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The impact of Federal Reserve asset purchase programmes: another twist[1]

This article examines the effectiveness of recent Federal Reserve asset purchase programmes. We estimate that once we control for factors such as the size and the maturity profile of Treasury issuance, the new Maturity Extension Program (MEP) could have an impact comparable to the one we estimate for the Large-Scale Asset Purchase (LSAP) programme. The effectiveness of such programmes is limited by Treasury debt management policy. Indeed, the Treasury's extension of the average maturity of outstanding debt during LSAP is likely to have pushed up the 10-year bond yield significantly.

JEL classification: E52, E63.

Just before making its most recent policy rate cut in December 2008, the Federal Reserve started a series of asset purchase programmes that focus on longer-term securities including government bonds (Graph 1). How effective will the recent programmes, especially the Maturity Extension Program (MEP), be in lowering interest rates?

We seek to answer this question using estimates from a simple model of US Treasury bond yield dynamics. We find, first, that the likely impact of the MEP on the 10-year government bond yield is sizeable. Second, the estimated impact on yields is comparable to that of the previous asset purchase programmes. And the effectiveness of Federal Reserve asset purchases is limited by the Treasury's debt management policy. Indeed, we estimate that the Treasury's extension of the average maturity of outstanding debt during the Large-Scale Asset Purchase (LSAP) programme pushed the 10-year bond yield up by 27 basis points during the first stage of the programme (LSAP1) and by 14 basis points during the second stage (LSAP2).

[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 Claudio Borio, Jagjit Chadha, Stephen Cecchetti, Bob McCauley, Bill Nelson and Christian Upper for useful comments on earlier drafts of this article, and to Jakub Demski for expert assistance with data and graphs.

Federal Reserve asset purchase programmes

A new Operation Twist focuses on the composition of Fed asset holdings

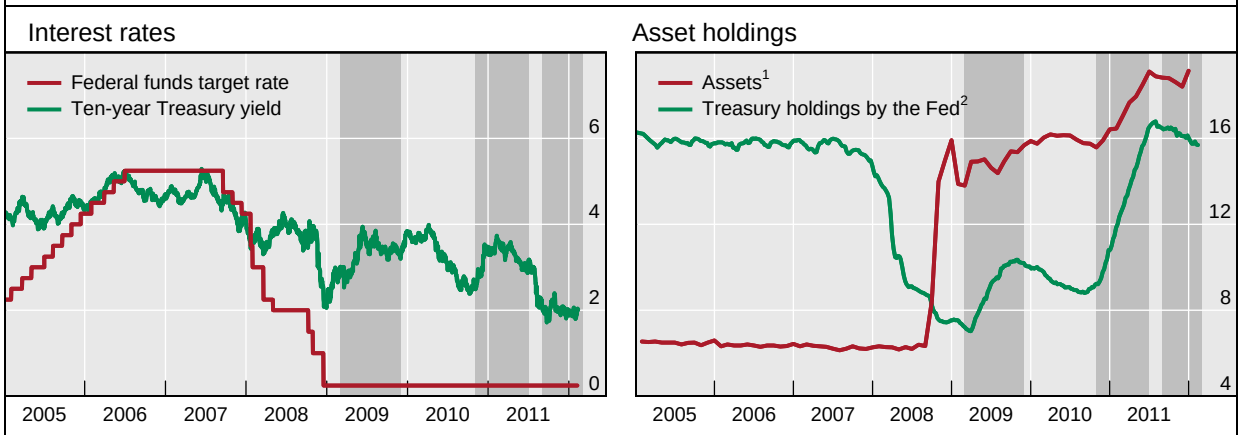
On 21 September 2011, the Federal Open Market Committee (FOMC) announced the new MEP, which seeks to increase the average maturity of the Federal Reserve portfolio of Treasury securities by 25 months to about 100 months by the end of 2012. To do so, the FOMC planned to buy $400 billion in Treasury securities with remaining maturities of 72 to 360 months and to sell an equal amount of Treasuries with remaining maturities of three to 36 months. About 64% of the purchases were allocated to the six- to 10-year segment, and another 29% to the 20- to 30-year segment.

The MEP differs from the previous LSAP programme. When LSAP was established in November 2008, the FOMC intended to acquire up to $600 billion in agency mortgage-backed securities and agency debt. From March 2009 to March 2010, it committed an additional $850 billion to purchases of agency securities, and a further $300 billion to acquiring longer-term Treasury securities (LSAP1). As the recovery faltered, in November 2010 the FOMC put in place LSAP2, which consisted of further purchases of $600 billion in longer-term Treasury securities until mid-2011. The Federal Reserve's asset holdings expanded rapidly as a consequence of these purchases, reaching about 17% of Treasury securities outstanding by mid-2011 (Graph 1).

Unlike the LSAP programme, the MEP explicitly aims at extending the average maturity of the Fed's Treasury holdings without changing the overall size of the central bank's balance sheet. In this regard it is essentially a new version of Operation Twist, implemented in the early 1960s, which sought to "twist" the yield curve by nudging the longer-term yields lower while keeping the short rates at existing levels. Under that programme, the Fed bought about $8.8 billion of longer-term Treasury securities and reduced its holdings of short-term Treasury bills by $7.4 billion. The size of purchases was comparable

Federal Reserve monetary policy measures

In per cent



The shaded areas represent LSAP1: March 2009–November 2009; LSAP2: November 2010–June 2011; and MEP: September 2011–June 2012.

[1] Federal Reserve total assets as a share of GDP. [2] Federal Reserve Treasury securities holdings as a share of Treasury securities outstanding, excluding intragovernmental holdings.

Sources: Federal Reserve Board; US Department of the Treasury; Bloomberg; national data. Graph 1

to the LSAP programmes, relative to GDP and to Treasury debt outstanding.

Early studies, such as Modigliani and Sutch (1966, 1967), find that Operation Twist 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 the US 10-year Treasury bond yield by about 15 basis points.

The likely impact of the MEP

How effective will the MEP be? Will it have a greater impact on Treasury bond yields than outright asset purchases under the LSAP programme? We evaluate the likely effects of the programme by estimating the impact on 10-year Treasury bond yields of the targeted 25-month maturity extension of the Fed portfolio of Treasury securities.

The effectiveness of the MEP

Central banks can affect government bond yields by changing either the size or the composition of their bond holdings, or both. The maturity structure of the Federal Reserve's Treasury holdings is a good indicator of the portfolio's composition. We estimate a dynamic model of yield determination to gauge the impact on the 10-year Treasury bond yield of changes in the average maturities of the Fed holdings of Treasury securities and of Treasury securities outstanding (see box). We control for the size of the Fed Treasury holdings relative to Treasury debt outstanding, the effective federal funds rate and a number of other factors reflecting macroeconomic and market conditions.

Fed maturity extension reduces bond yields …

Our estimates indicate, first, that the maturity structure of Fed Treasury holdings matters for Treasury bond yields.[2] Lengthening the average maturity of the Fed holdings by one month lowers the 10-year bond yield by 3.4 basis points, all other things being equal (Table 1). Assuming that the relationship is linear and ceteris paribus, the planned 25-month extension of the average

Estimated long-run coefficients from error correction model[1]

Impact on 10-year Treasury bond yield

Sample period	Average maturity of Fed Treasury holdings	Average maturity of Treasuries outstanding	Fed holdings relative to Treasuries outstanding	Fed funds rate
Jan 1990–Jun 2011	–0.034	0.070	–0.202	0.220
	(0.004)	(0.007)	(0.012)	(0.024)
Jan 1990–Jun 2007	–0.080	0.093	–0.126	0.262
	(0.018)	(0.013)	(0.035)	(0.027)

[1] Standard errors are reported in parentheses.

Source: Meaning and Zhu (2012). Table 1

[2] Kuttner (2006) finds that Fed purchases of long-term bonds have a significant impact on the term premia, but the effects of changes in the outstanding publicly held Treasury debt are insignificant.

Estimating the yield impact of Fed bond purchases

Using monthly US data from January 1990 to June 2011, we apply the Engle-Granger (1987) two-step procedure to estimate an error correction model of the dynamics of the 10-year Treasury bond yield. In the first step, we estimate a co-integrating vector, interpreted as the "long-run" equilibrium relationship, of the following form:

$$y_t^{10Y} = \alpha + \beta^F M_t^F + \beta^T M_t^T + \delta F_t + \kappa i_t + \gamma C_t + \varepsilon_t \qquad (1)$$

where y_t^{10Y} is the yield for a bond of 10 years remaining maturity at time t, M^F is the average maturity of the Fed holdings of Treasury securities, M^T is the average maturity of outstanding Treasury securities, F is the size of the Fed Treasury holdings relative to total Treasury debt outstanding, and i is the effective federal funds rate. The coefficients on these variables capture the individual impact on yields of Fed maturity transformation, Treasury debt maturity transformation, the relative size of Fed holdings of Treasury securities, and conventional interest rate policy.

Model (1) is similar to those of Kuttner (2006) and Greenwood and Vayanos (2008), and shares their limitations. First, changes in the maturity structure and size of Fed asset holdings and Treasury debt outstanding are not independent from each other. The overall effect of MEP will be smaller than the partial effect indicated by the coefficient β^F if the Treasury extends the maturity or increases the size of its outstanding debt. Unlike Kuttner (2006), we include F to control for effects arising from changes in the size of Fed holdings relative to the amount outstanding of Treasuries. It is important to bear in mind that F depends on both Fed and Treasury actions.[①]

In addition, M^F, M^T and F may be correlated with some omitted variables. We consider a set of control variables C which include the consensus forecasts of one-year-ahead inflation and real GDP growth rates, the VIX (an index of implied volatility), and the Cochrane-Piazzesi (2005) forward rate factor. First, a rise in expected inflation can increase long yields by raising the expected level of future short interest rates. Second, higher growth expectations could be associated with a rise in expected inflation, tighter monetary policy and higher interest rates. There is also evidence that expected real output growth plays a significant role in explaining time variation in bond risk premia. Third, implied volatility captures a "flight to safety" factor, as rising market strains may drive investors to shift to safe haven assets such as Treasury securities, depressing their yields. Fourth, Fama and Bliss (1987) and Cochrane and Piazzesi (2005) show that forward rates implied from the yield curve have significant predictive power for bond term or risk premia. Implied forward rates, along with lagged 10-year yields and lagged federal funds rates, convey information on the future path of the policy rate. We find that these variables are statistically significant and have signs in line with our priors, but they do not significantly affect the coefficient estimates on M^F, M^T and F.

Most of the included variables are tested to be non-stationary. In the second step, we formulate an error correction model that captures the dynamics of their interactions:

$$\Delta y_t^{10Y} = \sigma + \sum_{i=1}^{I} \rho_i \Delta y_{t-i}^{10Y} + \sum_{j=0}^{J} \beta_j^F \Delta M_{t-j}^F + \sum_{k=0}^{K} \beta_k^T \Delta M_{t-k}^T + \sum_{l=0}^{L} \delta_l \Delta F_{t-l} + \sum_{m=0}^{M} \kappa_m \Delta i_{t-m} + \sum_{f=0}^{F} \theta_f \Delta C_{t-f} + \phi_g \hat{\varepsilon}_{t-1} + \xi_t \qquad (2)$$

where $\hat{\varepsilon}_t$s are the regression residuals from (1) and represent the estimated error correction term, ie deviations of actual yields from their estimated implied equilibrium level. We use information criteria to select the "optimal" lag structure, which typically includes one or two lags for each variable. We focus our discussion based on estimates from the equilibrium co-integrating relationships.

One concern is that the model estimates may not be stable over time. We estimate the model with data from January 1990 to June 2007, before the large jump in the average maturity of Fed Treasury holdings. There is evidence that changes in the maturity structure of Fed holdings and

Treasury debt outstanding actually had more of an effect in this earlier period when Fed maturity extension or asset purchases were not used as policy tools (Table 1).

[①] We interpret the coefficient on F as representing the quantity effect on yields of the proportional reduction in Treasury debt supply resulting from Fed outright asset purchases. Whether this correctly measures the impact of the LSAP is debatable, as the ratio depends on both Fed and Treasury actions. But the Fed purchases take Treasury actions as given, and the size of intervention relative to total supply is a key determinant for yields. We conduct a number of robustness checks. First, we run regressions with the Fed holdings and Treasury debt outstanding, in logarithms, as two separate variables. The coefficient estimates on the two variables are significant and have the right signs, and those on the maturity variables are in line with the presented results. Second, we normalise the average maturity of Fed holdings by the Fed's market share, and the new variables are again significant with the right sign. More details are provided in Meaning and Zhu (2012).

maturity under the MEP could reduce the 10-year bond yield by 85 basis points, assuming that the stock and maturity of the outstanding Treasury debt remain unchanged.[3]

... as do changes in the size of Fed Treasury holdings

This caveat is important because our estimates, second, show that changes in the size of the Fed Treasury holdings relative to total Treasury debt outstanding can have a significant effect on yields. An increase of 1% in the ratio of Fed holdings to Treasuries outstanding reduces yields by 20 basis points for bonds of 10-year residual maturity. This effect was significantly smaller in the pre-crisis period, probably because bond purchases were not considered a policy tool at that time.[4] Indeed, as shown in Meaning and Zhu (2011), mere announcements of Fed asset purchases following the global crisis had sizeable effects on yields, on top of the impact of actual purchases.

Admittedly, the estimated model is quite simple, and may fail to control for other drivers of yields. That said, the results suggest that Fed asset purchase programmes have been effective. We estimate that in the absence of any Fed purchases, the 10-year Treasury yield would have been 180 basis points higher by mid-2011 (Graph 2). During LSAP1 and LSAP2, the proportion of outstanding Treasury debt held by the Federal Reserve increased by 3.0 and 7.7 percentage points (Graph 1), respectively, implying reductions of 60 and 156 basis points in the 10-yield Treasury yield (Graph 2). On the other hand, Fed outright asset purchases had little effect on the maturity structure of Fed Treasury holdings. The average maturity of these holdings increased by only two months during LSAP1 and actually declined by over six months during LSAP2 (Graph 3), so the yield effects of maturity transformation were small.

Taking account of the sizes of outright asset purchases during LSAP1 and LSAP2, and the planned size of the MEP asset trade to support the maturity transformation of Fed Treasury holdings, the programmes' effects on the 10-year Treasury yield are of similar magnitude.

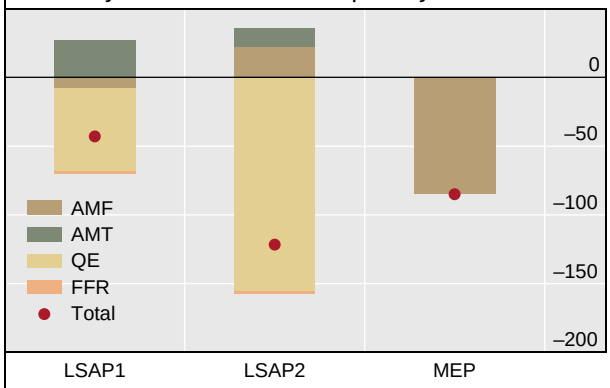
[3] See Meaning and Zhu (2012) for more details. Applying the same model to different maturities, they find that the MEP could have a significant impact on the entire Treasury yield curve.

[4] Interest rate policy appears to have been slightly more effective before the crisis. We estimate that lowering the federal funds rate by 100 basis points leads to a 22 basis point reduction in the 10-year bond yield. This compares to the pre-crisis sample estimate of 26 basis points.

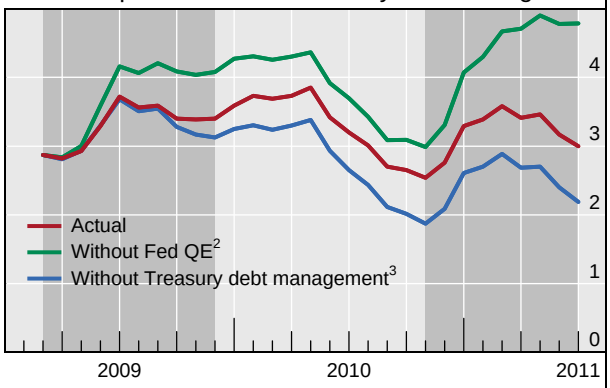
The impact of Federal Reserve asset purchase programmes

Ten-year Treasury bond yield

Maturity transformation and quantity effects[1]



Fed asset purchases and Treasury debt management



The shaded areas represent LSAP1: March 2009–November 2009; and LSAP2: November 2010–June 2011.

[1] AMF is the impact of changes in the average maturity of the Federal Reserve's Treasury securities portfolio; AMT is the impact of changes in the average maturity of Treasury debt outstanding; QE is the impact of changes in the size of the Federal Reserve's Treasuries portfolio relative to total Treasury debt outstanding; FFR measures the impact of changes in the federal funds rate. The projected impact of the MEP is based on the Federal Reserve decision to extend the average maturity of its Treasury debt portfolio by 25 months assuming the Treasury does not change the size and maturity profile of the debt outstanding. [2] Counterfactual 10-year Treasury bond yield keeping the average maturity of Fed holdings of Treasuries and the size of the Fed bond holdings relative to total Treasury debt outstanding constant at the February 2009 levels. [3] Counterfactual 10-year Treasury bond yields keeping the average maturity of Treasury debt outstanding constant at the February 2009 level.

Source: Authors' calculations. Graph 2

Asset purchases and Treasury debt management policy

Our estimates suggest that the effectiveness of the Federal Reserve's asset purchase programmes is constrained by the Treasury's debt management policy. A one-month maturity extension of Treasury debt outstanding raises the 10-year bond yield by 7 basis points, twice the yield reduction effect of a one-month maturity lengthening of the Fed holdings. This is unsurprising as the Fed portfolio makes up between 7 and 18% of the overall Treasuries market over our sample period.[5]

The impact of bond purchases on the 10-year bond yield would have been greater had the Treasury not expanded the supply of Treasuries – especially the longer-term securities – thereby increasing the maturity of Treasury debt outstanding during LSAP1 and LSAP2 (Graph 2). The net effects on 10-year bond yields of −43 basis points during LSAP1 and −121 basis points during LSAP2 are consistent with the estimates of D'Amico and King (2010) and Meaning and Zhu (2011, 2012).

Sovereign debt managers and monetary policymakers do not share the same goals.[6] Seeking to minimise borrowing costs and maximise returns, Treasury debt managers could be tempted to take advantage of the lower long

[5] That said, maturity transformation of Fed Treasury holdings via bond purchases seems to have a greater impact on yields per dollar spent than that of Treasury debt outstanding.

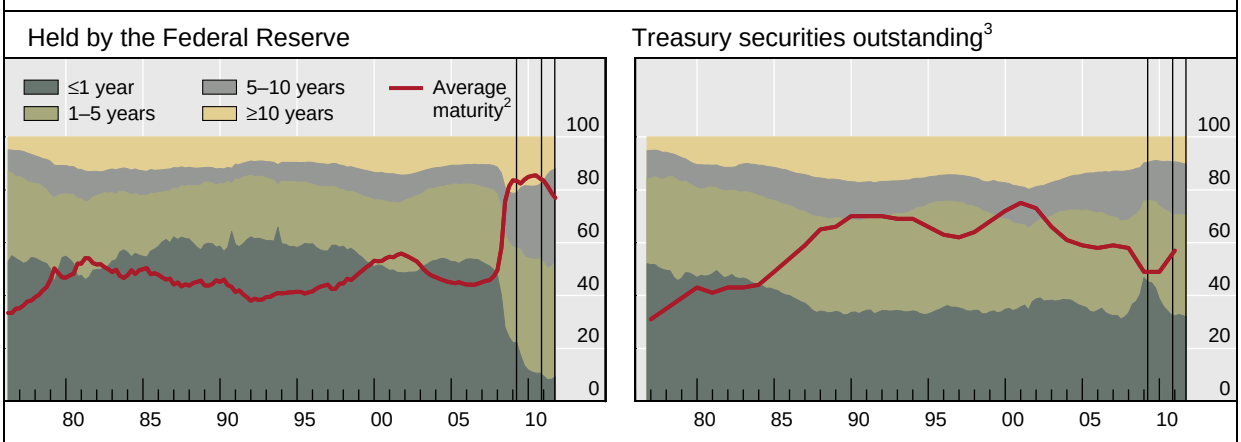
[6] Fisher (2002) argues that "the Treasury's debt management serves a single, overriding objective", which is "to meet the financing needs of the federal government at the lowest cost over time".

Treasury debt management limits the impact of Fed asset purchases

rates afforded by Fed bond purchase programmes by issuing more longer-term debt.[7] As a matter of fact, the Treasury increased the average maturity of outstanding debt during LSAP1 and LSAP2 from 47 months in March 2009 to almost 59 months in June 2011 (Graph 3). We estimate that, all other things being equal, this would have pushed the 10-year bond yield up by 27 basis points during LSAP1 and 14 basis points during LSAP2 (Graph 2, left-hand panel). Were it not for the Treasury's debt maturity extension, the 10-year yield would have been 80 basis points lower by mid-2011 (Graph 2, right-hand panel). The same lesson can be learned from the implementation of the original Operation Twist: its apparent lack of success can be partly attributed to the Treasury raising the average maturity of marketable debt from 41 months in 1960 to 55 months in 1963.[8]

The average maturity of Treasury debt outstanding remains well below the average level over the two decades preceding the crisis (Graph 3). Looking ahead, the Treasury may continue to favour issuance of longer-dated debt, and the average maturity of Treasury debt outstanding may rise further. The Treasury issued $310 billion in net marketable debt in the fourth quarter of 2011. It expects to issue an additional $444 billion in debt in the first quarter of 2012 and $200 billion in the second quarter, with plans for sales of more longer-term notes and bonds. The planned issuance of $644 billion in new debt in the first half of 2012 is larger than the $400 billion MEP. Expanding the size of Treasury debt outstanding would reduce the ratio of Fed Treasury holdings relative to debt outstanding, further diluting the stimulative effects of Fed asset purchases.

Maturity distribution of US Treasury debt securities[1]



[1] Breakdown of securities held outright refers to remaining maturity as a percentage of total; vertical lines mark the first days of the LSAP and MEP programmes: March 2009, November 2010 and September 2011. [2] In months. [3] Excluding intragovernmental holdings.

Sources: Federal Reserve Board; US Department of the Treasury; Datastream. Graph 3

[7] See Borio and Disyatat (2010), Chadha (2011), McCauley and Ueda (2009), Meaning and Zhu (2012) and Turner and Mohanty (2011).

[8] See United States Department of the Treasury (1968).

Conclusion

The Federal Reserve's new Operation Twist, the MEP, may have a significant impact on the 10-year Treasury bond yield, comparable to that of outright asset purchases under the LSAP programme. The MEP does not involve any size changes in the Fed balance sheet, but it is limited by the existing amount of short-maturity assets in the Fed asset portfolio. That said, the effectiveness of the Federal Reserve asset purchase programmes depends on Treasury debt management policy. When the Federal Reserve acts to lower yields for longer-dated bonds and the Treasury has large longer-term borrowing needs, a conflict of interests may emerge.