheets. Asset purchases by central banks can either be of government bonds (or bills) or of assets issued by the private sector. Asset purchases – unlike decisions about a target for a policy rate – are explicitly about quantities. They are the use by the central bank of its ability to create acceptable means of payment in unlimited quantity to acquire assets. In doing so, the central bank expands its balance sheet and shifts the portfolio mix of assets held by the private sector who come to hold more claims on the central bank (‘money’ – the liability side of the central bank’s balance sheet) and fewer of the claims that the central bank has acquired (which now form the asset side of its balance sheet). The central bank’s balance sheet rises; its extra liabilities – most of which are likely to be in the form of greater reserves held by the banking system – matched by greater assets.

The efficacy of these actions by central banks hinges on a number of key questions that set the research agenda for QE. Why might portfolio switches of this sort affect the wider economy? By what mechanism might the real cost and availability of credit to the private sector be affected? How can such policies affect demand in the economy? How does the mix of assets purchased by the central bank affect things? Is it only purchases of private sector assets that represent a form of funding for private spending – ‘credit easing’ – that can have effects? Or can purchases of government bonds and bills – ‘quantitative easing’ or QE – also have an effect?

We know that there are conditions under which asset purchases by the central bank – irrespective of whether they are of private sector or government securities – are completely neutral and so both credit easing and QE would be ineffective. It is a useful starting point to see what assumptions are needed to generate this in effectiveness result. One formalisation of the argument is in Eggertsson and Woodford (2003), although the central idea goes back at least to Wallace (1981). The essence of their result is that if the private sector – in the form of a single representative agent who has an infinite horizon, faces no credit restrictions and is rational – sees the assets held by the government and by the central bank as indistinguishable from their own assets, then any swap of assets with the central bank cannot change anything. This is true and is analogous to the Ricardian Equivalence proposition. But the representative agent assumption is a strong one, as is the assumption of perfect substitutability between assets. It is debatable whether this last assumption holds even in unstressed financial markets but it is very questionable in the wake of a financial crisis where markets are not operating smoothly. On this hinges the issue of the potency or otherwise of QE.

As is the case with Ricardian Equivalence, the Eggertsson and Woodford result does not hold in more general cases where there are credit constraints, limited financial market participation or distortionary taxes. Andrés *et al.* (2004), for example, present a model with limited participation in financial markets embedded in a DSGE model with agents with different preferences for government bonds. In that model, purchases by the central bank matter. Curdia and Woodford (2011) also consider the impact of credit imperfections and heterogeneity and show that certain types of asset purchase by

the central bank can affect demand and output. But that result only holds for central bank direct lending to the private sector – in other words credit easing. In their model, QE (the purchase of government bonds by the central bank) is ineffective despite their dropping the assumption of a representative agent – so that financial intermediation matters in their model – and despite the existence of imperfections in private financial intermediation and the possibility of disruptions to the efficiency of financial intermediation through banks. The reason why QE is ineffective is that Curdia and Woodford think of government bonds as one period claims paying a safe rate identical to the rate set by the central banks and which – optimally – is the same rate paid on bank reserves. The result is that reserves ('money') and government bonds become perfect substitutes. Swapping one for the other – QE – does nothing.

This result of Curdia and Woodford (2011) is itself a special one and depends on the fact that the government securities which the central bank buys are short-lived assets with identical characteristics to bank reserves. To generate an impact from QE, we need portfolio switches to not be a matter of indifference for investors. This is why many have viewed the most natural channel through which QE can work as being what might be called a 'portfolio balance' channel. The nature of the mechanism was initially described *inter alia* by Tobin (1961, 1963, 1969) and Brunner and Meltzer (1973). They stressed how central banks, through varying the relative supplies of financial claims with different durations (or maturities) and liquidity, could influence the pattern of yields on different assets due to imperfect asset substitutability. That meant that quantities that a central bank could influence (for example the relative quantities of money and government bonds held by the private sector) could affect asset prices, and so in turn affect real investment decisions. An important ingredient of this portfolio balance channel is heterogeneity across agents – some people have to come to hold different portfolios and prices need to change to make this an equilibrium. Somebody ends up with more of one sort of a claim as a liability (the central bank has issued more money) and more of another as an asset, and someone else has taken the other side of that. Ricardian equivalence mechanisms undermine this channel because with no credit restrictions the private sector sees that large portfolio switches that seem to change the flows between the government (including the central bank) and itself are actually irrelevant and can be nullified. Credit restrictions and heterogeneity are important features of models where portfolio balance effects generate first-order macroeconomic outcomes in the spirit of Tobin. Consider, for instance, the model of Kiyotaki and Moore (2012) which is a model of a monetary economy where financial assets differ in their liquidity. Entrepreneurs who want to undertake investment can only finance a limited proportion by issuing new claims (equities). So they hold a stock of highly liquid assets, in case opportunities come along. Money can always be used to finance investment; selling shares is more difficult. In this model, a liquidity shock means that the proportion of good investment projects that can be undertaken falls because issuing shares becomes more difficult. The central bank can alleviate the impact of such shocks by asset purchases: in this model, this means the central bank buying the less liquid asset (equities) for newly created money. Limited participation and imperfections in credit markets are at the heart of this model and explain why the neutrality result of Eggertsson and Woodford does not hold.

The Kiyotaki and Moore framework is an attempt to provide vigorous microfoundations to underpin insights from Tobin and others on how monetary policy can have real effects by changing the relative stocks of assets with different liquidity characteristics. Their article is part of a literature on macroeconomics with financial frictions that goes back at least to Bernanke and Gertler (1989), Kiyotaki and Moore (1997) and Holmstrom and Tirole (1998).

1.1. *The Transmission Mechanism of QE*

Much of what central banks have said about the mechanism by which QE works can also be understood in the context of portfolio balance models and models of credit imperfections. Miles (2011, 2012) describes two main channels through which asset purchases by the Bank of England can affect the economy and a stylised representation of these channels is shown in Figure 2.

The portfolio substitution channel is shown in the upper half of Figure 2. The Bank of England’s purchases of gilts reduce the free float of gilts while increasing central bank reserves held by commercial banks. In the case of Bank of England operations, most gilts were purchased from non-banks (as that is where most gilts were). Initially, most of the proceeds from the sale of gilts show up in bank deposits. If gilts and bank deposits were perfect substitutes when interest rates are close to zero that might be the end of the story – in terms of portfolio rebalancing for the non-bank private sector – and it is not clear that gilt yields would react. The economy would be in a liquidity trap and in this situation additional supplies of money do not lead to a reduction in bond yields or in any other yields. So, people who sold gilts would swap them for bank deposits; and banks might just passively accept higher reserves at the Bank of England. But bank deposits and bonds may not be perfect substitutes. There are at least two (related) reasons for this, one related to preferred habitats and the other to the pricing of duration risk.

When investors sell gilts to the Bank of England, they initially exchange a long-dated asset – the gilts – for a short-dated asset: bank deposits. Some investors may not care much about the resulting change in duration in their portfolio. But, they may be in a minority. Many investors in gilts – primarily pension funds and insurance companies –

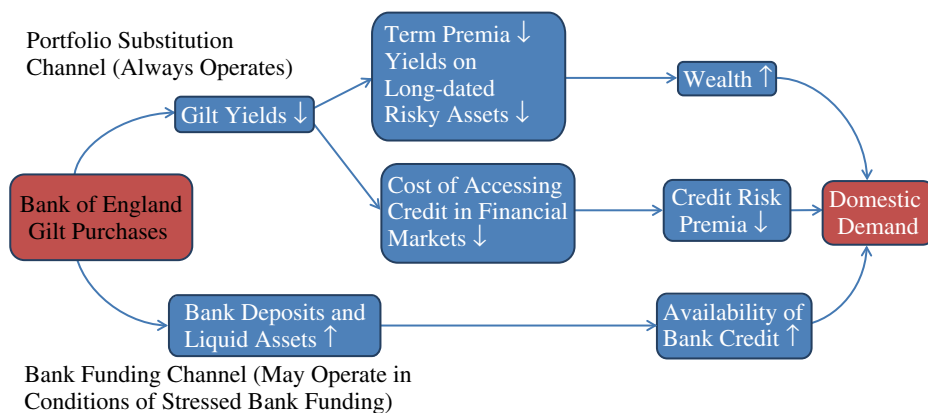


Fig. 2. Channels for the Impact of the Bank of England’s Gilt Purchases on Domestic Demand

have long-dated liabilities and prefer to match these liabilities with equally long-dated assets. (Pension funds and insurance companies own about 30% of gilts.) These investors are likely to use some of the proceeds of gilt sales to purchase other long-dated assets, such as corporate bonds, to restore the duration of their portfolio. By purchasing gilts, the Bank of England reduces the stock of privately held, relatively long-dated assets. With less duration risk to hold in the aggregate, those in the market that needed to be induced to take it should require a lower premium. This tends to reduce the term premium for all long-dated assets; the prices of long-dated risky assets – corporate bonds and equities – are likely to rise.

The rise in asset prices and decline in yields on these other assets may make it easier for many companies to raise funds, easing credit conditions. They will generate capital gains for households who are the ultimate owners of those risky assets, boosting their wealth. If households consume part of that increased wealth, or companies invest some of the extra funding raised on capital markets, demand (and GDP) will be higher. This is the portfolio rebalancing channel of asset purchases.

The mechanisms at work here are consistent with so-called preferred-habitat theories (Modigliani and Sutch, 1966), where investors have a preference for a particular segment of the yield curve. Vayanos and Vila (2009) develop a model where such effects operate so that the supply of bonds affects yields, even in the presence of arbitrageurs. (Greenwood and Vayanos (2010) present empirical evidence on this based on US data.) A special case of the Vayanos and Vila (2009) model delivers the so called ‘duration channel’, also emphasised in Gagnon *et al.* (2011). The idea here is that a central bank’s purchases of long-duration assets, like medium-to-long-term government bonds will reduce the average duration of the stock of bonds held by the private sector and this may cause a fall in the premium required to hold duration risk or (equivalently) raise the price that those wishing to maintain such duration are prepared to pay for something in reduced supply.

How powerful might these portfolio balance effects be? There is some evidence that the price of assets likely to be substitutes for the government bonds bought by the Bank of England did rise. Corporate bond yields did decline substantially in the months after the start of the Bank’s asset purchase programmes, particularly in 2009 when most of the purchases were made (see Figure 3(c)). How much of that decline was due to asset purchases by central banks is impossible to tell from a graph of course – which is why one does econometrics. But, what is clearer is that this decline in corporate bond yields was helpful for companies who can directly tap the capital markets. These companies may be able to replace bank funding with funds directly raised on financial markets. There is evidence that this happened in the UK during 2009. The decline in yields and the rise in asset prices also generate capital gains for households who own risky assets, and they may decide to consume part of their increased wealth.

The impact of asset purchases by the central bank on the yields on risky assets is the sum of any impact on government bond yields plus the impact on the spread between the yield on risky asset yields over government bonds. So, a reduction in gilt yields is not necessary for gilt purchases by the Bank of England to have an effect on the real economy via the portfolio balance mechanism: if the spread falls, asset purchases would be affecting the cost of finance to the private sector and potentially generating capital gains even if gilt yields are unchanged. There are certainly conditions under which the

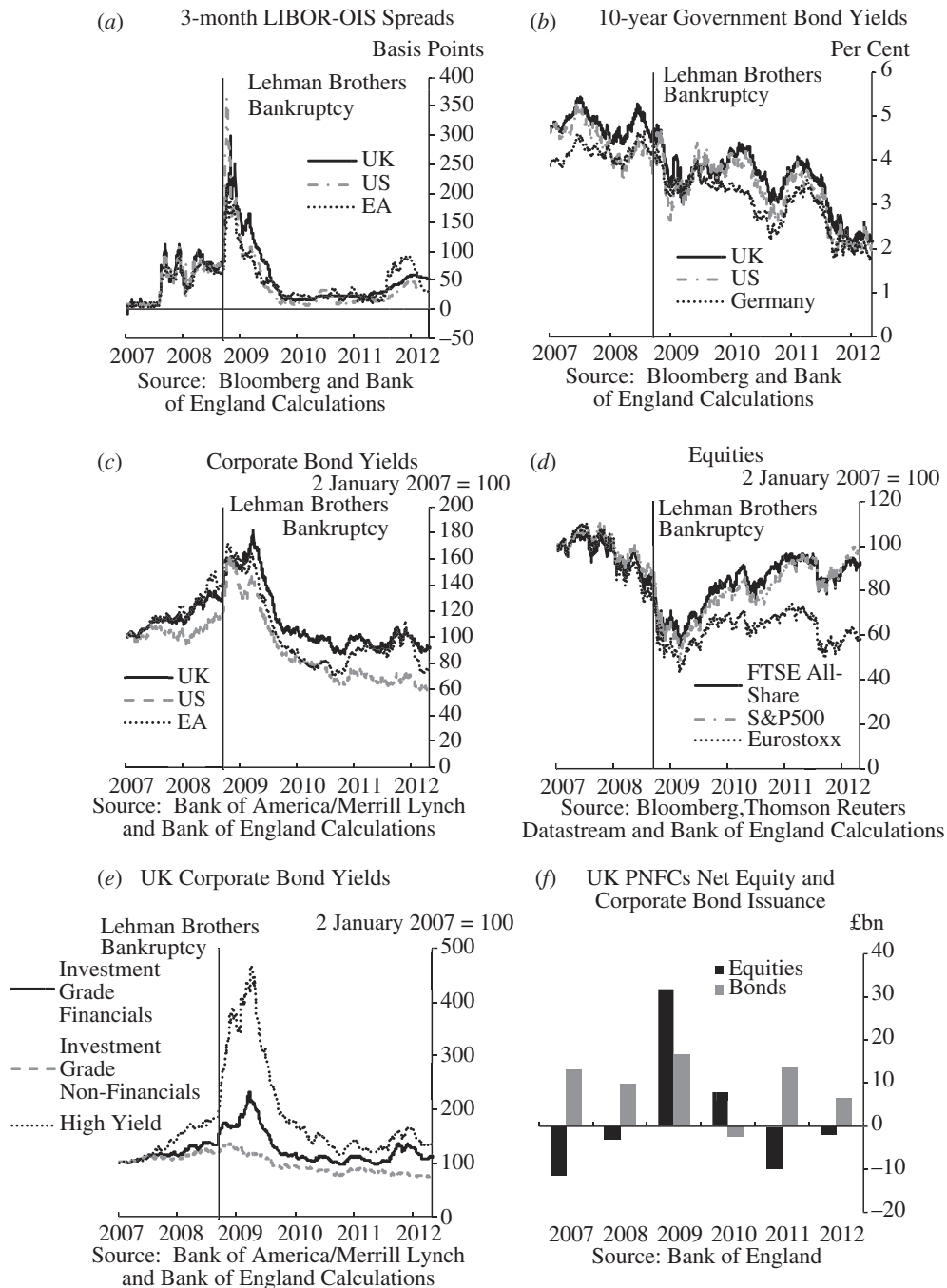


Fig. 3. Financial Market Indicators During the Crisis

sort of portfolio re-balancing and re-pricing described would not happen; as noted above, Eggertsson and Woodford (2003) present one example.

Figure 2 also illustrates a bank funding channel. This is a channel that might help to improve the availability of bank credit (or prevent it becoming less available). But, it is only under conditions of stress in the availability of funds to individual banks that one could expect it to operate. The more concerned banks are about their ability to refinance themselves, the less likely they are to grant loans. When the Bank of England purchases gilts owned by non-banks, all else equal, banks' deposits rise as do reserve balances at the central bank. To the extent that a bank's reserve holdings would then come to exceed its demand for liquidity, it is likely to be more willing to expand lending. Or, if a bank had already lost some other funding, it might be able to avoid a contraction in its lending or a sale of less liquid assets.

The bank funding channel might be weak. It would be weak when the funds generated by the central bank asset purchases come to banks as very short-term wholesale deposits and banks feel the need to increase their liquid asset holdings (in the form of reserve balances at the central bank) to insure against the risk that these deposits might be withdrawn at short notice. But, even then it may be that banks increase their liquid assets by less than the amount of short-term inflows. Should the money inflow to a bank – generated by asset purchases – be in the form of longer term funds (term deposits, bonds or even purchases of bank equity), then it is more likely that the additional funds could help banks to expand, or at least to avoid contracting, their lending.

2. Unconventional Monetary Policy in Practice: The Empirical Evidence

A casual reading of UK financial and macroeconomic developments since the crisis would suggest evidence in support of the efficacy of unconventional monetary policy. Interbank borrowing rates fell back sharply in late 2008 (Figure 3(a)) in the wake of a variety of measures aimed at providing support and liquidity to the banking sector. In 2009, the timing of credit and QE policies coincided with a rally in asset prices, with equities rising sharply and government and corporate bond yields showing large falls, particularly for the riskier high-yielding bonds (Figure 3(b–e)). Capital market borrowing conditions improved in the UK where there was a sharp rise in both corporate bond and equity issuance during 2009 (Figure 3(f)). There were also improvements in wider economic conditions. After the deepest recession since the 1930s, economic growth returned in the second half of 2009. But, the subsequent recovery has been sluggish and much weaker than after a normal cyclical downturn (Figure 4(a) and (b)), with bank lending growth very weak (Figure 4(d)).

However, casual empiricism cannot be used to answer the question whether non-conventional monetary policy has been effective as we need to form a counterfactual about what would have happened in the absence of policy intervention. Isolating the contribution of unconventional monetary policy in driving economic and financial developments during 2009 poses a number of difficult challenges given the large number of other potential contributory factors. Central banks were loosening policy at the same time as the fiscal authorities were trying to boost demand and there may have been spillover effects from other countries that were taking similar measures. Moreover, although the effects on financial markets are usually amenable to direct

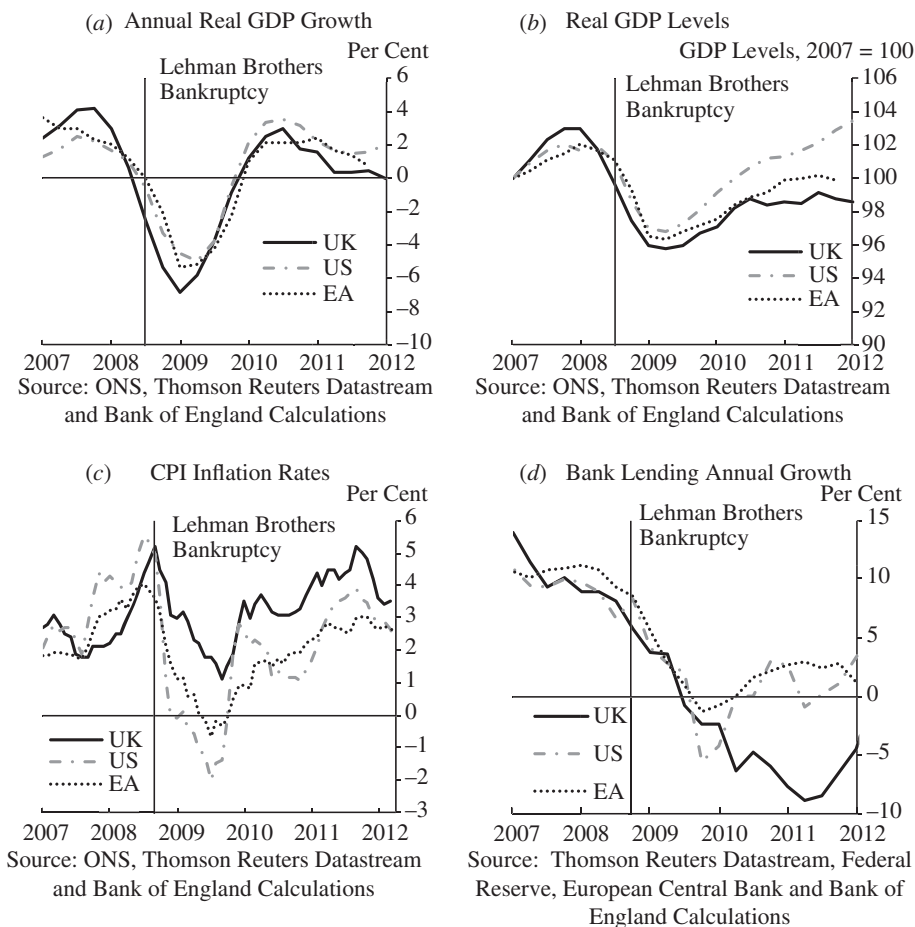


Fig. 4. Macroeconomic Indicators During the Crisis

observation through event studies, this is not true for the wider economic effects, where the lags may be long and variable and there are consequently a host of additional factors that need to be controlled for.

2.1. The Impact on Financial Markets

Most of the empirical literature on asset purchases by the Bank of England and the Federal Reserve has focused on the effects on financial markets and more narrowly on government bond markets. One of the first studies of the US Federal Reserves' large-scale asset purchases (LSAPs) by Gagnon *et al.* (2011) concluded that the Fed's purchases between December 2008 and March 2010 (LSAP1) had economically significant and long-lasting effects on longer term interest rates on a variety of securities, including Treasuries, agency mortgage-backed securities and corporate bonds. Using both event studies around key LSAP announcements and time series regressions relating risk premia to measures of the supply of government debt, they estimated that

the LSAPs reduced the 10-year term premium by somewhere between 30 and 100 basis points overall. A range of subsequent studies have also found that the Fed's LSAP1 asset purchases were successful in reducing medium and long-term interest rates, including those by D'Amico and King (2010), Krishnamurthy and Vissing-Jorgensen (2011) and Hamilton and Wu (2012). Swanson (2011) even found that using modern event study techniques, the Operation Twist episode in the US in 1961 when the Federal Reserve also purchased a large quantity of Treasuries led to similarly sized announcement effects on Treasury yields as LSAP2. Neely (2012) found that the US LSAP announcements also had substantial effects on international long-term rates and the spot value of the dollar.

For the UK, Meier (2009) and Joyce *et al.* (2011*a,b*) found that the first round of the Bank of England's asset purchases had economically significant effects on gilt yields. Based on an event study analysis, Meier (2009) suggested that the initial QE announcements reduced gilt yields by 35–60 basis points 'at the very least' compared with where they would otherwise be. Joyce *et al.* (2011*a*) estimated that medium-to-long-term gilt yields fell by 100 basis points overall, summing up the two-day reactions to the first round of the MPC's announcements on QE purchases during 2009–10. They also found that similar falls occurred in corporate bond yields and that there were also modest announcement effects on the sterling exchange rate. The size of these effects was broadly in line with the predictions of portfolio choice models estimated over the pre-crisis period, which also suggested that QE might have boosted equity prices by about 20%. The broad orders of magnitude of the estimated effects on long-term interest rates from these US and UK studies is consistent with Kozicki *et al.* (2011), who examine the empirical relationship between long forward interest rates and the size of central bank balance sheets using data pre-dating the crisis.

Most of the empirical studies on central bank asset purchases have used event studies as a key part of their analysis. One of the crucial issues in conducting event studies is the choice of the window size used to measure the reaction of financial prices. Too short, and there is a risk that the full market reaction will be missed; too long, and there is a risk that other factors may be driving the observed response. As an example of this, Joyce *et al.* (2011*a,b*) highlight that choosing a one-day rather than a two-day window to measure the impact of UK QE announcements halves the effects. Joyce and Tong (2012, this issue) examine the appropriate window length on the basis of a detailed narrative of the events following each of the UK announcements they analyse. Their conclusion is that the gilt market took varying amounts of time to incorporate the news in announcements on QE, with the early announcements taking two days to get fully incorporated into yields.

Although the precise estimates differ across studies, there is a broad consensus in the literature that central bank asset purchases had economically significant effects, at least on government bond yields. There is, however, more debate on the transmission channels linking asset purchases with asset prices and relatedly on the persistence of the reductions in yields. The majority of empirical studies of central bank asset purchases have concluded that they mainly affect bond yields and other asset prices because they reduce term or risk premia through portfolio balance effects (D'Amico and King, 2010; Gagnon *et al.*, 2011; Joyce *et al.*, 2011*a,b*). Portfolio balance effects themselves are sometimes broken down into effects through scarcity or local supply and effects through

duration risk. D'Amico *et al.* (2012) model the pre-crisis relationship between Treasury yields and term premia estimates and measures of aggregate duration and local supply, to quantify the respective impact through these two channels. Using their model estimates, they find that the Fed's, LSAP1 and LSAP2, operated through both the scarcity and duration channels, though scarcity effects appeared to predominate in LSAP2. For the UK, Joyce and Tong (2012) use high-frequency, disaggregated information on gilt yields to examine the effects of both announcements about future QE and the effects of the Bank of England's reverse auctions themselves. They also find evidence that the Bank of England's asset purchases had effects through both local supply effects (yields on gilts being purchased by the Bank fell by more) and duration risk effects (there were larger yield falls for bonds with longer maturities). But, other authors see the evidence differently. Krishnamurthy and Vissing-Jorgensen (2011), for example, emphasise the relative importance of signalling effects and what they term a 'safety channel' in explaining the impact of the Fed's purchases from the event study evidence, finding no evidence to support the duration risk channel as an explanation of the effects of asset purchases. Using estimated dynamic term structure models to decompose the fall in yields into changes in expected future policy rates and changes in term premia, Christensen and Rudebusch (2012) also infer that the Fed's LSAPs mainly worked through a signalling channel, although their results suggest the portfolio balance channel was more important in explaining the decline in UK yields in response to QE.

Evidence on the persistence of the effects of asset purchases is presented by Wright (2011). In his study, he attempts to measure the effects of US monetary policy on financial variables during the crisis using a structural vector autoregression, where monetary policy surprises are identified by assuming that the variance of policy shocks is larger on days that seem likely to contain policy news. The main result from the analysis is that although unconventional policy has significant effects on financial variables beyond Treasury yields, those effects die out very quickly, with a half-life of a few months. But, Wright's analysis does not allow him to say whether these effects were short-lived because financial markets initially overreacted or because they were either offset by other factors (e.g. improvements in the macroeconomic outlook). Joyce and Tong (2012) attempt to examine this issue by regressing gilt yields on the Bank's QE purchases and a range of macro control variables, finding that the depressing effect of purchases on yields is quite persistent once other macro and fiscal factors are controlled for.

2.2 *The Impact on the Wider Macroeconomy*

For reasons already discussed, quantifying the wider macroeconomic effects of unconventional monetary policies is particularly challenging. Given the obvious lags involved before the effects get fully passed through to output and inflation, event study analysis is not appropriate and analysis usually has to rely on constructing model-based policy and no-policy counterfactuals, which is obviously made difficult by the unusual circumstances of the financial crisis. Moreover, the fact that there is little historical precedent for these policies compared to conventional monetary or fiscal policy means that the results from this sort of counterfactual exercise inevitably have to be heavily qualified.

Despite these difficulties, a growing literature has begun to provide estimates of the macroeconomic effects. In one of the first studies of this nature, Baumeister and Benati

(2010) estimate a time-varying parameter structural VAR to investigate the macroeconomic impact of lower long-term bond spreads during the 2007–09 recession period. In all, the countries they analyse – the US, Euro area, Japan and the UK – they find a compression in the long-term yield spread exerts a powerful effect on both output growth and inflation and their counterfactual simulations indicate that unconventional monetary policy actions in the US and UK averted significant risks both of deflation and of output collapses.

The impact of the Fed's LSAPs on the US macroeconomy is also investigated by Chung *et al.* (2012), who carry out simulations using the Fed's FRB/US macroeconomic model augmented with a simple model of portfolio balance effects calibrated to be consistent with the first round of asset purchases (LSAP1) reducing long-term interest rates by 50 basis points. They find that the combination of LSAP1 and LSAP2 raises the level of real GDP relative to base by 3% and that the inflation is 1% higher than if the Federal Reserve had not carried out the programme of purchases, implying that asset purchases prevented deflation. They find that the Fed's asset purchases have effects equivalent to a cut in the federal funds rate of around 300 bp from early 2009 to 2012. Chen *et al.* (2012) attempt to quantify the effects of the Federal Reserve's LSAP2 using a DSGE model incorporating asset market segmentation (similar to Andrés *et al.* (2004) discussed above), which they estimate using Bayesian techniques. Under the assumption that there is a commitment to remain at the zero lower bound (ZLB) for four quarters, the authors find that a simulated LSAP2 policy increases GDP growth by 0.4% on impact and has a minimal impact on inflation. The authors conclude that the macro impact of LSAP2 was slightly smaller than a 50-basis point cut in the federal funds rate. They attribute its relatively weak impact to the low estimated level of segmentation they find.

For the UK, Kapetanios *et al.* (2012) examine the impact of the Bank of England's QE asset purchases on GDP and inflation in the UK. In this article, three VAR models, each incorporating structural change in different ways, are used to produce counterfactual forecasts, assuming that QE acted to reduce gilt spreads. The counterfactual scenarios are constructed by conditioning the model on actual gilt spreads and Bank Rate (the policy scenario) and on a gilt spread that was 100 basis points higher than actual outturns (the no-policy scenario), taking as given the finding from previous Bank of England research that QE reduced medium-to-long-term gilt yields by about 100 basis points. There is considerable uncertainty and variation across the models used. But, taking the preferred average estimates from the three models implies that QE had a peak effect of 1.5% on the level of real GDP and a peak effect of 1.25 percentage points on annual CPI inflation. These estimates are broadly similar to those produced by Bridges and Thomas (2012), who first calculate the impact of QE on the money supply and apply their estimates to two econometric models – an aggregate SVAR model and a linked set of sectoral money demand systems – that allow them to calculate how asset prices and spending need to adjust to make money demand consistent with the increase in broad money supply. (Other methods of quantifying the effects of the first round of asset purchases in the UK are discussed in Joyce *et al.* (2011 *b.*))

A number of articles have also looked at the macroeconomic effects of the ECB's policy interventions during the crisis (summed up as 'enhanced credit support' by Trichet (2009)). One of the first of these was by Lenza *et al.* (2010), who consider the

effects of the ECB's fixed-rate full allotment policy, which allowed financial institutions to obtain unlimited liquidity for extended periods. They assume that the ECB's policy worked through changing money market spreads. Using a Bayesian VAR model, they compute a policy forecast conditional on actual money market rates with a no-policy forecast conditional on a path for money market rates that would have prevailed if the ECB had not undertaken unconventional monetary policy. They find that the compression of spreads attributed to the ECB's unconventional policies has a similar impact to a standard monetary policy shock in normal times, leading to a sizeable impact on loans and interest rates, very modest effects on broad money, and boosting real activity and inflation with a delay. Other articles by Fahr *et al.* (2010), Giannone *et al.* (2011) and Peersman (2011) have also suggested that the ECB's actions were effective in supporting the euro-area economy. The article by Giannone *et al.* (2012, this issue) examines the impact of the unconventional policy measures taken by the ECB using a new data set on bank balance sheets that captures, among other things, the volumes of interbank lending and of Eurosystem loans to banks. Using a large Bayesian VAR containing macro and financial variables, the authors produce forecasts for lending to banks over the crisis period, conditional on realised outturns of industrial production and unemployment, and find that ECB lending to the banking sector was much higher than would otherwise have been expected. Taking this additional lending as a measure of the ECB's policy intervention, they use a model to look at the impact of the policy on the eurozone economy. They find significant positive effects, with euro-area industrial production 2% higher than it would otherwise have been and the unemployment rate 0.6 percentage points lower.

3. Conclusions

The very fact that the recovery in the Western economies remains so sluggish and weak suggests that either recessionary forces have been extremely strong; that QE does not work; that it has not been done in sufficient scale; or that its effects are limited and need to be supplemented with other measures. The consensus of the literature and the articles in this volume is that unconventional monetary policy does work – asset market purchases do lower yields and longer term interest rates and these lower yields in turn have a positive effect on the economy. This is why central banks are still contemplating further stages of QE. However, there are also many things we do not know and several areas of concern. The first is that even if QE has been effective in terms of boosting the economy, recovery still remains fragile. It has not therefore solved the problem of sluggish recovery after a financial crisis, though it has helped to mitigate it partially. This raises the possibility of increasing the scale of QE so that it can have a larger macroeconomic effect. Although we do not have much evidence on whether QE faces diminishing returns. We are once again limited by the lack of historical evidence, which means policymakers inevitably have to behave cautiously. The second area of concern, and one that was not covered in the conference, is what might be the costs of unconventional monetary policy. One concern is that a high level of bank reserves might reduce the level of interbank lending and lead that market to malfunction. When recovery occurs how will central banks reduce the level of reserves and avoid high levels of inflation? Perhaps most concerning is whether central bank purchases of

government bonds are helping to contribute to unsustainable levels of government debt. These are all contentious issues with proponents on both sides. For now, while the problems of recovery dominate, these issues receive less attention, but as future events unfold the debate is likely to shift into these areas.

So what have we learnt? The consensus of the research here, albeit mainly produced by central bank researchers, is that unconventional monetary policy does have an effect on the economy. There is inevitably uncertainty over the size and duration of the effect and the precise channel through which it works, although this is perhaps to be expected given the relatively short historical period we have at our disposal and the extreme nature of the recession which makes thinking about counterfactuals challenging. However, although unconventional monetary policy has been found to work, its effects have not been enough to offset the negative forces of a banking crisis and a deleveraging-led downturn. The implication is that central bankers and financial regulators need to work on improving their macro and micro prudential frameworks, so that the limited but significant potency of unconventional monetary policy does not need to be relied upon so heavily in the future.

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