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Quantitative Easing: a Sceptical Survey

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Quantitative Easing: a Sceptical Survey

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1) Introduction

Assessment of the impact of Quantitative Easing (QE) is a difficult task. QE programs are both very unusual and very large. They are only undertaken in times of severe economic difficulty and in circumstances when more conventional monetary policy cannot be used because the policy rate is at the zero lower bound. This severely limits investigation of the effects of QE. Studies can use contemporary high-frequency data from periods when QE is in operation, in which case data on some key macroeconomic variables, most especially output and inflation is not available; or else they can use data from periods when QE is not in operation, in which case they must assume that key macroeconomic relationships are not disrupted by the extraordinary events that led QE to be adopted. Clearly, neither approach is ideal.

QE consists of large purchases of mainly longer-term government bonds and related assets. Policymakers in the US and UK turned to QE in the hope that these purchases would reduce interest rates faced by households and firms and result in increased output and inflation. The structure of this survey reflects this chain of causation. We first review evidence on the impact of QE on government bond rates. We consider evidence from the "QE1" and "QE2" programs as well as "Operation Twist" in the US and evidence from the UK "QE1", "QE2" and "QE3" programs. In doing so, we review the results of event studies and estimates of econometric models. We then review evidence on the impact of QE on other assets prices such as corporate bond rates, equity yields, exchange rates and commodity prices. Finally, we consider evidence on the impact of QE on the "real economy", reviewing econometric studies of the impact of QE on output and inflation.

We review empirical evidence on the impact of QE programs in the US and UK since 2008. We do not consider the impact of earlier episodes of QE, especially in Japan and do not consider interventions by the ECB since 2007, as these focussed on supporting short-term money markets and so are different from the large scale asset purchases seen in the

US and UK. We do not consider alternative policies to address the economic crisis or political economy aspects of QE. We do not address the causes of the financial crisis or the possible future shape of policy including macroprudential regulation.

2) Evidence of the impact of QE on government bond rates

2a) Event studies

Event studies assume that all changes in the variable of interest that occur within a short time period are due to the event under consideration. Most evidence comes from the US QE1 program. The first stage of the program, $600bn purchases of housing agency debt and related securities, was announced on November 25th 2008 (although arguably the program was signalled in Chairman Bernanke's Jackson's Hole speech in late August). Following several indications of a likely increase in the size of the program, a major expansion of $1.15 trn comprising $850bn additional purchases of agency debt and $300bn longer-dated government bonds was announced on March 18th 2009. Movements in the government bond rate in the days after these announcements have been taken as evidence of the impact of the program. Three studies find that the program reduced 10-year government bond yields by around 100 basis points (bp), with the 18th March 2009 announcement having a particularly large effect. Gagnon et al (2011) report a reduction of 91 basis points (bp), Glick and Leduc (2011) find an effect of around 100 bp and Krishnamurthy and Vissing-Jorgensen (2011) report a reduction of 107 bp. Another study, Meaning and Zhu (2011), reports a smaller but still sizeable effect of around 80 bp; they also report reductions of around 85bp in the 5-year bond rate.

The first round of QE in the UK, UK QE1, began gradually. The body used for asset purchases, the Asset Purchase Facility Fund, was set up in January 2009 and some purchases of commercial bills occurred in February. The Inflation Report news conference on Wednesday 11th February 2009 indicated that an asset purchase program was likely.

On 5th March the MPC announced the purchase of £75bn assets; subsequent announcements on 7th May, 6th August and 5th November then increased the program to £125bn, £175bn and then £200bn. Maintenance of the program at £200bn was announced in February 2010. Of the £200bn purchases, £198bn were of government bonds, spread across a wide range of maturities. Unlike US QE1, differing estimates of the impact of the program have been reported. Joyce et al (2011) find an overall reduction of around 100bp in the 10-year government bond rate as a result of the program, with the largest effect coming after the announcement on 5th March. Meier (2009) finds an effect of between 40-100bp, arguing there is an "effect of QE on gilt yields of, at the very least, 35-60 basis points". By contrast, Glick and Leduc (2011) and Meaning and Zhu (2011) find smaller effects, close to 50bp. This may reflect the fact that these latter papers use a 1-day window whereas Joyce et al (2011) use a 2-day window (and report a stronger response on the second day, Joyce et al, 2011, Chart 10). The 50bp difference between these studies highlights the importance of window length in event studies: adding a single day doubles the estimated impact of UK QE1.

The first indication of the US QE2 program was given on 10th August 2010 when the Federal Open Market Committee (FOMC) announced it would roll-over holdings of Treasury securities as they matured, extending the life of the program by using redemption payments to purchase fresh assets. Further statements led to the announcement on 3rd November 2010 of $600bn purchases of long-dated government bonds. Evidence from event studies is mixed but with no indication of a large impact. Krishnamurthy and Vissing-Jorgensen (2011) report a reduction of 18bp in the 10-year government bond rate for a 1-day window and 30bp for a 2-day window, with smaller reductions in the 5- and 30-year rates. Glick and Leduc (2011) find no effect on the 10-year rate while Meaning and Zhu (2011) report a slight increase in the 10-year and a slight fall in the 5-year rate. The FOMC announced "Operation Twist" on 21st September 2011. This was an attempt to flatten the yield curve by selling $400bn assets with a maturity of less than three years and using the proceeds to purchase

assets with a maturity over 6 years. The only event study on this, Meaning and Zhu (2011), finds this had a measurable but small impact, raising the 5-year rate but reducing the 10-year rate. This is consistent with evidence from a similar exercise in the early 1960s (Swanson 2011).

The UK QE2 program of £75bn purchases of government bonds was announced on 6th October 2011. Meaning and Zhu (2011) report this did not reduce government bond rates, being associated with small increases in rates across the yield curve. The UK QE3 program of a further £50 bn purchases was announced on 9th February 2012. We do a brief event study of the effects of this announcement. On 9th February, 20- 10- and 5-year (zero-coupon) UK government bond rates were 3.43%, 2.40% and 1.11% respectively. On Friday 10th February, the day after the announcement, they were 3.36%, 2.45% and 1.01% respectively. On Monday 13th February they were 3.37%, 2.29% and 0.99% respectively. An event study with a 1-day window implies UK QE3 reduced the 20-year rate by 7bp, increased the 10-year rate by 5bp and reduced the 5-year rate by 10bp. A 2-day window implies UK QE3 reduced government bond rates, by 6bp, 11bp and 12bp respectively for 20-, 10- and 5-year rates. These are small effects. The reductions increased slightly in the rest of February 2012, but this may well reflect the negotiations around the Greek bail-out and bond-swap.

These event studies suggest that initial large scale asset purchases were effective in reducing government bond rates in the US and UK. Given the scale of these programs (by the end of UK QE1 the Bank of England held nearly 30% of freely floating gilts) this is not surprising. Perhaps more surprising is the lack of impact from later initiatives: we might have expected more from the $600bn spent on the US QE2 program. But event studies are only informative about movements in bond rates within a narrow time frame, no more than 6-10 days across a QE program of many months. They do not address longer-term movements in bond rates. Figure 1) (reproduced from Meaning and Zhu, 2011) depicts UK and US government bond rates in 2007-2011 with key QE-related events highlighted. US

government bond rates fell over the period of the US QE1 program, from close to 4% in the 3rd quarter of 2008 to around 2% in early 2009. Event studies suggest about half of this decline may have been due to QE1. However bond rates then rose sharply, ending 2009 close to their 2007 levels. This may mean that QE has only a temporary, and swiftly unwound, effect on bond rates. The fact that the most pronounced movements in US bond rates in this period occurred outside periods of QE, for example in the 3rd quarter of 2008, may indicate that other forces are more important. But this decline may also reflect anticipation of a QE program; discussion of QE became widespread as the policy rate fell rapidly to its lower bound in the 3rd quarter; arguably the US QE1 program was widely expected and the only "news" in the initial announcement concerned the size of the program.

The UK 10-year government bond rate also fell in the early months of the UK QE1 program in February and March 2009, from 3.8% to close to 3%; anticipation of QE may have affected bond yields prior to this, especially after the launch of US QE four months earlier. The 100 bp reduction estimated in the event study in Joyce et al (2011) suggests that the bond rate would have risen slightly in the absence of QE; the observed reduction is perhaps more consistent with the smaller 50bp reduction estimated in Meier (2008), Glick and Leduc (2011) and Meaning and Zhu (2011), with the marked fall around 5th March especially suggestive of an effect. However, this reduction was soon reversed and bond rates at the end of the program were back to their levels of late 2008. As in the US, the strongest movements in UK government bond rates occurred outside periods of QE programs. In particular the periods leading up to bail-outs for Greece (May 2010 and July 2011; the latter renegotiated in October 2011 and February 2012), Ireland (November 2010) and Portugal (May 2011) are associated with falls in UK and US government bond rates, clearly suggestive of a "flight-to-quality" around these events irrespective of the effects of QE. Given that the scale of these bailouts was comparable to that of QE programs (close to €240bn for Greece, €85bn for Ireland and €78bn for Portugal), this is not a surprise. This

again raises the question of how much impact QE has on bond rates. Event studies cannot hope to address these issues, so we next consider econometric evidence.

Figure 1: Government bond yields in the US and the UK

Government bond yields[1]
In per cent

United States

30-year
10-year
5-year
2-year
1-year

United Kingdom

30-year
10-year
5-year
2-year
1-year

[1] The vertical lines correspond to announcement days of each asset purchase programme. For the United States: 25 November 2008, 1 December 2008, 16 December 2008, 28 January 2009, 18 March 2009, 29 April 2009, 24 June 2009, 12 August 2009, 23 September 2009, 4 November 2009, 10 August 2010, 27 August 2010, 21 September 2010, 12 October 2010, 15 October 2010, 3 November 2010 and 21 September 2011. For the United Kingdom: 11 February 2009, 5 March 2009, 7 May 2009, 6 August 2009, 5 November 2009, 4 February 2010 and 6 October 2011.

Sources: Bloomberg; national data.   Graph 2

2b) Econometric studies

QE programs are rare events that only happen in times of severe financial stress and economic turmoil. As a result econometric investigation of QE requires difficult compromises that are reflected in the two types of econometric study of the impact of QE on bond yields. The first type uses data from periods when QE programs were in operation. This enables

direct investigation of these programs but is only feasible using daily or other high frequency data. The need for high frequency data makes it difficult to control for variables such as inflation and output that might be expected to affect bond rates. This problem is reduced in normal circumstances when the short-term interest rate set by policymakers reflects these factors. However QE is not used in normal circumstances, only being used when the policy rate is at the zero lower bound and so unable to act as a high frequency sufficient statistic for developments in the real economy. The inability to control for movements in inflation and output is a severe impediment for this type of study.

The second type of econometric study of QE uses lower frequency historical data from before 2008, using a richer set of explanatory variables. Typically, this approach studies the impact of changes in the stock of government bonds on bond rates in normal times. By scaling-up responses to the relatively minor changes in the stock of bonds in the pre-crisis period to reflect the much greater movements observed during QE, some indication of the likely impact of QE may be obtained. There are two apparent weaknesses with this approach. First, it can indicate the likely impact of a generic QE initiative but not the impact of a specific QE program. Second, and more seriously, it assumes that the relationships that drive bond rates in normal circumstances are not changed by the financial stress and economic turmoil that leads to QE being used or by the very large scale of QE programs. These are both debatable assumptions.

As with event studies, most evidence is available for the US QE1 program. Taken together econometric estimates suggest the program did reduce government bond rates, especially 10-15 year rates. However the effects are smaller and more diverse than those found in event studies. Gagnon et al (2011) use historical monthly data for 1985-2008; they regress the 10-year Treasury bond yield and the 10-year yield term premium on official holdings of US Treasury debt (the amount of Treasury debt held by the US Treasury, the Federal Reserve and foreign governments and central banks) including the unemployment gap, core CPI inflation and interest rate volatility as controls. They estimate that increased

official holdings of Treasury debt reduces the term premium and hence drives down government bond rates. Using these estimates to infer the impact of the $1.75 trn US QE1 program, they obtain a reduction in the 10-year bond rate of between 38-82 bp depending on the dependent variable. D'Amico and King (2010) use the contemporary data approach, using daily data for March 25 to October 30 2009 to estimate yield curve models. They regress the change in an asset's yield since the start of the sample on US QE1 purchases of the asset and purchases of substitute assets, controlling for changes in the residual maturity of the asset. Doing this for a range of assets they find significant reductions in bond yields across the yield curve with a largest effect of around 50 basis points on the 15-year bond rate, a slightly smaller effect on the 10-year rate but reductions of less than 20bp for durations of less than 5 years or over 25 years.

Wright (2011) constructs measures of the "surprise" component of various US monetary policy announcements; he finds, for example, that the 25th November 2008 initial $600bn announcement of US QE1 is equivalent to a 80 bp cut in the policy rate while the major extension of US QE1 to $1.75trn announced on 18th March 2009 is equivalent to a 340 bp reduction. Glick and Leduc (2011) evaluate the impact of QE programs by regressing government bond yields on this measure using daily data. For US QE1, they estimate a significant reduction in the 10-year bond rate. However, since the estimates are expressed in terms of the effect of a 1-standard change in the monetary policy surprise, it is unclear what this implies for the size of the reduction in bond rates due to US QE1. Szczerbowicz (2011) considers the different aspects of US QE1, allowing purchases of government bonds and mortgage backed securities (mbs) and agency debt to have different effects on the 10-year rate. She finds similar effects from both components of QE1, a reduction of 22 bp from government bond purchases and 17bp from purchases of mbs and agency debt. Meaning and Zhu (2011) use a similar approach to D'Amico and King (2010). For US QE1 they find an average reduction of 27 bp for bonds with maturities between 5-25 years. However they only consider the effect of the $300bn purchase of government bonds; since these were less

than 20% of the amount purchased, this is not an estimate of the impact of the whole program.

Considering the UK QE1 program, Joyce et al (2011) estimate VAR and multivariate GARCH models using monthly historical data for the 1991-2007 period. Using a portfolio balance approach and a VAR comprising returns on and portfolio shares of gilts, investment-grade corporate bonds, equities and money as endogenous variables and inflation, industrial production and the slope of the yield curve as exogenous variables (this is a strong assumption since it rules out any impact of the various endogenous interest rates on output and inflation), they simulate the effects of QE by considering a shock that reduces the share of government bonds in private sector portfolios, calibrated to mimic the scale of UK QE1. They estimate this shock reduces yields on gilts by 85 bp. However the impulse responses unwind rapidly and the effect after 6 months is reduced to 32 bp. This rapid reduction in the estimated impact of QE might suggest some caution in interpreting impact studies that focus on immediate responses to announcements. Using contemporary daily data and the same methodology as they used to assess US QE1, Glick and Leduc (2011) find that UK QE1 also led to a significant reduction in the 10-year bond rate, although the size of the effect is unclear. Meaning and Zhu (2011) use contemporary daily data to estimate a model that lacks the rich dynamic responses of Joyce et al but which incorporates QE asset purchases more directly and also considers the impact on a wider range of government bonds. They find that UK QE1 reduced government bond rates by 27bp, although the reduction for 10-15 year bonds is larger, 75 bp. The comparison between these papers highlights two important methodological issues. The first is the importance of controls: Meaning and Zhu (2011) have a smaller set of controls and do not include the fiscal deficit; concern about the deficit in 2009 may have affected UK bond yields in this period. The second is the relative importance of the stock of bonds that is held versus the flow of bond purchases. Joyce et al (2011) consider bond holdings whereas Meaning and Zhu (2011) consider the impact of bond purchases. The former view implies persistent effects of QE purchases, whereas the

latter suggests that the effects of QE are temporary and diminish as QE purchases cease (the implications are discussed further in Davies, 2011). The stark contrast between the 100 bp reduction in Joyce et al (2011) and the more modest 27bp reduction found by Meaning and Zhu (2011) led to much commentary (eg "Bank of England said to have over-estimated QE boost; *The Financial Times*, 11th December 2011), highlighting the political sensitivity around QE.

Early analysis suggests that the impact of the US QE2 program may have had a smaller impact on bond yields, albeit a larger effect than found in event studies. Hamilton and Wu (2011) estimate a sophisticated model of bond pricing that incorporates a preferred habitat assumption into an affine arbitrage-free model to motivate an effect of the supply of bonds on prices; they find a reduction of 13 bp on average. Meaning and Zhu (2011) estimate a reduction of 21 bp across the yield curve (but a surprisingly large reduction of 108bp for 20-year bonds). Szczerbowicz (2011) estimates a small and insignificant effect from US QE2, although the sample here is small.

An interesting strand of work considers how QE in one country affected bond rates in other countries. Neely (2011) analyses the impact of US QE1 on foreign 10-year government bond rates using daily data. He finds a considerable impact on foreign bonds rates, with falls of 65, 78, 54, 50 and 19 bp in the UK, Australia, Canada, Germany and Japan, respectively. Glick and Leduc (2011) find similar effects, although the effect on UK rates is smaller, at 45 bp. These estimates suggest that the impact of US QE1 on UK bond yields was comparable to that of the UK's own QE program and that US QE1 might explain a part of the fall in UK bond rates in late 2008. Glick and Leduc (2011) find that UK QE1 had a muted impact on foreign bond rates with most effects in the low single digits. Given the small scale of this program in global terms, this finding is not surprising. They also find no effect of US QE2 on foreign bond rates, confirming the limited effect of that program.

Summarising the evidence on the impact of QE on government bond rates, event studies find that the initial large scale asset purchase programs (US and UK QE1) did

reduce government bond rates although estimates of the size of the effect vary. Econometric investigations tend to find smaller effects. This may be because there is a strong initial response to announcements of QE programs which then unwinds over times, an effect that can be detected using econometrics but not event studies. Econometric models estimated on historical data and used to infer the impact of QE estimate larger effects than do models estimated on contemporary data. This may suggest that bond rates are less responsive to policy in periods of economic and financial turmoil, in which case estimates based on historical data should be treated with some caution. The strong impact of US QE1 on overseas bond rates is also notable, suggesting that globally significant QE programs may have important spill-over effects. The impact of subsequent programs (US and UK QE2 and Operation Twist) appears to be more modest. There are several possible explanations of this. These programs may have been expected by the markets and already affected bond rates through anticipation effects. Or there may be have more rapid portfolio adjustment in response to the second round of QE, leading the effects of bond purchases to be transferred more rapidly onto the prices of other assets. A more simple explanation might be that QE programs are more able to reduce bond rates when those rates are relatively high. Both US and UK QE1 programs were introduced when the 10-year bond rate exceeded 3%; when subsequent programs were introduced this rate was less than 3%; this might be tested in econometric studies by controlling for the bond rate at the start of the program (cf Breedon et al, 2012).

3) Evidence of the impact of QE on other asset prices

If the main objective of QE is to affect the real economy, the impact of QE programs on government bond rates is only part of a chain of causation that connects government bond rates, returns on other assets, aggregate demand and then output and inflation. In this section we consider evidence on the second stage of this process; the impact of QE on corporate bond rates, money market rates, exchange rates and equity yields.

As with studies on government bond rates, event studies suggest that QE has a sizeable impact on corporate bond rates. Krishnamurthy and Vissing-Jorgensen (2011) report a strong impact of US QE1 on corporate bond rates with reductions of 77bp for AAA bonds, 93bp for A, 60bp for BA and 43 bp for B. Neely (2011) reports similar findings: a 78bp reduction for BAA-rated corporate bonds. Joyce et al (2011) report a smaller effect for UK QE1, a fall of around 50 bp, but only for higher quality assets at shorter durations. Econometric evidence is more mixed; the estimates of Joyce et al (2011) suggest that UK QE1 led to a reduction of 81bp in investment-grade corporate rates, falling to 32 bp after 6 months. This effect is similar to the effect estimated for government bond rates. By contrast, the estimates of Krishnamurthy and Vissing-Jorgensen (2011) and Wright (2011) for US QE1 and QE2 find a much smaller effect. This may be because Joyce et al use historical data whereas the other papers use contemporary data.

There is little evidence of any impact of QE programs on money market rates. Neely (2011) finds US QE1 had insignificant effects in the US and a range of other countries. Szczerbowicz (2011) finds no evidence that US QE1 or QE2 had any impact on the LIBOR-OIS spreads, in contrast to the clear effect of earlier government bailouts and guarantee schemes. Glick and Leduc (2011) and Neely (2011) consider the impact on US QE1 on exchange rates, concluding that it was associated with depreciations of the US dollar against major currencies in the range of 3-11%. Glick and Leduc (2011) also find that US QE2 has a more negligible effect. They also find a smaller effect associated with UK QE1 with depreciations of sterling in the range of 1.5-3.5%. Joyce et al (2011) find much the same, noting that the slight fall in Sterling is much less than the 8% depreciation implied by a simple UIP calculation. The relatively small impacts of US QE1 on exchange rates do not offset the marked impact of the program on foreign government bond rates; this suggests that a stimulus to economies overseas may be an important but unforeseen aspect of US QE1.

There is less evidence on the impact of QE on other financial assets. Joyce et al (2011) estimate the response of equity yields to UK QE1, falling by 282bp on impact and by 120 bp after 6 months. Glick and Leduc (2011) find that QE affects commodity prices, with US QE1 reducing commodity prices by 11% with the effects concentrated in energy-related commodities and precious metals; UK QE1 had a similar but smaller effect. Finally, we note that QE does not appear to have affected interest rates facing SMEs and households, especially rates on unsecured borrowing. UK evidence (from the database on the Bank of England website) suggests that effective interest rates on this type of borrowing increased in 2008-9 as widening spreads outweighed the effects of lower policy rates.

4) Evidence of the impact of QE on the real economy

This section considers the impact of QE programs on output and inflation. Event studies are not feasible since these variables are only observed at monthly or lower frequencies. Evidence comes from econometric studies using data largely drawn from before 2008. We consider six studies (all from within Central Banks or first published as Central Bank Working Papers). Three studies, Baumeister and Benati (2010), Lenza et al (2010) and Kapetanios et al (2012) share a similar methodology, with two others, Peersman (2011) and Bridges and Thomas (2012) sharing elements of the approach. It is therefore worth considering the methodology in some detail.

Consider the following simplified model:

(1) $\qquad Y_t = \Theta_0 + \Theta_1 Y_{t-1} + e_t$

where $Y_t = (y_t, \pi_t, i_t, s_t)'$ is a (4x1) vector of endogenous variables, comprising measures of output (y), inflation (π), the short-term policy rate (i) and the spread between the policy rate

and a longer-term rate (s), e_t is a (4x1) vector of error terms, Θ_0 is a (4x1) parameter vector

and Θ_1 is a (4x4) parameter matrix, whose elements are Θ_1^{ij} for $i, j \in \{y, \pi, i, s\}$. There are

four structural shocks, comprising an aggregate demand shock (ε^d), an aggregate supply

shock (ε^s), a conventional monetary policy shock (ε^{cmp}) and unconventional monetary

policy shock (ε^{ump}). The reduced form errors are related to the underlying structural shocks

by the relationship

(2) $e_t = B\varepsilon_t$

where $\varepsilon_t = (\varepsilon^d_{t}, \varepsilon^s_{t}, \varepsilon^{cmp}_{t}, \varepsilon^{ump}_{t})'$ and B is a (4x4) matrix whose elements are $B^{i,j}$ for

$i \in \{y, \pi, i, s\}$. and $j \in \{d, s, cmp, ump\}$. The model is identified by a mixture of exclusion

and sign restrictions on B. In particular, the conventional monetary policy shock is defined

as moving the policy rate and the spread in opposite directions while the unconventional

monetary policy shock is defined as affecting the spread but not the policy rate.

The effect of QE on output and inflation is then analysed: this is done by comparing

forecasts of these variables obtained using this model with forecasts obtained from a

counterfactual scenario in which QE did not occur. The counterfactual forecast is

constructed by fixing the spread at a value that, it is assumed, would have been observed in

the absence of QE. Baumeister and Benati (2010) assume that the spread would have been

60bp higher in the US (using the mid-point of Gagnon et al's, 2011, estimated reduction of

38-82bp) and would have been 50bp higher in the UK (using Meier's, 2010, estimate of a 35-

60 bp reduction). Kapetanios et al (2012) assume that the spread would have been 100bp

higher in the UK (using the reduction reported by Joyce et al, 2011). Lenza et al (2010)

assume that the spread would have remained fixed at the immediate pre-crisis level.

Baumeister and Benati (2010) use US quarterly data for 1954Q3-2008Q4 and UK

quarterly data for 1955Q1-2008Q4 (they also estimate models for the Eurozone and Japan).

They find that in the absence of QE, output growth would have fallen to -10% compared to an actual fall of 3% and that inflation would have been negative. For the UK, they find that output growth would have fallen to -14% and inflation fallen to below -4%. Clearly, these estimates suggest QE had a dramatic impact, saving the UK and US from economic catastrophe. Are they plausible? It is certainly arguable that policy interventions in late 2008 and 2009 prevented a much worse outcome. But QE was only part of a much wider series of interventions that included fiscal policy. These other interventions are not included in the model so it is possible that the inferred impact of QE captures some of these other effects. The estimates also imply that QE had an immediate impact: for both the US and UK the largest impact of QE is felt in 2009Q1. But UK QE1 did not begin until the middle of 2009Q1 and US QE1 was only expanded from $600bn to $1.75 on March 18th 2009, near the end of the quarter in which QE is estimated to have its largest impact.

Kapetanios et al (2012) use a similar approach to investigate the impact of UK QE1. They use three alternative models. The first is a large-scale VAR estimated using monthly data for April 1993 to September 2011. The model comprises 43 variables, reflecting real activity, prices and policy rates in the UK, US and the Eurozone). This helps ensure a good forecasting performance but makes the model vulnerable to the critique that the many relationships built into the model might change as a result of the crisis. The second model is a switching VAR with 4 regimes. The VAR has 6 variables: output growth, inflation, M4 growth, the 3 month TB rate, the spread between the 10-year bond rate and the 3-month Treasury Bill rate and growth in the FTSE all-share index. Unlike Markov-style models, in this model the economy does not oscillate between regimes; rather it progresses from one regime to another over time. This model is less vulnerable to changes in economic relationships, allowing the use of a longer time period, January 1963 to September 2011. However some regimes are short: for example, the final regime is estimated over the period of the financial crisis. The final model is a VAR in which the parameters are allowed to change over time, evolving as random walks. The VAR has 4 variables: output growth, inflation, the spread and the 3 month TB rate and is estimated using quarterly data over

1968-2011. This model is designed to overcome the problem of economic relationships that evolve over time; however it is vulnerable to sudden changes in these relationships, which may have occurred during the financial crisis.

They find that UK QE1 increased output growth and inflation; summarising across models, GDP growth was 150-200 bp higher and inflation 75-150bp higher. Impulse responses suggest the largest impact on output and inflation, 200bp and 150 bp respectively, occurred in March 2010, a month after the end of asset purchases was announced. Given that UK GDP fell by 4.9% in 2009, these results imply that output would have fallen by close to 7% if there had been no QE. Also CPI inflation would have been uncomfortably close to zero rather than its actual value of 2.1%. In short these results suggest that QE saved the UK from a much deeper recession and the threat of deflation. Although these estimates are lower than found by Baumeister and Benati (2010) (and the timing of the maximal effect more plausible), it might be argued that these estimates are on the high side. The assumption that QE lowered the spread by 100bp is questionable. As discussed above, most studies find a much smaller effect, close to 50 bp and most econometric estimates find an effect of less than 50 bp. Perhaps a reduction of 50bp, following Baumeister and Benati (2010), might have been considered. They also assume that the 100bp reduction applies across the yield curve: the evidence discussed above suggests there were smaller reductions in shorter–dated bonds.

Lenza et al (2010) investigate the impact of conventional and unconventional monetary policy initiatives of the ECB using monthly data for January 1991 to August 2009. This is not a study of QE, since the ECB has not opted for large scale purchases of long-dated financial assets. Rather, it is a study of the effect of large-scale unconventional policy interventions in the short-term money market. They use a large-scale VAR comprising 31 variables covering various aspects of output, unemployment, prices, the money supply and policy and other interest rates in the Eurozone. They analyse the impact of unconventional monetary policy on interest rate spreads and use this to infer the impact on the real

economy. Their counterfactual scenario implies that unconventional monetary policy had a strong effect of short-term interest rates: for example the 3-month rate is assumed to be close to 3% in mid-2009 compared to an actual rate of less than 1%. The estimated impact on output is initially negative, reducing output growth by up to 100bp; the effect become positive after mid-2009 and rises to a peak of 260bp by late 2009 before declining, disappearing after mid-2012. The cumulative effect is positive. The initial impact on inflation is persistently negative, only becoming positive by March-April 2011 by which time the effect is small. The cumulative effect is negative. The policy simulations suggest that the effect of the policy was transmitted via changes in interest rates spreads rather than through the money supply. The results are mixed: the positive impact on output is offset by the finding that inflation was reduced; this is an odd finding for a policy that is assumed to have reduced interest rates by up to 200bp. The finding of little change in the broad money supply is also a little odd: given the importance of bank lending in the Eurozone, one might have expected a positive impact on output to be reflected in a higher money supply.

These studies all measure the impact of QE by assuming a counterfactual value for the interest rate spread that would have been observed in the absence of QE. The counterfactuals that are used are open to the criticism: in particular, they assume that QE had a strong and lasting impact on government bond rates and hence on the spread. The evidence surveyed above suggests that initial QE programs had a strong initial impact on bond rates but that subsequent programs had little effect. Econometric evidence also suggests that even in the early programs, the strong initial impact was only-short lived. By assuming a strong impact of QE on the spread throughout the period, these studies may be assuming QE had a stronger effect than it actually did (although it might be argued that Joyce et al (2011) under-estimate the impact of QE since they do not allow for anticipation effects).

Bridges and Thomas (2012) analyse the impact of UK QE1 from a more explicitly monetarist perspective. They argue that QE increased UK M4 by around £120bn or 8%.

They analyse the impact of such an increase using an 8-variable VAR estimated using UK quarterly data for 1964Q1-2007Q3 and comprising the level of output, inflation, the real exchange, the money supply, stock prices, a short-term interest rate and the rate on government bonds. There are eight shocks including conventional and unconventional monetary policy shocks, distinguished by the assumption that unconventional policy does not affect the short-term rate. The effects of QE are simulated by choosing unconventional monetary policy shocks that result in a permanent 8% increase in the nominal money supply beginning in 2009Q1, setting the other shocks to zero. Simulations suggest that QE reduced the bond rate spread by a maximum of 175bp by the start of 2010, a much larger effect than in other studies. However this effect unwinds, becoming zero by mid-2011 and stabilising at a 50bp increase. Equity prices increase by 200bp by early 2010; this effect then also unwinds and stabilises at a 50bp increase. The nominal exchange rate depreciates but this effect is almost exactly offset by higher prices. The response of output is more modest. The level of output is projected to begin increasing in mid-2009 rising to a maximum effect of around 150bp by the start of 2010. The effect then declines and becomes negligible by mid-2011. Inflation increases, but only from early 2010. It reaches a peak of around 200bp before declining, although remaining above zero throughout the forecast period.

As the authors acknowledge, these results assume that a model that is estimated using pre-crisis data and that is simulated using much larger shocks than occurred in the estimation period can deliver reliable insights in to the impact of QE. The very strong response of asset prices, especially bond rates, is perhaps implausible in the light of other studies. That said, the estimated response of output and inflation to QE seem more plausible than some of the larger effects obtained in some other studies.

Peersman (2011) considers the impact of policy interventions on the monetary base and money multiplier and investigates transmission to the real economy via this route rather than via interest rate spreads. In contrast to the papers above, he assesses the impact of unconventional monetary policy by analysis of the impact of identified unconventional policy

shocks rather than by comparison with a counterfactual no-intervention case. Using monthly data for the Eurozone for 1991M1-2009M12, he analyses a VAR that includes industrial production as a proxy for output, the (CPI) price level, total credit, the monetary base, the interest rate on credit (an average of various private sector lending rates) and the policy rate. Conventional policy shocks have hump-shaped effects on output and inflation. Unconventional monetary policy shocks have similar effects, although these occur several months later. This similarity leads Peersman (2011) to suggest that the two forms of monetary policy can to some extent be seen as substitutes in terms of their impact on the real economy, with an unconventional monetary policy shock that increases the monetary base by 10% having the same impact as a 25bp cut in the policy rate. However there are differences in the transmission mechanism with conventional policy widening credit spreads and increasing the money multiplier and unconventional policy having the opposite effect.

Chung et al (2011) use a different approach. They estimate the reduction in government bond rates due to increased Fed holdings of government bonds as part of QE and simulate the impact of this reduction in bond rates using the large scale FRB/US macroeconomic model. They assume that the impact of QE unwinds over time, from an initial reduction of 50bp that reduces to a 30bp reduction by late 2010 and a 10bp reduction by late 2012. They find that US QE1 boosted GDP growth by almost 200bp with the strongest effect felt in early 2010 and that US QE2 increased GDP growth by around 100bp. The effect is similar to that of a 300bp reduction of the policy rate.

Econometric estimates of the effects of QE programs on output and inflation (with the exception of Baumeister and Benati, 2011), are broadly similar. QE increased GDP growth by around 1-3% with a similar effect on inflation. This evidence suggests that QE has proved effective in limiting the scale of the downturn caused by the financial crisis that began in 2007. However it suggests that QE, by itself, is not strong enough to spark an economic recovery. Of course, this conclusion is tentative. There is relatively little evidence on the effects of QE and most of this uses the same methodology.

5) Conclusions

What have we learnt? We have stressed the difficulty of assessing the impact of QE and the compromises forced on investigations of these issues. Given this, we doubt it is possible to achieve any consensus on this. However, some consistent conclusions do emerge from our survey of the evidence.

First, event studies suggest that initial large scale QE programs did succeed in lowering government bond rates, especially at the longer end of the yield curve. However, econometric studies suggest that these effects may have been only temporary. By contrast there is little evidence of subsequent QE programs having much effect. This may be because they were introduced when bond rates were already quite low. Or it may be because initial QE programs were sufficient to demonstrate the commitment of policymakers to addressing the financial crisis, leaving little for subsequent programs to add. Second, QE appears to have been an effective response to the severe economic difficulties of late 2008 and 2009, preventing even larger declines in output and inflation than were experienced. However, QE is a rather weak policy instrument; the very large initial asset purchase programs had effects comparable to a reduction of 200-300 bp in the policy rate; subsequent programs had little effect. Third, (with one exception) studies of the impact of QE on the real economy use the same methodology. Alternative estimates based on different models and methodologies would be useful in widening an evidence base that is currently too narrow.

As we approach the fifth anniversary of the first US QE programs in 2008, issues of how policymakers might unwind QE are likely to become more prominent. Large scale sales of government bonds might threaten the stability of an already fragile market and lead to rapid increases in bond rates. This suggests that reduction in the size of Central Bank balance sheets is likely to be done more gradually. This may create difficulties for policymakers who may need to moderate or delay increases in the policy rate to absorb the

effect of bond sales. Given continuing uncertainties in the Eurozone and slow progress in reducing fiscal deficits, it may well be some years before QE begins to be reversed.

References

Baumeister, C. and L. Benati (2010). Unconventional monetary policy and the great recession - Estimating the impact of a compression in the yield spread at the zero lower bound. ECB Working Paper No. 1258.

Bridges, J. and R. Thomas (2012). The impact of QE on the UK economy — some supportive monetarist arithmetic, Bank of England Working Paper, No 442.

Breedon, F, J Chadha and A Waters (2012). The Financial Market Impact of UK Quantitative Easing, Oxford Review of Economic Policy (to appear).

Chung, H., Laforte, J.P., Reifschneider, D. and J. Williams (2011). Have we underestimated the likelihood and severity of zero lower bound events?. Federal Reserve Bank of San Francisco Working Paper No. 2011-01.

D'Amico, S. and T. King (2010). Flow and Stock Effects of Large-Scale Treasury Purchases. Board of Governors of the Federal Reserve System Finance and Economics Discussion Series No. 2010-52.

Davies, G. (2011). Can bonds survive the Fed's exit? The Financial Times, March 30, 2011.

Gagnon, J. Raskin, M., Remache, J. and B. Sack (2011). The Financial Market Effects of the Federal Reserve's Large-Scale Asset Purchases. International Journal of Central Banking, 7, 3-43.

Glick, R. and S. Leduc (2011). Central Bank Announcements of Asset Purchases and the Impact on Global Financial and Commodity Markets. Federal Reserve Bank of San Francisco Working Paper No. 2011-30.

Hamilton, J.D. and J.C. Wu (2011). The Efectiveness of Alternative Monetary Policy Tools in a Zero Lower Bound Environment. NBER Working Paper No. 16956.

Joyce, M. Lasaosa, A., Stevens, I. and M. Tong (2011). The financial market impact of quantitative easing in the United Kingdom. International Journal of Central Banking, 7, 113-161.

Kapetanios, G., Mumtaz, H., Stevens, I. and K. Theodoridis, (2012). Assessing the economy-wide effects of quantitative easing', Bank of England Working Paper No 443.

Krishnamurthy, A. and A. Vissing-Jorgensen (2011). The Effects of Quantitative Easing on Long-Term Interest Rates."

Lenza, M., H. Pill and L. Reichlin (2010) Monetary policy in exceptional times. Economic Policy, 25, pp 295-339.

Meier, A (2009), "Panacea, curse, or nonevent: unconventional monetary policy in the United Kingdom", IMF Working Paper No. 09/163.

Meaning, J. and F. Zhu (2011). The impact of recent central bank asset purchase programmes. Bank of International Settlements Quarterly Review December 2011, 73-83.

Neely, C. (2011). The Large-Scale Asset Purchases Had Large International Effects." Federal Reserve Bank of St. Louis. Working Paper No. 2010-018C.

Peersman, G. (2011). Macroeconomic Effects of Unconventional Monetary Policy in the Euro Area, CESifo Working Paper No. 3589.

Szczerbowicz, U. (2011). "Are unconventional monetary policies effective?" Working Paper 1107, LUISS Guido Carli.

Swanson, E. (2011). "Let's Twist Again: A High-Frequency Event-Study Analysis of Operation Twist and Its Implications for QE2." Brookings Papers on Economic Activity (Spring).

Wright, J. (2011). "What Does Monetary Policy Do to Long-Term Interest Rates at the Zero Lower Bound?" NBER Working Paper 17154.