

The impact of recent central bank asset purchase programmes¹

This article analyses the effectiveness of the asset purchase programmes implemented by the Federal Reserve and the Bank of England. Both the Federal Reserve's Large-Scale Asset Purchase (LSAP) programme and the Bank of England's Asset Purchase Facility (APF) had a significant impact on financial markets when the first stages were announced, but the effects became smaller for later extensions of the programmes. Applying a methodology developed by D'Amico and King (2010), we estimate that the lasting reduction in bond supply via central bank asset purchases lowered government bond yields significantly. The effect is largely similar for the LSAP and the APF. Our estimations also suggest that the Federal Reserve's new maturity extension programme (MEP) should have an effect on longer-term Treasury bond yields comparable to that of the outright asset purchases under the LSAP.

JEL classification: E52, E63.

Following the recent global financial crisis and the onset of the ensuing recession, central banks in the major advanced economies lowered policy rates rapidly to close to zero. Several central banks also implemented policy measures considered non-standard (see box), including outright purchases of large amounts of long-term bonds. This led to dramatic increases in the securities holdings of the Federal Reserve and the Bank of England (Graph 1).² In recent months, central banks have responded to the deepening European sovereign debt crisis and the faltering recovery in the major advanced economies by expanding the existing asset purchase programmes or adopting new measures, such as the Federal Reserve's maturity extension programme (MEP) in September 2011.

In this article, we estimate the impact of the recent purchases of Treasury securities by the Federal Reserve and of gilts by the Bank of England on

¹ The views expressed in this article are those of the authors and do not necessarily reflect those of the BIS. We are grateful to Morten Bech, Claudio Borio, Stephen G Cecchetti, Eli Remolona, Jing Yang and Christian Upper for useful comments on earlier drafts of this article, and to Jakub Demski for assistance with data and graphs.

² For instance, the Federal Reserve's outright securities holdings tripled from about \$790 billion in mid-2007 to over \$2.6 trillion by mid-2011.

government bond yields using two different methodologies.³ We first study the immediate financial market impact of both the announcements of the programmes and of the actual purchases. Our event study points to large responses to the announcements of US LSAP1 and UK APF1, and smaller responses to the announcements of later programmes. We then estimate the impact of the actual purchases using the methodology of D'Amico and King (2010). We find that yields fell significantly over the course of each programme.

Asset purchases by central banks can affect real activity through several channels.⁴ First, through the portfolio balance channel, purchases of longer-term securities can lower the long end of the yield curve and lead investors to buy assets with greater duration or higher credit risk. This can increase prices for a range of private assets, including home and equity prices. In the second, the signalling channel, a central bank communicates, via asset purchases, its commitment to monetary stimulus. This can lower the expected future path of short-term rates and reduce longer-term yields. A credible commitment can

US and UK asset purchase programmes

Since late 2008, a number of central banks have established asset purchase programmes in order to improve financial conditions, revive credit flows and stimulate economic activity. The purchases have been concentrated in government securities and related assets.

The US Federal Reserve announced its Large-Scale Asset Purchase (LSAP) programme on 25 November 2008, with purchases of up to \$600 billion in agency mortgage-backed securities (MBS) and agency debt. In March 2009, the Federal Open Market Committee expanded the LSAP with an additional \$850 billion in purchases of agency securities and another \$300 billion in purchases of longer-term Treasury securities. The announced total amount of \$1.75 trillion represented 14.5% of the combined outstanding Treasury and agency securities, which stood at around \$12 trillion at the beginning of the LSAP. The operations (LSAP1), which were extended to March 2010, became known as Quantitative Easing 1. As the recovery faltered, the Federal Reserve put in place LSAP2 in November 2010, which consisted of further purchases of \$600 billion in longer-term Treasury securities until mid-2011.

On 21 September 2011, the Federal Reserve announced a new maturity extension programme (MEP). Under the programme, by the end of June 2012 the Fed would buy \$400 billion in Treasury securities with remaining maturities of six to 30 years, while selling an equal amount of Treasuries with remaining maturities of three months to three years.

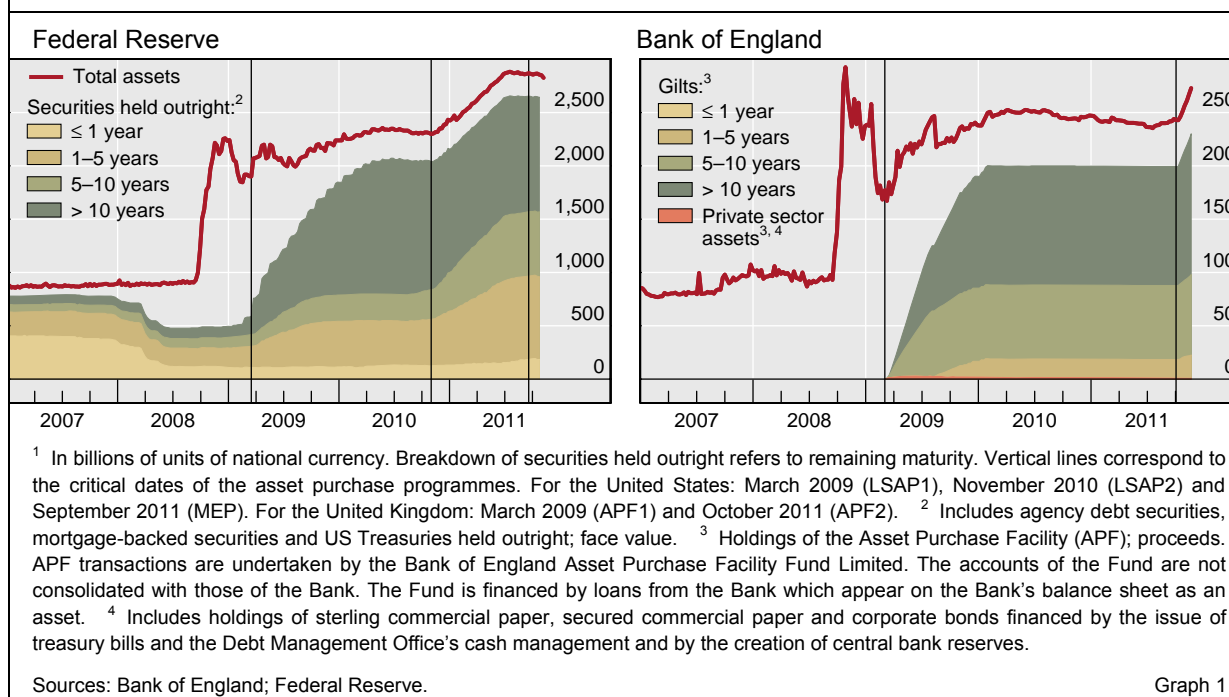
The Bank of England established an Asset Purchase Facility (APF) Fund in January 2009 to buy high-quality assets to improve liquidity in credit markets.[Ⓞ] Initially, it committed £75 billion to purchase bonds with residual maturity between five and 25 years. This was raised to £125 billion in May, £175 billion in August and £200 billion in November 2009 (APF1). By February 2010, the purchases of gilts amounted to £198 billion, which was about 29% of the free float gilt market. On 6 October 2011, the Bank decided to expand the APF by a further £75 billion to £275 billion (APF2).

[Ⓞ] Benford et al (2009) and Cross et al (2010) provide detailed accounts of the APF, and Joyce et al (2010) estimate the impact of the asset purchases on financial markets.

³ See Meaning and Zhu (2011) for a comprehensive analysis.

⁴ Chen et al (2011) discuss in detail the domestic and international channels of transmission for central bank asset purchases. Meaning and Zhu (2011) analyse the strength of the portfolio balance channel.

Central bank balance sheets and outright asset purchases¹



also reduce uncertainty, inspire confidence and drive down risk premia while supporting asset prices. Third, in the traditional interest rate channel, if nominal prices and wages are slow to adjust, reducing longer-term yields and subsequently real interest rates encourages spending by firms and households.

Here we focus on the overall impact of the purchases on asset prices, without distinguishing between the various channels. However, we do provide some evidence on the portfolio balance channel, which was considered by Gagnon et al (2011) as the main channel through which the LSAP programme affected yields.

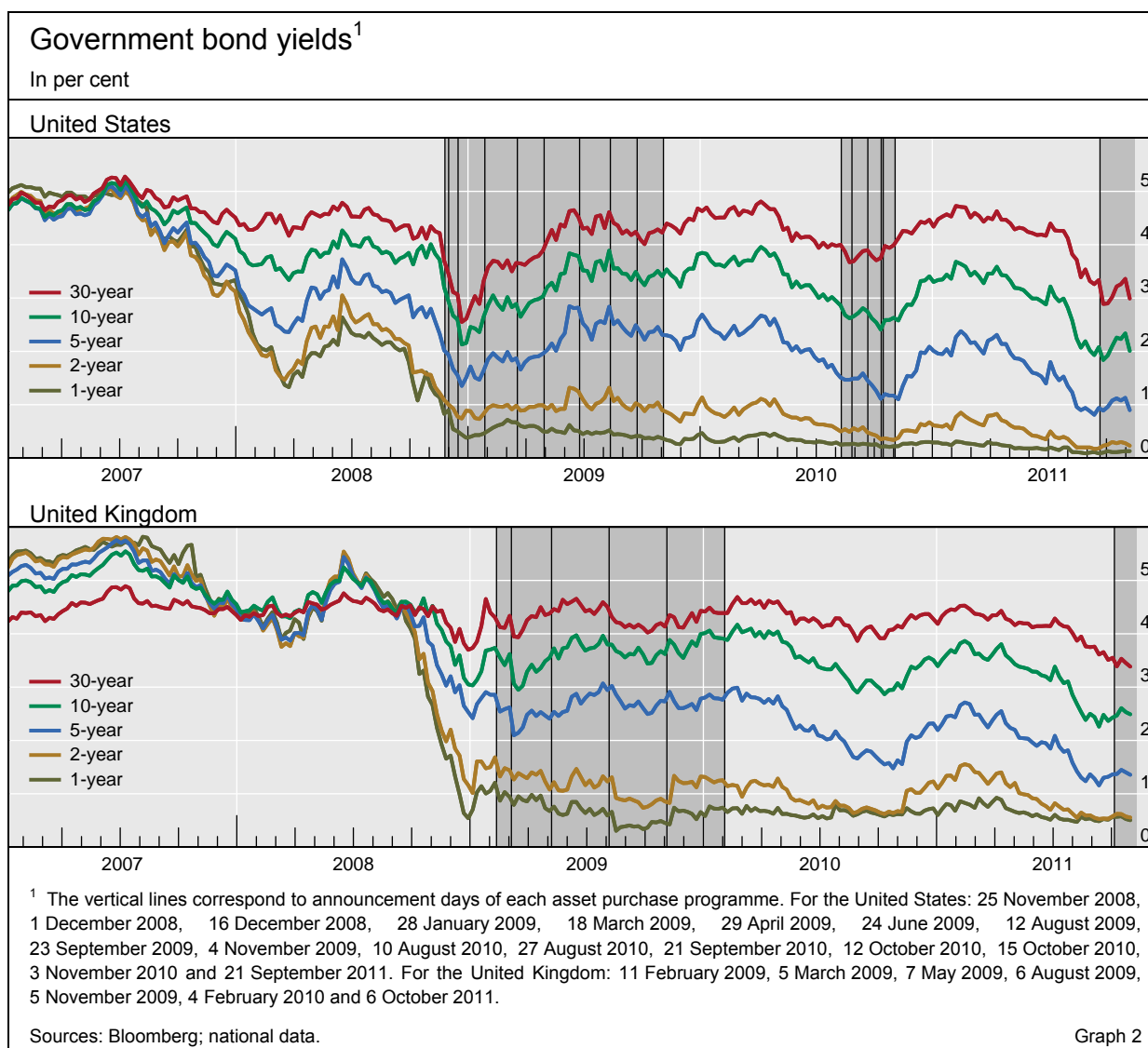
Announcement effects of asset purchases

Bond yields reacted to asset purchase programmes

US and UK asset purchases appear to have had an immediate and non-negligible impact on sovereign bond yields across the maturity range (Graph 2). Following most of the relevant announcements related to the US and UK asset purchase programmes, bond yields declined across maturities, with the largest impact on the five- and 10-year yields. The effects were greatest after the initial announcement of each programme.

We study the financial market responses to the major announcements of US and UK asset purchase programmes using an event study methodology, as in Gagnon et al (2011). We use one- and two-day event windows to measure the cumulative changes in a number of key financial indicators.⁵ Large-scale asset purchases are a relatively new and less well understood policy tool compared to changes in policy rates. We therefore allow the event windows to

⁵ Chen et al (2011) find sizeable effects of announcements of central bank asset purchase programmes on the global financial market, with significant cross-country differences.



be longer than usual to allow the market reactions to the policy announcements to fully register, but short enough to exclude the likely impact of other relevant events close to the announcement dates.

Graph 3 reports our findings on the cumulative effects with a one-day event window. First, the announcements had a strong and immediate impact on government bond yields. The five- and 10-year yields fell most, reflecting the intention of the Federal Reserve and the Bank of England to target longer-maturity assets. But not all announcements lowered long yields: for instance, yields actually rose after the Bank of England's 6 October 2011 decision to extend its APF. This might have reflected the rising market unease with the ongoing tensions in Europe's sovereign debt markets. In addition, the three-month OIS rate declined by about 30 basis points during LSAP1, suggesting investors might have lowered their expectations of future effective federal funds rates in response to the policy announcements.

Second, US LSAP1 and UK APF1 had far greater impact on sovereign bonds of different maturities and on corporate bond yields than the later programmes. This suggests that the novelty or surprise factor associated with LSAP1 and APF1 might have waned over time as "more of the same" failed to

Longer-term yields were most affected ...

... but the impact was smaller for later programmes

evoke market reactions of similar magnitude. Another factor could have been the additional impact of large-scale purchases of agency debt and agency MBS under LSAP1. While one-day reactions of 15- and 30-year mortgage rates to LSAP1 and LSAP2 announcements were small, two-day responses were significant. In addition, only one announcement is included in the analysis for the US MEP and UK APF2, but the impact was rather small for an initial announcement.

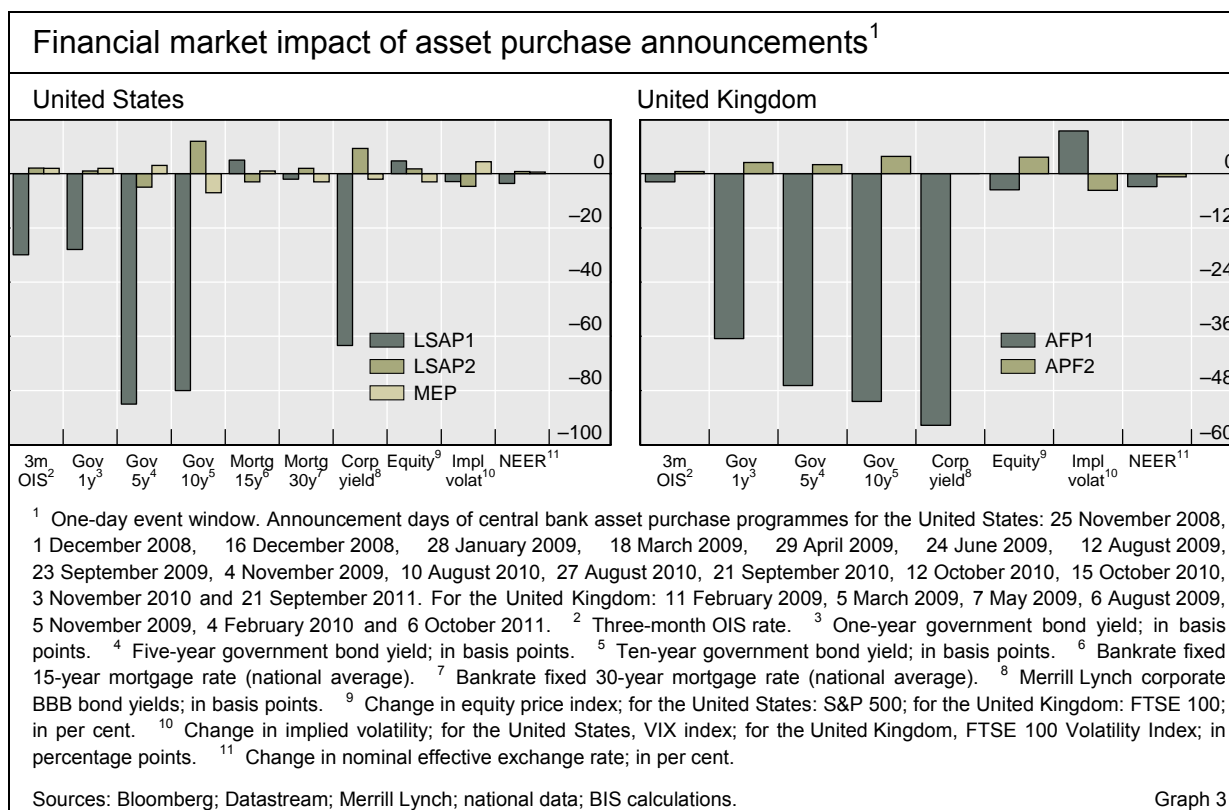
Corporate bond yields dropped ...

... as the portfolio balance channel may have been at work

Third, the impact of the programmes extended well beyond the assets purchased. The announcements led to sizeable reductions in corporate bond yields: US BBB bond yields fell by 63 basis points in one day and almost 100 in two days after the LSAP1 announcements. Similarly, APF1 announcements prompted declines in UK BBB bond yields of 56 basis points in one day and 98 in two days. This could reflect investors' portfolio rebalancing set in motion by central bank actions. The announcements preceded significant depreciations in the nominal effective exchange rates of the US dollar (7.7% in two days) during LSAP1 and sterling (3.7%) during APF1, but had little impact with later programmes. Equity prices rallied strongly during LSAP1 and APF2, but fell with MEP and APF1.

Fourth, the programmes apparently had a stabilising effect on financial markets. Implied volatility of stock prices, taken as a proxy for overall uncertainty in financial markets, fell after the announcements of LSAP1 and APF2, but not APF1.

Two caveats are in order concerning the event study estimates. First, the announcement effects of asset purchases were sometimes "contaminated" by the impact of concurrent central bank statements on the economic outlook and policy actions other than asset purchases. Second, some announcements were



noisier and had a lower degree of precision, and markets therefore faced greater uncertainty. For instance, in some cases central banks had yet to determine the size and operating procedures of such programmes.

The impact of asset purchases

In this section, we estimate the impact on government bond yields of actual bond purchases under the various programmes. We focus on the stock effect, ie the impact on yields associated with a lasting reduction in the bond supply.⁶ D'Amico and King (2010) find large stock effects: the Fed's \$300 billion Treasury purchases during LSAP1 lowered yields, on average, by about 30 basis points across the yield curve, and as much as 50 basis points for bonds with 10–15 years of remaining maturity. This is equivalent to a reduction of about 200 basis points in the federal funds rate.

We first replicate the D'Amico and King (2010) results for LSAP1. We then estimate the stock effects of LSAP2, ie the Fed asset purchase initiative between November 2010 and June 2011, and of the Bank of England's gilt purchases under APF1, which ran from March 2009 to January 2010. The purchase data are of daily frequency for individual government securities, each identified by a unique US CUSIP or UK ISIN code.

The impact of US LSAP2 and UK APF1

Ultimately, what matters for the macroeconomic impact of the asset purchase programmes is whether they achieve a lasting reduction in yields. The price or yield impact of a reduction in bond supply may occur on the day of the policy announcement, at the time of actual purchases or after their completion, or a mixture of all three. While event studies measure the market impact of the presence of asset purchase programmes as perceived by market participants, a cross-sectional regression which covers a period starting from immediately prior to the announcement of treasury purchases to the day of final purchase allows us to capture the full impact of treasury purchase programmes on the yield curve, in particular that of the actual purchases.

Stock effects matter

Following D'Amico and King (2010), we use cross section two-stage least squares to estimate the stock effects of US LSAP2 and UK APF1. In the first stage, we instrument the level of purchases to take account of any endogeneity arising from the fact that central banks might have preferred to purchase those securities that were undervalued and were therefore likely to see a price rise

⁶ Meaning and Zhu (2011) estimate the flow effects (ie responses of yields to each new set of bond purchases) of UK and US asset purchases. They find that all three programmes exhibit significant flow effects: an LSAP1 operation with typical asset purchase composition lowered yields by 3.5 basis points on the day of purchase, and a typical LSAP2 operation reduced yields by 4.7 basis points. A typical APF1 operation, on the other hand, led to a yield decrease of 1.5 basis points.

even in the absence of central bank purchases.⁷ In the second stage, we run regressions of the following form:⁸

$$\frac{\Delta p_i}{p_{i,0}} = \mu + \kappa \widehat{Q}_i + \kappa_s \widehat{Q}_s + \gamma_1 RM_i + \gamma_2 RM_i^2 + \zeta_i \quad (1)$$

where Δp_i is the price change for security i during a purchase programme, $p_{i,0}$ is its price just before the start of the programme, \widehat{Q}_i is the instrumented value of purchases of security i and \widehat{Q}_s is that of near-substitute purchases during an asset purchase programme,⁹ and RM_i is the remaining maturity of security i . Based on the estimates of bond price changes, we construct a set of counterfactual yields, ie those that would have prevailed in the absence of the asset purchase programmes. To do so, we first estimate bond price changes due to asset purchases, and then subtract these from the observed yields.

LSAP2 and APF1 led to sizeable declines in bond yields ...

Several key points emerge from the analysis. First, US and UK asset purchase programmes resulted in significant declines in yields as the central banks removed part of the supply of treasury securities from the market (Table 1). LSAP2 on average lowered the yield curve by 21 basis points, with a maximum impact of 108 basis points for some securities with remaining maturity of around 20 years. APF1 on average lowered yields by 27 basis points for gilts with a remaining maturity of five to 25 years. APF1 had its greatest impact on the yields for gilts of about 12 years to maturity, which were reduced by as much as 74 basis points.

When interpreting these estimates, one has to bear in mind that the different programmes varied in size. LSAP2 was approximately twice as large as LSAP1.¹⁰ This means that, on average, LSAP2 was less effective per billion dollars spent than LSAP1, although the maximum impact was similar. The greater effectiveness of LSAP1 in reducing bond yields could be partly attributed to the additional impact from Fed purchases of agency debt and

⁷ Results from the first-stage regressions suggest that the asset purchase programmes indeed successfully targeted underpriced maturity segments.

⁸ Considering the possibility that our coefficients of interest, κ and κ_s , may vary for different maturities, for LSAP we include interaction dummies which separate securities with less than 15 years of remaining maturity from the rest. For APF1, we use interactive dummies to separate gilts which were within the APF initial purchase range from those which were not. We do not control for factors such as changes in the growth outlook or inflation expectations. These variables may have had a significant impact on yields as they changed over the course of each programme, but cross section regressions could only take account of the impact of the change in the growth outlook at the end of the programme compared to that at the beginning, and could only provide the same average estimated impact across different maturities.

⁹ Near substitutes are defined as securities with a remaining maturity within two years of the remaining maturity of the security in question.

¹⁰ The amount of \$600 billion in Treasuries may understate the true extent of supply withdrawn by the Fed as LSAP2 was supplemented by additional securities bought by the Fed reinvesting funds originated from other Fed programmes. Taking this into account, the Fed purchases made over the course of LSAP2 were just under \$750 billion.

The stock effects of US and UK asset purchases ¹						
	Own sector	Near substitutes	Remaining maturity	Remaining maturity squared	Adjusted R ²	No observations
US LSAP2						
< 15 years remaining maturity	2.351 (1.049)	0.031 (0.022)				
> 15 years remaining maturity	3.215 (0.022)	-0.146 (0.231)	-0.146 (0.000)	0.0000913 (0.000)	0.63	188
UK APF1						
IPR ²	0.1583 (0.062)	-0.02830 (0.025)				
Non-IPR	-	0.010 (0.022)	-	-	0.21	31
¹ Standard errors are reported in parentheses. ² IPR indicates "initial purchase range" of between five and 25 years' remaining maturity, as laid out by the Bank of England for gilt purchases. The range was later extended to three–25 years. Table 1						

agency MBS. The programme sizes of LSAP1 and APF1 were similar, and their average and maximum yield effects were of roughly the same magnitude.

Our results are largely in line with those of previous work. For instance, Williams (2011) adjust the existing estimates by the size of asset purchase programmes: for a \$600 billion operation, the estimated impact on longer-term bond yields ranges from 14 basis points in Greenwood and Vayanos (2008) and 15 basis points in Krishnamurthy and Vissing-Jorgensen (2011) to 18 basis points in Gagnon et al (2011) for US asset purchases, and 40 basis points in Joyce et al (2011) for UK purchases.

Third, the effectiveness of the three asset purchase programmes also differs if we compare them in terms of their size relative to total treasuries outstanding. The Bank of England's purchases under APF1 represented about 29% of the free float of gilts. The announced purchases of LSAP1 and LSAP2, on the other hand, accounted for about 4.7% and 6.6%, respectively, of the US Treasury debt outstanding at the start of each programme. According to this metric, APF1 was less effective than the two US programmes.

... but might be subject to diminishing returns

The impact of Operation Twist¹¹

On 21 September 2011, the Federal Reserve announced a \$400 billion maturity extension program (MEP), also known as Operation Twist since it is similar to the programme of the same name implemented in the early 1960s.¹² Compared to the recent LSAP and APF, the new Operation Twist has

Operation Twist ...

¹¹ Meaning and Zhu (2011) distinguish the quantity effects of asset purchases from the impact of a maturity transformation of the Federal Reserve holdings of Treasuries. They find that the MEP could have a large impact on the 10-year Treasury yield, but its success will depend crucially on the Treasury's debt management policy.

¹² The original Operation Twist, implemented under the Kennedy Administration, aimed at lowering longer-term yields while maintaining the existing level of short-term interest rates. The Fed bought about \$8.8 billion of longer-term Treasury securities and reduced its holdings

the distinct feature of keeping the size of the Federal Reserve balance sheet unchanged, as the purchases of longer-term Treasury securities will be financed with the proceeds from selling shorter-term ones rather than through increases in reserves.

Will the MEP be as effective as the asset purchase programmes implemented so far? We evaluate the MEP based on the likely stock effects arising from the \$400 billion simultaneous purchases of longer-dated bonds and sales of short-term Treasury securities. First, we assume that these purchases follow the maturity distribution of MEP purchases published by the Federal Reserve. We then distribute the \$400 billion of sales uniformly among the Federal Reserve's existing stock of securities with a remaining maturity between three months and three years. Finally, we estimate the impact of the MEP using previous estimates from the LSAP2 stock effect regressions.

... could have a large impact on the yield curve

The simulations suggest that on average, yields may drop 22 basis points for securities with a remaining maturity over eight years, consistent with the estimated stock effects of previous programmes. However, selling securities at the short end would raise yields in the three-month to three-year sector by around 60 basis points on average. This compares to Hamilton and Wu's (2011) estimates of a 14 basis point drop in the 10-year yield and an 11 basis point increase in the six-month rate. However, the Federal Reserve expects a small impact of the sales on the yields of short-term securities. This expectation probably relies on the Federal Reserve's commitment to maintain "exceptionally low levels for the federal funds rate at least through mid-2013", which should anchor short-term yields.

Conclusion

The asset purchase programmes implemented by the Federal Reserve and the Bank of England significantly reduced yields of longer-term bonds. Government bond yields fell significantly and the prices of some risky assets increased as the programmes were announced. The purchase programmes had a lasting and large yield impact by withdrawing bond supply from the market. The impact per billion dollars spent of the US and UK asset purchase programmes was comparable. In terms of programme size relative to the amount of outstanding debt, however, the purchases might be subject to diminishing returns as central banks hold a larger share of the sovereign debt. Looking ahead, our estimates suggest that the impact on bond yields of the new Operation Twist can be expected to be comparable to previous LSAP programmes.

Recent asset purchases seem to have been effective, but there are limitations for further actions. First, long-term government bond yields are already very low, and the scope for further reduction becomes smaller as more purchases are carried out. Second, it may be harder to achieve the same degree of effectiveness as with the initial programmes once the surprise or

of short-term Treasury bills by \$7.4 billion. Early studies, eg Modigliani and Sutch (1966, 1967), show that the operation had little impact on long-term bond yields. However, based on event studies with high-frequency data, Swanson (2011) estimates that it could have lowered US 10-year Treasury bond yields by about 15 basis points.

novelty element wanes. Third, central banks face some risks associated with large holdings of longer-term securities and riskier private debt. For instance, a sharp balance sheet expansion due to outright asset purchases, if it persists, may affect inflation expectations. Also, it can be difficult to unwind large asset holdings in a way that does not roil markets.

Given these caveats, central bank asset purchases are unlikely to replace conventional interest rate policy in normal times. That said, they have proven to be useful tools in these extraordinary times to tackle the unique problems arising from the global financial crisis and the ensuing recession.

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