The United Kingdom's quantitative easing policy: design, operation and impact

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In response to the intensification of the financial crisis in Autumn 2008, the Bank of England, in common with other central banks, loosened monetary policy using both conventional and unconventional policy measures. In the United Kingdom, the principal element of these unconventional measures was the policy of asset purchases financed by central bank money, so-called quantitative easing (QE). Over the period March 2009 to January 2010, £200 billion of assets were purchased, overwhelmingly made up of government securities, representing around 14% of annual GDP. This article reviews the motivation for these central bank asset purchases and describes how they were implemented. It goes on to review a range of evidence for the impact of the asset purchases made to date, both on financial markets and more widely on the economy. While there is considerable uncertainty about the magnitudes, the evidence suggests that QE asset purchases have had economically significant effects.

Introduction

After the failure of Lehman Brothers in September 2008, confidence in the world economy collapsed, international financial markets became dysfunctional and credit conditions tightened markedly.

As the crisis intensified, central banks internationally took measures to loosen monetary policy and support demand. In the United Kingdom, the Bank of England's Monetary Policy Committee (MPC) cut interest rates sharply, with cuts of 3 percentage points in Bank Rate during 2008 Q4 and a further 1½ percentage points in early 2009. In early March 2009, Bank Rate was reduced to ½%, effectively its lower bound. But, despite this substantial loosening in policy, the MPC judged that without additional measures nominal spending would be too weak to meet the 2% CPI inflation target in the medium term. The MPC therefore also announced that it would begin a programme of large-scale purchases of public and private assets using central bank money.[2] The aim of the policy was to inject money into the economy in order to boost nominal spending and thus help achieve the 2% inflation target.

The policy of expanding the central bank's balance sheet through asset purchases, financed by central bank money is widely referred to as quantitative easing (QE).[3] The Bank of England's asset purchases were overwhelmingly focused on purchasing a large amount of UK government bonds (gilts). Between March 2009 and January 2010, the Bank purchased £200 billion of assets, mostly medium and long-dated gilts. These asset purchases represented nearly 30% of the amount of outstanding gilts held by the private sector at the time and around 14% of annual nominal GDP. Combined with earlier liquidity support measures to the banking sector,[4] these purchases increased the size of the Bank's balance sheet relative to GDP threefold compared with the pre-crisis period.

The Government also authorised the Bank to pursue a number of activities targeted to improve the functioning of specific financial markets (see Fisher (2010a)). This included purchases of high-quality commercial paper and corporate bonds. The scale of these operations was much less than for the gilt purchases, consistent with the Bank acting as a backstop purchaser/seller with the intention of improving market functioning.

Figure 1 QE transmission channels
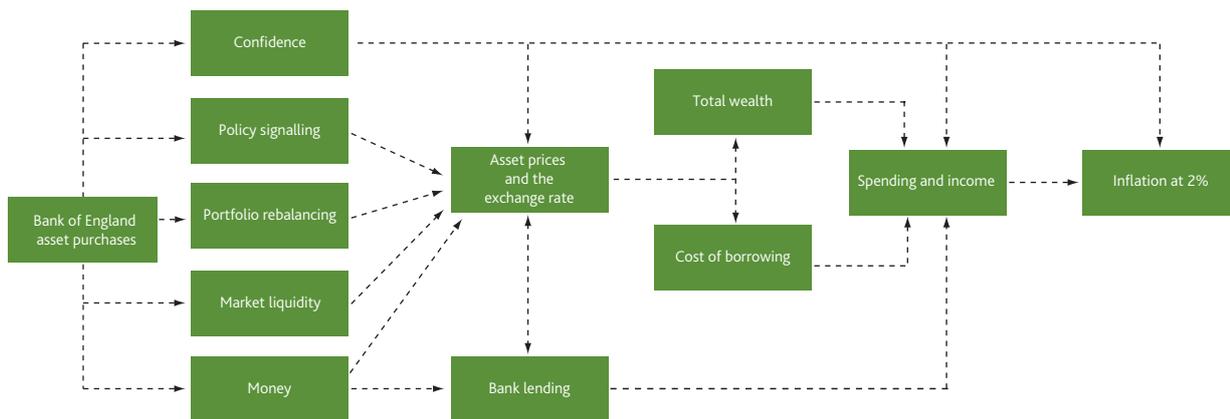
This article provides an overview of the United Kingdom's QE policy. The next section explains the possible channels through which asset purchases may affect the economy. The following section briefly explains the design of the QE programme and how the purchases were implemented. The article then reviews a range of evidence on the financial and wider macroeconomic effects. The final section concludes.

Transmission channels for asset purchases

How do asset purchases affect spending and inflation?

The aim of undertaking asset purchases was the same as a cut in Bank Rate, to stimulate nominal spending and thereby domestically generated inflation, so as to meet the MPC's 2% inflation target in the medium term.[1] As discussed in a previous *Quarterly Bulletin* article by Benford *et al* (2009), there are a number of potential channels through which asset purchases might affect spending and inflation.[2] Purchases of financial assets financed by central bank money should initially increase broad money holdings, push up asset prices and stimulate expenditure by lowering borrowing costs and increasing wealth. Asset purchases may also have a stimulatory impact through their broader effects on expectations and by influencing bank lending, though this channel would not be expected to be material during times of financial crisis. These channels are considered in more detail below with **Figure 1** providing a simple pictorial representation.

Channels working through asset prices

Policy signalling effects: This channel includes anything economic agents learn about the likely path of future monetary policy from asset purchases. For example, asset purchases may have led market participants to expect policy rates to remain low for longer than otherwise by signalling the MPC's determination to meet the inflation target. At the time the MPC decided to initiate asset purchases, policymakers were concerned about the risks of inflation falling significantly below target in the medium term. This could have led to lower

inflation expectations, which would have pushed up on real interest rates, even with nominal rates kept at very low levels, and reduced spending in the economy. By helping to ensure that inflation expectations remain well anchored to the target, asset purchases could help to support spending. More generally, policy announcements on asset purchases might contain 'news' about the underlying state of the economy, for example if agents relied on central bank analysis to inform their views on the economy.

Portfolio balance effects: Central bank asset purchases, through this channel, push up the prices of the assets bought and also the prices of other assets. When the central bank purchases assets, the money holdings of the sellers are increased. Unless money is a perfect substitute for the assets sold, the sellers may attempt to rebalance their portfolios by buying other assets that are better substitutes.[3] This shifts the excess money balances to the sellers of those assets who may, in turn, attempt to rebalance their portfolios by buying further assets — and so on. This process will raise the prices of assets until the point where investors, in aggregate, are willing to hold the overall supplies of assets and money. Higher asset prices mean lower yields, and lower borrowing costs for firms and households, which acts to stimulate spending. In addition, higher asset prices stimulate spending by increasing the net wealth of asset holders.

While policy signalling effects affect expected policy rates, portfolio balance effects work by reducing the spreads of

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(1) For discussion of the other factors affecting inflation more recently, see Section 4 of the August 2011 *Inflation Report*.
(2) The channels through which QE may affect the economy are the subject of a lot of debate. In conventional New Keynesian models, asset purchases can only work to the extent that they change agents' expectations of the future path of policy rates (see, for example, Eggertsson and Woodford (2003)). Asset purchases on their own do not change behaviour because the assumptions made imply the distinction between public and private asset holdings is unimportant. But in other models with credit constraints, distortionary taxes or incomplete markets, and with imperfect substitutability between different assets, asset purchases may also affect asset prices by changing the relative supplies of different assets (see, for example, Andrés, López-Salido and Nelson (2004) and Harrison (2011)).
(3) The concept of imperfect substitutability goes back to Tobin (1958). Dale (2010) and Joyce *et al* (2011) discuss some of the related theoretical background. Various factors may affect the degree of substitutability between assets, including duration, credit risk and liquidity.

longer-term interest rates over expected policy rates (term premia) and the required return on risky assets relative to risk-free assets (risk premia) more generally.[1]

Liquidity premia effects: When financial markets are dysfunctional, central bank asset purchases can improve market functioning by increasing liquidity through actively encouraging trading. Asset prices may therefore increase through lower premia for illiquidity. The effects of this channel may, however, only persist while the monetary authority is conducting asset purchases.

Other channels

Confidence effects: Asset purchases may have broader confidence effects beyond any effects generated through the effect of higher asset prices. For example, to the extent that the policy leads to an improved economic outlook, it might directly boost consumer confidence and thus people's willingness to spend. Some of this more general improvement in confidence may also be reflected back in higher asset prices, especially by reducing risk premia.

Bank lending effects: When assets are purchased from non-banks (either directly or indirectly via intermediate transactions), the banking sector gains both new reserves at the Bank of England and a corresponding increase in customer deposits. A higher level of liquid assets could then encourage banks to extend more new loans than they otherwise would have done. But, given the strains in the financial system at the time and the resultant pressures on banks to reduce the size of their balance sheets, the MPC expected little impact through this channel.[2]

How does the economy adjust to asset purchases?

The overall effect of asset purchases on the macroeconomy can be broken down into two stages: an initial 'impact' phase and an 'adjustment' phase, during which the stimulus from asset purchases works through the economy, as illustrated in **Chart 1**. As discussed above, in the *impact phase*, asset purchases change the composition of the portfolios held by the private sector, increasing holdings of broad money and decreasing those of medium and long-term gilts. But because gilts and money are imperfect substitutes, this creates an initial imbalance. As asset portfolios are rebalanced, asset prices are bid up until equilibrium in money and asset markets is restored. This is reinforced by the signalling channel and the other effects of asset purchases already discussed, which may also act to raise asset prices. Through lower borrowing costs and higher wealth, asset prices then raise demand, which acts to push up the consumer price level.

In the *adjustment phase*, rising consumer and asset prices raise the demand for money balances and the supply of long-term assets. So the initial imbalance in money and asset markets shrinks, and real asset prices begin to fall back. The boost to

Chart 1 The qualitative economic impact of QE
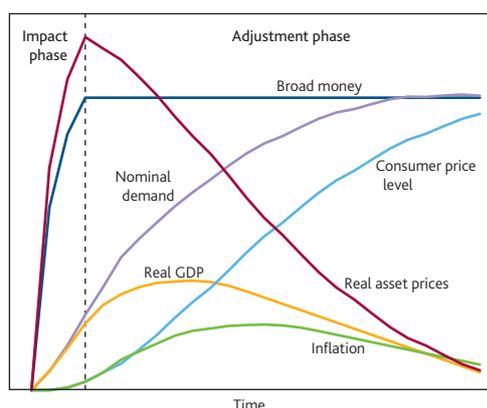
demand therefore diminishes and the price level continues to increase but by smaller amounts. The whole process continues until the price level has risen sufficiently to restore real money balances, real asset prices and real output to their equilibrium levels. Thus, from a position of deficient demand, asset purchases should accelerate the return of the economy to equilibrium.

Design and operations

How did the transmission channels affect the design of the programme?[3]

The Bank of England's asset purchase programme has attached particular importance to the *portfolio balance channel*. That is why purchases have been targeted towards long-term assets held by non-bank financial institutions, like insurers and pension funds, who may be encouraged to use the funds to invest in other, riskier assets like corporate bonds and equities.[4]

Before asset purchases began, the main holders of gilts were UK non-bank financial institutions and overseas investors. Gilts only represented a modest part of UK non-bank financial institutions' overall portfolios, suggesting they might be prepared to reinvest some of the money from gilt sales in other assets. Overseas investors might be more inclined to choose to invest in foreign assets. However, to do so they would need to change their sterling for foreign currency, putting downward pressure on the exchange rate. And, since all central bank money has to be held by someone, those who received the sterling might then choose to invest in other sterling assets.

(1) The evidence considered in this article suggests that the larger effect was through lower premia. This is also consistent with the US evidence, eg Gagnon *et al* (2010).
(2) See minutes of the Monetary Policy Committee meeting for the 4 and 5 March 2009, published on 18 March 2009.
(3) For more information on the design of the Bank's asset purchase programme see Fisher (2010a,b).
(4) Fisher (2010b) notes that the Japanese QE programme over 2001–06 purchased government bonds which had been mostly held by banks, who used the proceeds to deleverage without obviously increasing the demand for other assets.

At the end of 2008, UK banks held only about 4% of the total stock of gilts, and these tended to be shorter-maturity ones. As **Chart 2** shows, the banking sector actually increased its holdings of gilts during the period that the Bank was conducting asset purchases, suggesting that the main impact was to reduce the gilt holdings of the non-bank private sector relative to what would otherwise have happened.

Chart 2 Change in gilt holdings by sector since 2008 Q1[(a)]
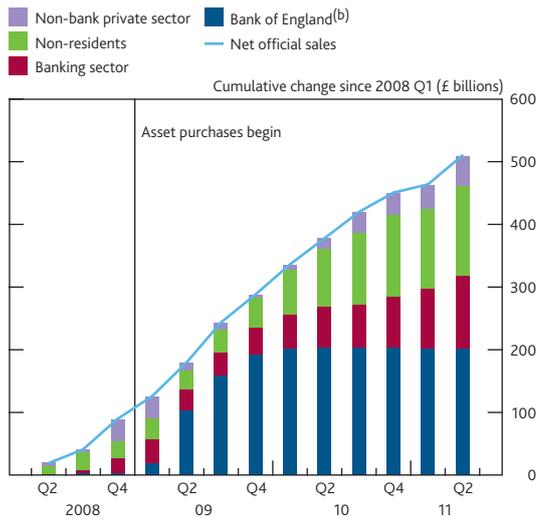
(a) Purchases by the non-bank private sector exclude repos.
(b) Gilts acquired through asset purchases are held by the Asset Purchase Facility, a subsidiary of the Bank of England.

The MPC has not used the asset purchase programme explicitly to *signal future intentions* about the likely path of policy rates. It emphasised its ongoing commitment to meet the inflation target using its normal communication channels, for example, the minutes of MPC meetings and the *Inflation Report*.[(1)] That said, asset purchases gave a clear signal that the Bank would continue to be able to loosen monetary policy and stimulate demand even when Bank Rate is effectively at its lower bound, which could have had strong expectations effects. This signal could have substantially changed the distribution of future macroeconomic outcomes, reducing the chance of further large falls in asset prices and hence reducing risk premia more generally, as well as having the sort of broader *confidence effects* discussed above.

For the Bank's purchases of gilts, the liquidity premia channel was not expected to be very important. The gilt market continued to function effectively throughout the crisis, although even here the strains in financial markets could be discerned at times. The liquidity premia channel was more important in the design of the Bank's (relatively small-scale) purchases of private sector assets. This programme sought to improve the availability of capital market finance to companies more directly, by improving the liquidity in certain markets.[(2)] In this case, purchases provided confidence to investors and issuers that they could find buyers for these assets if they

needed to sell quickly without incurring an excessive price discount.

Operational considerations

The Bank of England Asset Purchase Facility (APF) was announced on 19 January 2009, with the details set out in an exchange of letters between the Governor of the Bank of England and the Chancellor of the Exchequer later in the month. Initially the APF bought private sector assets funded by the issuance of Treasury bills and the cash management operations of the Debt Management Office (DMO). The APF became a vehicle for monetary policy when, in March 2009, the MPC decided to purchase assets financed by the creation of central bank money.

While the MPC reviewed the appropriate scale of the programme each month, due to the large size of the programme, it tended to conduct policy in terms of a target level of purchases over periods longer than a month. This allowed purchases to be conducted at a pace that would not generate additional market disorder. At the March 2009 meeting, the MPC decided to purchase £75 billion of assets over a three-month period. A monthly rate of purchases of £25 billion was maintained until the August MPC meeting when it fell to just over £16 billion a month, falling again to just over £8 billion a month over the three months following the November MPC meeting. In total £200 billion of assets were purchased, mostly comprising gilts. **Charts 3** and **4** show the amounts purchased of gilts, commercial paper and corporate bonds. Further details of the key announcements related to asset purchases are given in **Table A**.

The Bank of England executed the MPC's decisions with a concern to avoid unnecessary disruption to the gilt market. As the Bank accumulated a large percentage of some gilts in issue, there was a risk that segments of the gilt market might become dislocated. To alleviate this, in August 2009 the Bank announced it would start to lend out a proportion of the gilts it had bought, through the DMO, in exchange for other gilts that had readier availability.[(3)] At the same time, the maturity of conventional gilts the Bank would purchase was extended from 5–25 years to all conventional gilts with maturities of three years or more. This simply reflected the fact that by this stage the Bank was holding a large proportion of some of the gilts in issue in the 5–25 year maturity range. **Chart 4** illustrates the composition of APF gilt purchases by maturity.

Given the shortest residual maturity of gilts purchased was three years, the earliest redemption is not until 2013. Interest

(1) See Bean (2011).
(2) Tucker (2009) and Fisher (2010a) describe the Bank's role in these private sector asset markets as acting as a 'market maker of last resort' and set out some guiding principles for such operations.
(3) They were not lent out against cash as that would have undone some of the intended impact of the initial asset purchases.

Chart 3 Cumulative APF purchases of commercial paper and corporate bonds

- Stock of corporate bonds financed by Treasury bills
- Stock of commercial paper financed by Treasury bills
- Stock of corporate bonds financed by reserves
- Stock of commercial paper financed by reserves
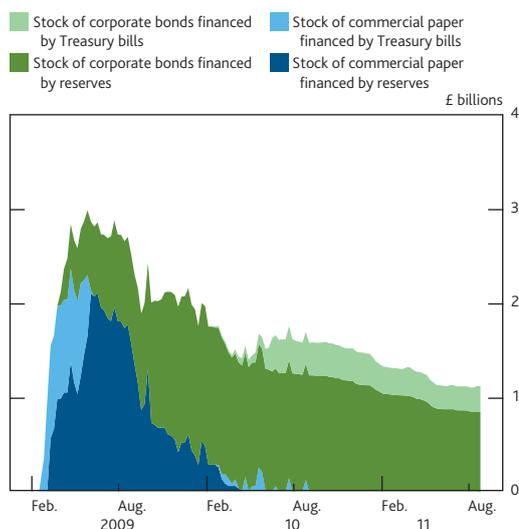
Chart 4 Cumulative gilt purchases by maturity

- 25+ years
- 5–10 years
- 10–25 years
- 3–5 years
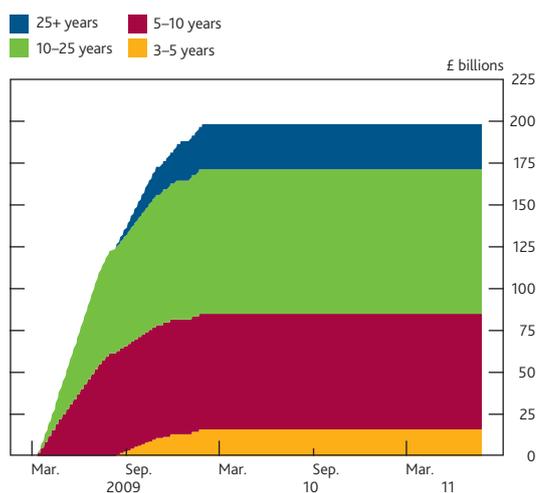
receipts from gilts purchased accumulate in the APF, and so will repayments of principal when they fall due. They are not automatically reinvested unless the MPC decides to do so.

Evidence on the impact

This section describes some of the evidence on the impact of the Bank's QE asset purchases on the economy, shedding some light on the importance of the different transmission channels discussed above. It is difficult to measure directly the effects of monetary policy measures such as QE and so estimates of those effects are highly uncertain.

Asset prices and quantities
Gilt yields
The bulk of the Bank of England's asset purchases were of conventional gilts, so it might be expected that the largest initial impact would have been on the gilt market. A natural starting point for assessing the effect of the policy is to look at

Table A APF and QE-related announcements

Date	Event
2009	
19 January	The Chancellor of the Exchequer announces that the Bank of England will set up an asset purchase programme.
30 January	Asset Purchase Facility Fund established. Exchange of letters between the Chancellor of the Exchequer and the Governor on 29 January 2009.
5 February	Bank Rate reduced from 1.5% to 1%.
11 February	February *Inflation Report* and the associated press conference give strong indication that QE asset purchases are likely.
13 February	First purchases of commercial paper begin.
5 March	Bank Rate reduced from 1% to 0.5%. The MPC announces it will purchase £75 billion of assets over three months funded by central bank money. Conventional bonds likely to constitute the majority of purchases, restricted to bonds with residual maturity between 5 and 25 years.
11 March	First purchases of gilts begin.
25 March	First purchases of corporate bonds begin.
7 May	The MPC announces that the amount of QE asset purchases will be extended by a further £50 billion to £125 billion.
3 August	Secured commercial paper facility launched.
6 August	The MPC announces that QE asset purchases will be extended to £175 billion and that the buying range will be extended to gilts with a residual maturity greater than three years. The Bank announces a gilt lending programme, which allows counterparties to borrow gilts from the APF's portfolio via the DMO in return for a fee and alternative gilts as collateral.
5 November	The MPC announces that QE asset purchases will be extended to £200 billion.
22 December	The Bank announces that it will act as a seller, as well as a buyer, of corporate bonds in the secondary market.
2010	
8 January	First sales of corporate bonds.
4 February	The MPC announces that QE asset purchases will be maintained at £200 billion. The Chancellor authorises the Bank to continue to transact in private sector assets, with further purchases financed by issuance of Treasury bills. The MPC's press statement says that the Committee will continue to monitor the appropriate scale of the asset purchase programme and that further purchases will be made should the outlook warrant them.

Shading denotes announcements used in the event study analysis by Joyce *et al* (2011) referred to in the following section.

the immediate reaction of gilt yields to announcements about QE, as ordinarily market prices would be expected to respond directly to news about asset purchases, rather than waiting for the purchases themselves to occur.

Chart 5 (taken from Joyce *et al* (2011)) shows the average reaction of medium to long-term gilt yields to the six pieces of QE news highlighted in **Table A**.[1]

By far the largest gilt market reaction was in March 2009 (75 basis points) when the QE programme was first announced, but there were also large reactions after the February 2009 *Inflation Report* and associated press conference, which suggested that a policy of asset purchases was likely, and after the August announcement of a further extension of the programme. All these reactions were statistically significant in relation to the normal volatility over the pre-crisis period. Summing over the reactions in gilt yields

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(1) The reaction is measured by the change in yields over a two-day window from close of business the day before each announcement to the day after.

Chart 5 Announcement impact on gilt yields, OIS rates and gilt-OIS spreads[a]

Gilt
OIS
Gilt-OIS
Three-year OIS

Basis points

Feb.   Mar.   May   Aug.   Nov.   Feb.   Total
       2009   10
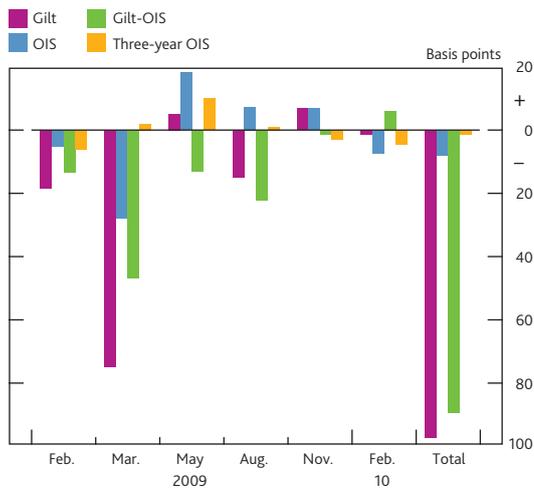
Sources: Joyce et al (2011), Bloomberg and Bank calculations.

(a) Average change in 5–25 year spot rates unless otherwise specified.

to each of the QE news events gives an overall average fall of just under 100 basis points.

Most of the fall in gilt yields was not reflected in corresponding interest rates implied by overnight index swap (OIS) contracts, which fell by less than 10 basis points in total over the six events. To the extent that OIS rates can be used as a benchmark for default risk-free rates,[1] this suggests that the fall in gilt yields cannot primarily be attributed to signalling effects about future policy rates, or more broadly to macroeconomic news. Instead, it is consistent with the main effect coming through portfolio rebalancing.[2]

As an alternative measure of the impact of QE purchases on gilt yields, Joyce et al (2011) make use of a Reuters survey of economists' expectations regarding the total size of QE purchases to calculate the amount of asset purchase news in each announcement. **Chart 6** shows there was a strong negative relationship between two-day changes in zero-coupon gilt yields and the amount of QE news in each announcement. A simple regression of the two suggests a fall in gilt yields of 0.62 basis points for each additional £1 billion of unanticipated QE purchases announced. Separate OLS regressions of QE news on OIS rates and gilt-OIS spreads were also estimated. Scaling up the estimates suggests an overall impact from £200 billion of unanticipated purchases of 125 basis points on yields, split between about 45 basis points on OIS rates (policy signalling channel) and 80 basis points on gilt-OIS spreads (portfolio balance channel).

As discussed above, the portfolio balance effect of QE on gilt yields would be expected to show up in lower term premia (the spread of long-term interest rates over expected policy rates). Using a term structure model of the nominal and real gilt yield curves (based on Joyce, Lildholdt and Sorensen

Chart 6 Size of surprise and average gilt yield changes

Gilt reaction (basis points)

May   Nov.
              Q3 GDP
              August

              OLS regression

February
and March

Surprise size (£ billions)
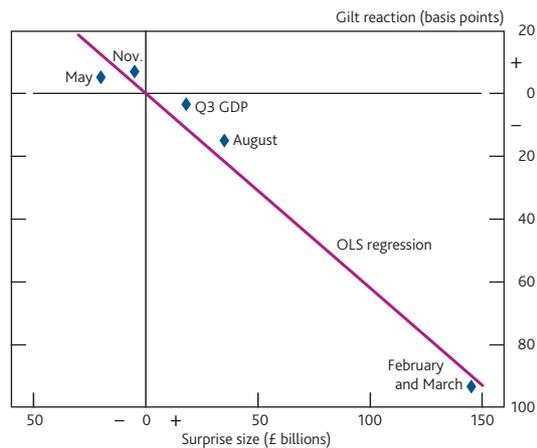
Sources: Joyce et al (2011), Thomson Reuters Datastream and Bank calculations.

(2010)), **Chart 7** shows the decomposition of gilt yields into expected future short rates and term premia over a two-month window from the start of February 2009 to the end of March 2009, the period when most of the news about the United Kingdom's asset purchases occurred. According to the model decomposition over this period, term premia were compressed by around 25 basis points at medium and longer maturities, but expected real short-term rates also declined and there was a modest increase in expected inflation. However, the fact that the fall in yields at long maturities is not fully explained could be consistent with an additional supply effect on term premia (of a further 25 to 35 basis points) that the model does not capture.

Chart 7 Affine term structure model gilt yield decomposition for February-March 2009

Expected real short rate
Expected inflation
Residual
Real term premium
Inflation risk premium
Total

Percentage points

Five-year   Ten-year   Fifteen-year
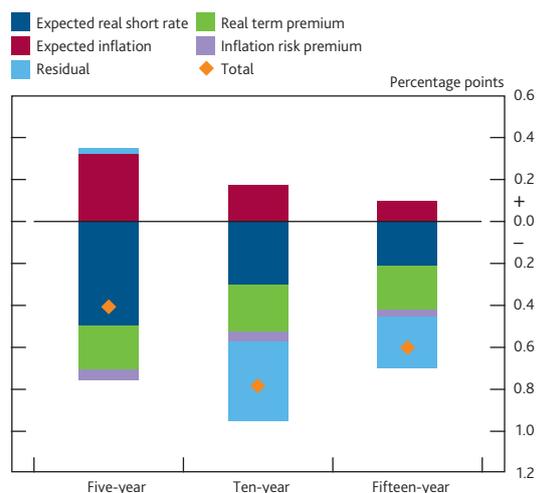
Sources: Bloomberg and Bank calculations.

(1) Since OIS contracts settle on overnight rates and are collateralised they should contain minimal credit risk. For more information, see Joyce and Meldrum (2008).
(2) Portfolio rebalancing might be expected to affect gilt yields but not OIS rates, as the latter are inferred from derivatives contracts which are less likely to be affected by supply constraints. The Bank's market contacts suggest that institutional investors would be unlikely to use OIS contracts as a substitute for their gilt holdings, implying that there is some segmentation between the two markets.

Other asset prices

The portfolio balance effect suggests that, to the extent that investors regarded other assets — such as corporate bonds and equities, and foreign assets — as closer substitutes for gilts than money, they would have wanted to reduce their money holdings associated with QE purchases and buy those other assets. This would be expected to have put upward pressure on the prices of those assets, and perhaps downward pressure on the sterling exchange rate. Quite apart from this effect, announcements about QE might have contained information about the economy that had implications for perceptions of future corporate earnings and the uncertainty around them; and changes in the prices of gilts may have affected the rate at which investors discount future cash flows. All of these effects might be expected to have taken time to feed through, as it took time for investors and asset managers to rebalance their portfolios and asset prices are unlikely to have anticipated this process fully (particularly given the novelty of the QE policy).

Indeed, as summarised in **Table B**, the announcement reactions of some other asset prices were less unequivocal than those for gilt prices. Corporate bond yields, however, did show a clear reaction. Summing over the immediate reaction to the six QE news announcements, sterling investment-grade corporate bond yields fell by 70 basis points, with spreads relative to gilt yields remaining broadly flat. Sterling non-investment grade corporate bond yields fell by 150 basis points, with spreads narrowing by 75 basis points.[1] Over the same announcement windows, international investment-grade bond yields fell by less than sterling-denominated bonds, suggesting that there was a UK-specific effect.

Table B Summary of asset price movements

Asset	Change around announcements	Change 4 March 2009– 31 May 2010	Comments
Gilts	-100 basis points (bp) (*of which* -90bp in gilt-OIS spreads)	+30bp (*of which* +15bp in gilt-OIS spreads)	Portfolio balance channel dominates the signalling effect.
Gilts (reaction to QE 'news')	-125bp (*of which* -80bp in gilt-OIS spreads)	+30bp (*of which* +15bp in gilt-OIS spreads)	Portfolio balance channel dominates when controlling for QE news using Reuters survey.
Corporate yields (investment grade)	-70bp	-400bp	Smaller fall than gilts perhaps due to shorter average duration. Spreads flat around announcements but significantly down over the period.
Corporate yields (high yield)	-150bp	-2,000bp	Larger announcement effects, possibly reflecting the removal of tail risk.
FTSE All-Share	-3%	+50%	No announcement effects, but prices up during the period.
Sterling ERI	-4%	+1%	Small announcement effect.

Source: Joyce *et al* (2011).

Equity prices did not react in a uniform way in response to QE news. The FTSE All-Share index fell slightly following the publication of the February *Inflation Report* and more sharply following the March MPC announcement. Over the same period, however, international equity prices fell by even more, suggesting that there might have been a small positive UK-specific effect. Following the next three QE announcements, UK equity prices increased somewhat, but fell after the February 2010 announcement, though this is unlikely to have been a QE effect, as the February decision was widely expected.

Sterling's reaction was more in line with what might have been expected. Uncovered interest parity would predict a depreciation in response to lower domestic interest rates. Summing over the immediate reactions to the six QE news announcements, the sterling ERI did indeed depreciate by around 4%.

Of course, as already discussed, these initial market reactions are unlikely to have reflected the full effects of QE. **Table B** and **Chart 8** show that, over a longer period from March 2009 to May 2010, there were sustained rises in asset prices. But it is not possible to know how much of those rises were directly attributable to QE in the United Kingdom, as this was part of a more general pickup in international asset prices, reflecting the large fiscal and monetary stimulus across the advanced economies.

Chart 8 Changes in major UK asset prices
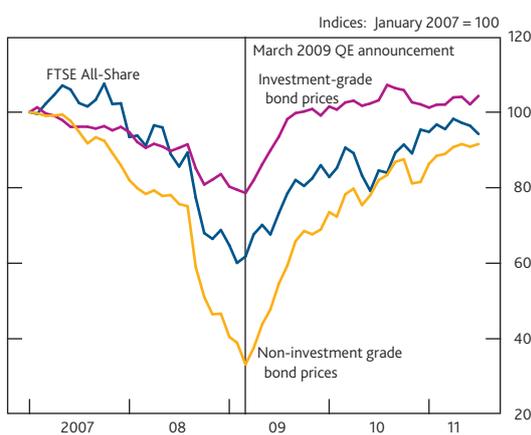
Sources: Bloomberg, Merrill Lynch and Bank calculations.

Econometric model estimates based on applying a portfolio balance approach to historical (pre-crisis) data suggest that the initial reaction of gilt and corporate debt markets shown in **Table B** was broadly in line with what might have been expected. The equity price response might, however, have been expected to be much larger (of the order of 20%),

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[1] These numbers imply corresponding gilt yields fell by around 75 basis points. This is different from the 100 basis point average fall in gilt yields discussed above, as sterling corporate bonds have a shorter average duration.

though this is subject to great uncertainty (see Joyce *et al* (2011)).[1]

Corporate bond and equity issuance

Firms might have been expected to respond to higher equity and corporate bond prices by increasing their use of capital markets to raise funds and there is some evidence of this. Net equity issuance by UK private non-financial corporations was particularly strong in 2009, reversing the negative net issuance observed over 2003–08. Net corporate bond issuance by UK private non-financial corporations in 2009 was also stronger than over the 2003–08 period. It is not possible to know what would have happened in the absence of QE, but the Bank's market contacts suggest that there was strong institutional investor demand for corporate bonds during the second half of 2009.

Inflation expectations

Inflation expectations might be expected to increase in response to the monetary stimulus associated with QE. **Chart 9** shows that short to medium-term RPI inflation breakeven rates derived from gilts fell sharply in late 2008 to unusually low, and even negative, levels before subsequently rising (though long-term breakeven rates remained more stable). This pattern is consistent with a fall and subsequent increase in market participants' inflation expectations, although it is hard to draw a direct signal from these measures, as they will have been affected by market functioning and will also incorporate premia for uncertainty around inflation.

Chart 9 Inflation breakeven rates from gilts[a]
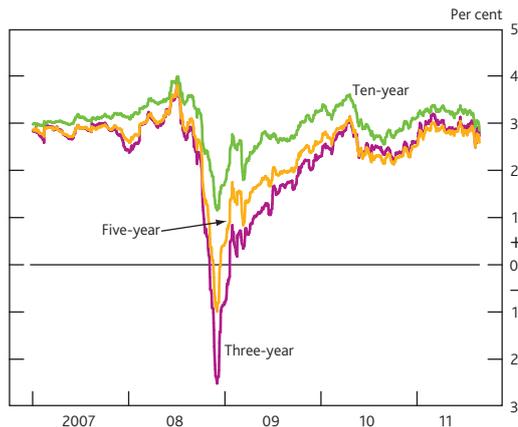
Sources: Bloomberg and Bank calculations.

(a) Data refer to RPI spot rates.

The various survey-based measures of longer-term household and economist inflation expectations shown in **Chart 10** also suggest some evidence of falls during late 2008, which then reversed gradually during 2009. This suggests that QE may have helped reduce the weight that agents placed on outcomes of persistent low inflation, though a number of other external factors (such as energy and other import prices)

Chart 10 Indicators of long-term inflation expectations
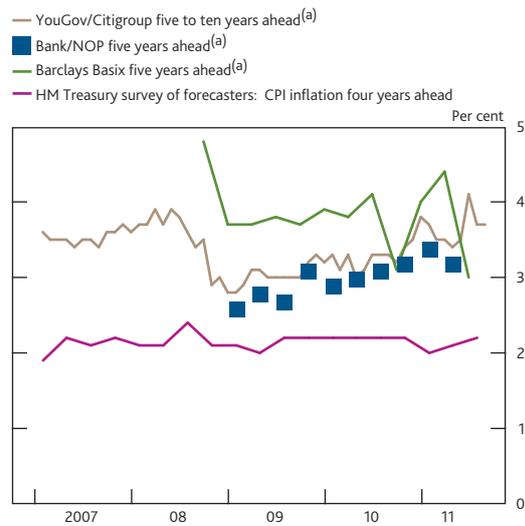
Sources: Barclays Capital, Bloomberg, Citigroup, GfK NOP, HM Treasury, YouGov and Bank calculations.

(a) Bank/NOP, Barclays Basix and YouGov/Citigroup household measures do not reference a specific price index and are based on the median estimated price change.

are likely to have influenced inflation expectations over this period.

Money and borrowing rates

From the onset of the financial crisis in 2007, broad money growth slowed dramatically in the United Kingdom, falling from around 10% a year to below 1% a year in early 2010. Since then, money growth has picked up slightly but remains below nominal GDP growth (**Chart 11**). This pattern reflects, in part, a sharp slowdown in lending to the non-bank private sector. Aggregate credit flows have reached an unusually low

Chart 11 Broad money and nominal GDP[a][b][c]
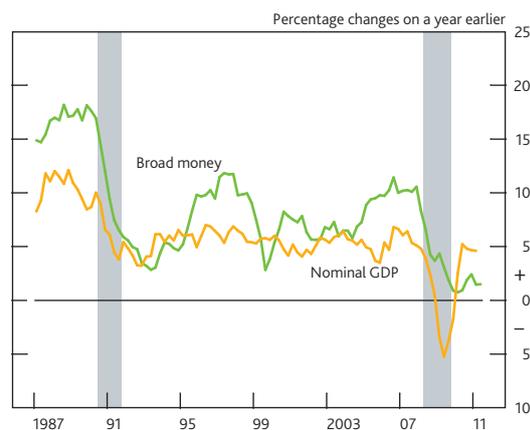
(a) Recession periods are shown in grey. Recessions are defined as at least two consecutive quarters of falling output (at constant market prices) estimated using the latest data. The recessions are assumed to end once output began to rise.
(b) Nominal GDP is measured at current market prices.
(c) Broad money is constructed as headline M4 growth prior to 1998 Q4 and M4 growth excluding intermediate OFCs thereafter. Intermediate OFCs are: mortgage and housing credit corporations; non-bank credit guarantors; bank holding companies; and those carrying out other activities auxiliary to financial intermediation. Banks' business with their related 'other financial intermediaries' is also excluded, based on anecdotal information provided to the Bank of England by several banks.

(1) To provide an idea of plausible magnitudes, a 100 basis points fall in risk-free rates would, all else equal, be expected to increase equity prices by 15%, using a dividend discount model (as in Inkinen, Stringa and Voutsinou (2010)).

level relative to nominal GDP. But also net issuance of equity and long-term debt by banks, as they have sought to deleverage and rebuild their capital bases, and net repayments of bank debt by non-banks have both detracted from broad money growth (see Bridges, Rossiter and Thomas (2011) for more details).

Offsetting those trends somewhat has been the increase in the money supply generated by asset purchases by the Bank. To the extent that those purchases were made from non-banks or that banks used the money to buy other assets from the non-bank sector, purchases by the Bank would initially have increased the level of broad money relative to nominal GDP.

Higher asset prices may then have encouraged firms to increase the extent to which they use capital markets for finance, rather than banks. This may have resulted in higher growth of nominal spending relative to broad money than would have been the case in the absence of central bank asset purchases. **Chart 12** shows that there is evidence that UK firms in aggregate did, to an extent, disintermediate the banking sector during 2009 through higher issuance of capital market equity and debt relative to bank borrowing.

Chart 12 Net external finance raised by UK private non-financial corporates
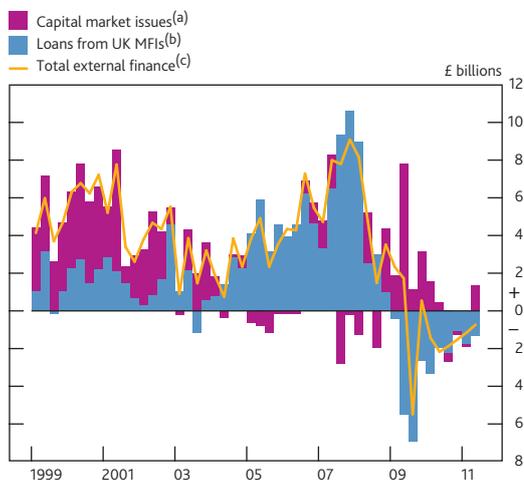
(a) Non seasonally adjusted.
(b) Monetary and financial institutions. Three-month moving averages. Includes sterling and foreign currency funds.
(c) The total may not equal the sum of its components.

To the extent that it facilitated a rebuilding of banks' balance sheets, QE purchases may, through lower borrowing costs, have also helped to ensure that bank lending growth fell less rapidly than would otherwise have been the case. There is, however, little evidence that effective new bank lending rates for households or firms fell significantly following QE purchases, even though there were substantial falls in the spread between interbank lending rates and OIS rates over the period (**Chart 13**). But it is hard to estimate what the counterfactual would have been.

Chart 13 Sterling three-month Libor-OIS spreads
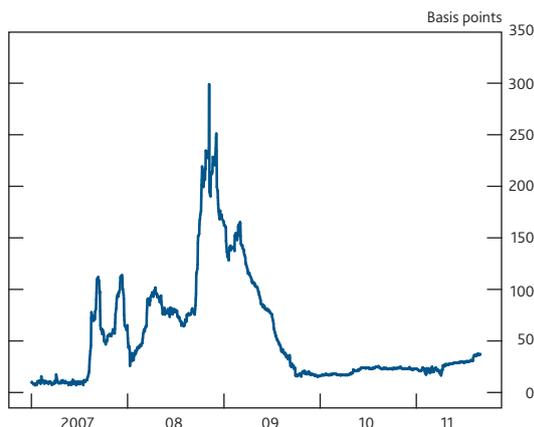
Sources: Bloomberg and Bank calculations.

Confidence

It is very hard to disentangle the effect of QE from that of other factors affecting confidence. There is circumstantial evidence, however, that confidence improved during the period in which asset purchases were taking place. One source of evidence can be found in the distributions around future asset prices implied by options markets. **Chart 14** shows that the option-implied distribution around the FTSE 100 equity index twelve months ahead did not just shift horizontally in line with the increase in the index in the period following QE purchases but also narrowed markedly, with investors placing much less weight on large downside risks. This change in the shape of the distribution is consistent with investors being more confident about the outlook for future equity prices, though it is also likely to reflect other international developments in addition to QE in the United Kingdom.

Chart 14 Option-implied distribution of the FTSE 100 index twelve months ahead
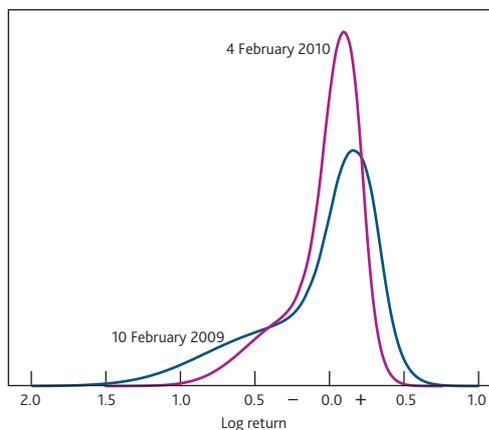
Sources: Bloomberg and Bank calculations.

Similarly, measures of confidence for households and firms also improved markedly in 2009 following QE purchases. **Chart 15** shows that confidence for both consumers and firms fell to between two and four standard deviations below recent historical averages during 2008. However, those falls were

Chart 15 Survey-based measures of consumer and business confidence

Standard deviations from mean (2004–08)

YouGov(a)(b)

European Commission(a)(c)

CIPS services(d)(e)

Nationwide(a)

2007   08   09   10   11
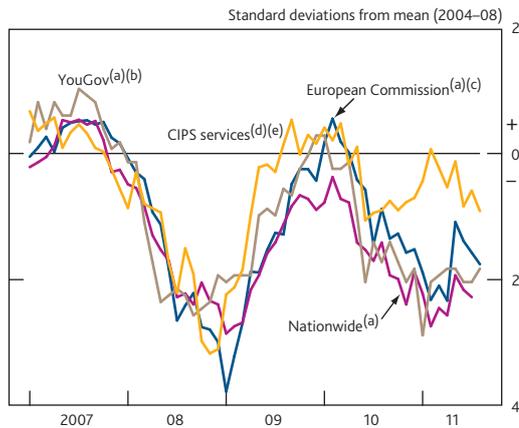
Sources: CIPS/Markit, research carried out by GfK NOP on behalf of the European Commission, Nationwide, YouGov and Bank calculations.

(a) Consumer confidence.
(b) Overall prosperity index derived from the answers to questions 1, 2d, 4 and 5 of the YouGov survey.
(c) This aggregate confidence index is derived by averaging the answers to questions 2, 4, 7 (with inverted sign) and 11 in the GfK NOP survey carried out on behalf of the European Commission. Data are seasonally adjusted.
(d) Business confidence.
(e) CIPS/Markit services business expectations. Data are seasonally adjusted.

almost entirely reversed during 2009, as QE purchases were being made. Again, it is hard to know how much of that increase was due directly to QE purchases, given that there was a global recovery in confidence during the period and action to stimulate global demand from a range of countries. But the movements are consistent with QE having reduced the perceptions of large downside risks and uncertainty in the economy as a whole during 2009.

Wider macroeconomic effects

The wider macroeconomic effects of QE are difficult to quantify. A host of other factors have been important in influencing the UK economy during the crisis period, making it almost impossible to isolate the incremental effects of QE. But despite these difficulties, a growing number of studies have begun to evaluate the macroeconomic effects of unconventional monetary policies in the United Kingdom and elsewhere using a variety of approaches.[1] What follows is an assessment of the macroeconomic effects of the United Kingdom's asset purchases drawing on the latest Bank of England research.

Model-based estimates

SVAR approach: A common approach is to characterise QE solely through its effects on longer-maturity government bond yields. The simplest starting point for this kind of analysis is to use a small structural vector autoregression (SVAR) containing the policy rate, a government bond yield (the ten-year spot rate), real GDP growth and CPI inflation. A 'QE shock' can be identified by assuming that a negative shock to bond yields leads to a contemporaneous rise in GDP and CPI inflation, but has no effect on policy rates (which are constrained at the zero bound). Estimating this model using quarterly UK data over a

sample period predating the crisis (1992 Q1 to 2007 Q2), and shocking the ten-year gilt yield by 100 basis points, results in a peak impact on the level of real GDP of just under 1.5% and a peak effect on annual CPI inflation of about ¾ percentage points. These effects should be taken as illustrative, given the simplicity of the model and the fact that it has been estimated on a sample predating the crisis. Furthermore, in looking at an impulse response, the assumption is that QE is similar to a typical one-period shock to bond yields. This implies rather less persistence than might be expected if QE has operated primarily through a portfolio balance effect. Despite these caveats, the effects on key macro variables appear economically significant.

Multiple time-series models approach: It is also possible to use more sophisticated econometric models to look at this issue. Kapetanios *et al* (2011) use three different time-series models of varying complexity to conduct counterfactual forecasts of the effects of QE. The approach (broadly similar in spirit to Lenza, Pill and Reichlin (2010)) is to use these models to conduct conditional forecasts under 'policy' and 'no policy' scenarios and then to attribute the difference in the resulting forecasts to the effects of the policy. In the no policy scenario, it is assumed that without QE five and ten-year gilt yields would have been 100 basis points higher, although a variety of alternative scenarios are also examined. Averaging across the models suggests that QE had a peak effect on the level of GDP of around 1½% and a peak effect on annual CPI inflation of about 1¼ percentage points.[2] These estimates vary considerably across the individual model specifications, and with the assumptions made to generate the counterfactual forecasts, suggesting they are subject to considerable uncertainty.

Monetary approach: An alternative method of estimating the effects of QE is to focus on its impact on the money supply. Bridges and Thomas (2011) first calculate the impact of QE on the money supply, allowing for the various other influences on broad money over the period. They then 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. Their preferred model estimates suggest that the higher money supply resulting from QE may have boosted the level of GDP by around 2% and CPI inflation by about 1%, though again these estimates are subject to a lot of uncertainty.

Bottom-up approach

Ideally one would want to make an assessment using a properly specified structural model. But no such model

(1) Papers on the effects of other central bank's unconventional policies include: Lenza, Pill and Reichlin (2010) on the European Central Bank's policy actions and Chung *et al* (2011) on the Federal Reserve's policy actions.
(2) These numbers refer to the lower of the two 'no policy' variants given in the paper.

embodying all the relevant transmission channels discussed earlier appears to exist. The forecasting model used by the Bank of England, in common with most large-scale macroeconomic models, does not explain risk premia and therefore does not embody a portfolio balance channel. But, to make a rough calculation, one can take a more bottom-up approach. More specifically, the effects of the QE policy can be broken down into two main elements: (1) the impact of asset purchases on gilt prices and other asset prices and (2) the effect of asset prices on demand and hence inflation.

A number of ways of estimating (1) were already discussed above. The analysis of the QE announcement effects suggested that asset purchases pushed down medium to long-term gilt yields by about 100 basis points. The effect of QE on a broader range of asset prices is much more uncertain, but there was an immediate 70 basis points fall in investment-grade corporate bond yields and a 150 basis points fall in sub-investment grade yields. There is considerable uncertainty about the effect on equity prices and the immediate market reaction is unlikely to provide an accurate guide, but an estimated portfolio balance model would suggest an impact of around 20%.[1] Combining these effects on government and corporate bonds and equity prices suggests an overall boost to households' net financial wealth of about 16%.

To quantify the next leg in the transmission mechanism, between asset prices and demand, a range of simple models may be used. To calculate the impact on consumer spending, it is necessary to calculate the wealth elasticity of consumption. One way of doing this is to make an annuity calculation, assuming that households perceive the policy's effects as long-lasting and want to spend their extra wealth evenly over their lifetimes. To calculate the effects on business and dwellings investment, one can use Q models, where the incentive to invest depends on the market value of capital relative to its replacement cost. Higher asset prices should raise the market value of capital and reduce the cost of finance, boosting investment spending. Allowing for reasonable uncertainty about the initial impact on asset prices, the result of these sorts of calculations would suggest a peak impact on the level of real GDP of between 1½% and 2½%.

The timing of the output effects from a change in asset prices might be expected to be slower than from a normal interest rate cut, which has a peak effect on output after a year. This reflects the fact that, unlike a conventional interest rate shock, QE is not associated with an immediate change in household and corporate interest rate payments. Of course, there are major uncertainties here and this sort of calculation ignores some of the transmission channels discussed earlier. It makes no allowance for any effect through confidence or any effect through the exchange rate. So it might well understate the effects.

To quantify the impact on inflation a Phillips curve relationship can be used. A typical rule of thumb from a Phillips curve relationship might be expected to imply that a 1% increase in GDP would lead to a subsequent rise in inflation of ½ to 1 percentage point after a year. Obviously this is highly uncertain and might provide a poor guide if QE were to lead to higher inflation expectations or have large effects on the exchange rate. Nevertheless, applying this mapping to the estimated impact of asset purchases on GDP would suggest there could have been a subsequent impact on inflation of between ¾ to 2½ percentage points.

Summary of the macro effects

If we compute the range across the different estimation methods, using the middle of the ranges of the bottom-up estimates, this would suggest that QE may have raised the level of real GDP by 1½% to 2% and increased inflation by between ¾ to 1½ percentage points (as shown in the bottom row of **Table C**).[2] These estimates are clearly highly uncertain, particularly as none of the methods used to produce them fully capture all the likely transmission channels set out earlier, but they do suggest that the effects of QE were economically significant.

Table C Estimates of the macroeconomic impact of QE, peak impact on the level of output and inflation

Method	Level of GDP (per cent)	CPI inflation (percentage points)
SVAR	1½	¾
Multiple time-series models average impact[a]	1½	1¼
Monetary approach[b]	2	1
Bottom-up approach	1½–2½	¾–2½
Range across methods[c]	1½–2	¾–1½

(a) Kapetanios et al (2011) (these estimates are based on the lower variant reported by the authors).
(b) Bridges and Thomas (2011).
(c) Calculated using the mid-point of the reported range for the bottom-up approach.

As another metric on how large these effects are, they can be compared with the cut in Bank Rate that would be required to produce a similar rise in CPI inflation. The Bank's forecasting model suggests that a 100 basis point cut in Bank Rate increases CPI inflation by about ½ percentage point after 18 to 24 months. Applying the Bank model ready-reckoner to the estimated ¾ to 1½ percentage point impact on inflation would therefore suggest that the effect of QE was equivalent to a 150 to 300 basis point cut in Bank Rate, a significant reduction. Of course, there are large uncertainties even with this range, and the true number could plausibly be either

(1) This figure is also consistent with an approach based on modelling money demand (eg Bridges and Thomas (2011)).
(2) For comparison, Chung et al (2011) estimate that phase one of the large-scale asset purchase programme in the United States boosted the level of real GDP by almost 2%, while inflation is a percentage point higher than it would have been if the Federal Open Market Committee had never initiated the programme. According to their estimates, the full programme of asset purchases will raise GDP by almost 3%.

smaller or larger, but it provides a rough order of magnitude of the monetary stimulus implied by the QE policy.

Conclusion

This article provides an overview of the design, operation and impact of the Bank's asset purchase programme that began in 2009 in response to the intensification of the financial crisis.

The scale and speed of the programme was intended to reverse declining confidence and the increasing risk of inflation falling significantly below target in the medium term. In large part, the design of the scheme was intended to target purchases of medium to long-dated gilts from the non-bank financial sector.

The most clear-cut evidence on the impact is from asset prices. Gilt yields were depressed by around 100 basis points. Effects on a broader range of asset prices can be discerned but with greater difficulty, reflecting the lags involved and the wider range of influences. These changes in asset prices were expected to have conventional effects on output and then inflation. The article reviews a range of approaches taken in recent Bank of England research to quantify the possible impact of those asset price changes on output and inflation. This evidence suggests that the policy had economically significant effects — equivalent to a 150 to 300 basis point cut in Bank Rate — but there is considerable uncertainty around the precise magnitude of the impact.

The MPC may decide in the future to increase asset purchases or to begin the process of selling assets back. The economic and financial circumstances in which further asset purchases or sales are made may be very different from those that prevailed in early 2009, so it cannot be assumed that the magnitude of the effects will necessarily be the same.

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