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Reactions of real yields and inflation expectations to forward guidance in the United States

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We study the impact of forward policy rate guidance by the Federal Reserve's Federal Open Market Committee (FOMC) used as an unconventional monetary policy tool at the zero lower bound of the policy rate on real and breakeven US Treasury yield curves. We find that explicit FOMC policy rate guidance announcements led to a significant reduction in real yields at horizons of 2 to 5 years ahead. By contrast, long-term breakeven inflation rates were little affected, suggesting that inflation expectations have remained well anchored, and that explicit FOMC policy rate guidance has not adversely affected central bank credibility.

Keywords: monetary policy; central bank communication; forward guidance; real yields; inflation expectations

JEL Classification: E52; E58

I. Introduction

Explicit policy rate guidance has become an important unconventional monetary policy tool since the zero lower bound was reached in the United States, and it is hoped that by affecting long-term interest rates, it can affect aggregate demand (Yellen, 2013). With reaching the zero lower bound on the policy rate in the wake of the global financial crisis, the Federal Reserve's Federal Open Market Committee (FOMC) could not decrease the short-term nominal rate further, and therefore could not decrease the short-term real interest rate further to stimulate the economy without raising inflation expectations. But by using forward policy rate guidance at the zero lower bound, the FOMC might be able to lower longer-term real interest rates further, without raising inflation expectations (Rajan, 2013). This is possible since longer-term nominal interest rates in the United States remained above zero even when the policy rate had reached the zero lower bound. This contrasts with Japan, where long-term bond yields are already very low, and can therefore not be lowered much further. In Japan, where deflationary expectations have become entrenched, the Bank of Japan would like to raise inflation expectations to the inflation target of 2% (Rajan, 2013). In January 2013, the Bank of Japan introduced an inflation target of 2%, and committed to 'pursue monetary easing and aim to achieve this target at the earliest possible time' (Bank of Japan, 2013). The European Central Bank introduced forward guidance in July 2013

(Draghi, 2013), and the Bank of England introduced forward guidance in August 2013 (Bank of England, 2013).

Eggertsson and Woodford (2003) show within a New-Keynesian model that it is desirable for a central bank at the zero lower bound of the policy rate to commit to future monetary accommodation once the zero lower bound ends. They derive optimal monetary policy in the event of a temporary decline in the natural rate of interest, under the assumption that credible commitment is possible, and find that this optimal policy involves a commitment to eventually bring the general price level back up to a level even higher than would have prevailed if the disturbance had not occurred. Such a policy is time-inconsistent; in the words of Krugman (1998, p. 139), 'monetary policy will in fact be effective if the central bank can credibly promise to be irresponsible, to seek a higher future price level.' In this article, we investigate whether forward guidance by the FOMC at the zero lower bound reduced the FOMC's inflation-fighting credibility, as measured by an increase in medium- and long-term inflation expectations, which would suggest that it was seen as a commitment to be irresponsible in the spirit of Eggertsson and Woodford (2003) and Krugman (1998), or whether the FOMC was able to lower longer-term real interest rates further without raising inflation expectations, as suggested by Rajan (2013) as a possibility.

Forward guidance at the zero lower bound may lead to either an increase or decrease in nominal bond yields in different dynamic stochastic general equilibrium (DSGE) models (De Graeve *et al.*, 2014). Within the New York Fed DSGE model (Del Negro *et al.*, 2012), stimulatory forward guidance leads to a decrease in nominal long-term bond yields, whereas within the models of Smets and Wouters (2007), it leads to an increase in nominal long-term bond yields (De Graeve *et al.*, 2014). By contrast, the more robust result from such structural models is that forward guidance at the zero lower bound leads to a reduction in real bond yields (De Graeve *et al.*, 2014). In this article, we investigate whether the effect of the FOMC's explicit forward guidance on long-term real yields is consistent with this more robust prediction by DSGE models of a fall in real long-term bond yields.

In practice, central banks have emphasized that their policy rate guidance is conditional on economic developments, rather than being an unconditional commitment. The FOMC explicitly linked its forward guidance to an unemployment rate threshold in December 2012 (Federal Open Market Committee, 2012). The Bank of Canada made its forward guidance conditional on the outlook for inflation (Carney, 2012).

Woodford (2012) considers the effects of forward policy rate guidance internationally and discusses relevant papers. Bank of England (2013) provides an overview of the literature on the effects of forward policy rate guidance internationally. Recent papers examining the effect of central bank interest rate projections on nominal market interest rates include Detmers and Nautz (2012, 2013) for the Reserve Bank of New Zealand, which has the longest history of publishing interest rate forecasts, starting in 1997. An overview of the literature on central bank communication more generally is provided in Blinder *et al.* (2008). Bernanke *et al.* (2004) study the effect of central bank communication more generally to shape public expectations about the future course of interest rates in the United States and Japan, using event studies and by estimating no-arbitrage term structure models. They find a potentially important role for central bank communication in the United States to try to shape public expectations of future policy actions, as do Gürkaynak *et al.* (2005) and Campbell *et al.* (2012).

Research on the effects of unconventional monetary policy at the zero lower bound of the policy rate on real yields and breakeven inflation rates has focussed on the effects of quantitative easing, rather than on the effects of explicit policy rate guidance. Neely (2010) finds that large-scale asset purchase (LSAP) buy announcements reduced long-term real US Treasury yields. Krishnamurthy and Vissing-Jorgensen (2011) find that an inflation channel operated in the Federal Reserve's first two Quantitative Easing programmes (QE1 and QE2), with evidence from both inflation swap rates and Treasury Inflation Protected Securities (TIPS) yields showing that expected inflation increased, implying larger reductions in real than in nominal yields. Using a structural VAR to identify the effects of monetary policy shocks for the period November 2008 to December 2010, Wright (2012) finds slight evidence that stimulative monetary policy shocks led to a rotation in breakeven rates derived from TIPS, with short-term breakeven rates rising and long-term forward breakeven rates falling. Hofmann and Zhu (2013) have

studied whether central bank asset purchases have led to higher inflation expectations in the United States and the United Kingdom. They find that central bank asset purchases had significant effects, but that their quantitative importance was uncertain. They conclude that the reaction of inflation swap rates on the days of programme announcements suggests that central bank asset purchases were probably not the main driver of the shifts in inflation expectations.

Recent research on the effects of quantitative easing by the Federal Reserve finds a greater role for a signalling channel and for forward policy rate guidance in its effects on government bond yields than earlier research did. Bauer and Rudebusch (2012) find that Federal Reserve government bond purchases have important signalling effects which lower expected future short-term interest rates, and that the signalling channel is more important than earlier research had suggested. Using model-based analysis, Curdia and Ferrero (2013) conclude that forward policy rate guidance is essential for quantitative easing to be effective, and that communication about the beginning of federal funds rate increases will have stronger effects on bond yields than communication about the end of asset purchases.

Moessner (2013a, 2013b) studied the effect of explicit FOMC policy rate guidance announcements on short- to long-term nominal market interest rates, and found that they led to a significant reduction at a range of maturities. The contribution of this article is to quantify the effect of explicit FOMC policy rate guidance announcements used as an unconventional monetary policy tool at the zero lower bound on the two components of nominal bond yields, namely on real US Treasury yields and breakeven US Treasury yields, across the yield curve. To the best of our knowledge, this is the first article to quantify the impact of the FOMC's explicit policy rate guidance announcements at the zero lower bound on real yields and breakeven inflation rates.

We find that explicit FOMC policy rate guidance announcements led to a significant reduction in real yields at horizons of 2–5 years ahead. Such a reduction in real yields is consistent with the result of Moessner (2014) that FOMC forward guidance led to an increase in US equity prices, since lower real yields would be expected to lead to higher equity prices. This finding is also consistent with the more robust result from DSGE models that forward guidance at the zero lower bound leads to a reduction in real long-term bond yields (De Graeve *et al.*, 2014).

By contrast, we find that long-term breakeven inflation rates were little affected, suggesting that inflation expectations have remained well-anchored, and that explicit FOMC policy rate guidance has not adversely affected central bank credibility. This finding favours the view of Rajan (2013) that the FOMC could lower longer-term real interest rates further without raising inflation expectations, rather than a commitment by the FOMC to be irresponsible in the spirit of the theoretical models of Eggertsson and Woodford (2003) and Krugman (1998).

The outline of the article is as follows. Section II presents the data, Section III presents the method, Section IV discusses the results and Section V concludes.

II. Data

Real yields and breakeven inflation rates

We study the reactions of real US Treasury yields across the yield curve derived from US TIPS for instantaneous forward rates 2–10 years ahead (Fig. 1). We also study the reactions of breakeven inflation rates across the yield curve derived from

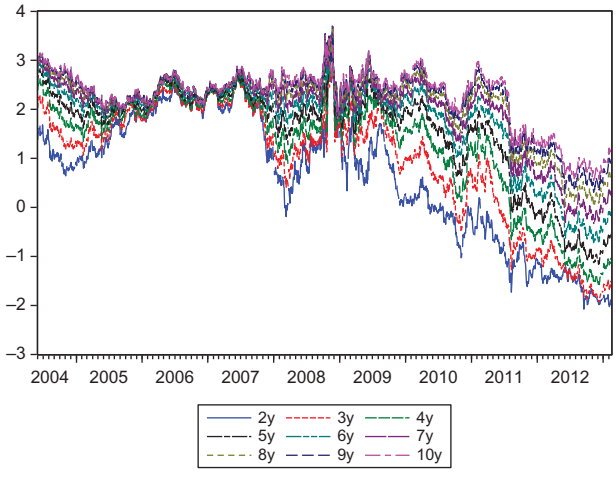

Fig. 1. US Treasury instantaneous forward real rates, 2 to 10 years ahead (in per cent)
Source: Computed following the methodology of Gürkaynak *et al.* (2008) as made available on the Federal Reserve website at http://www.federalreserve.gov/pubs/feds/2008/200805/200805abs.html.

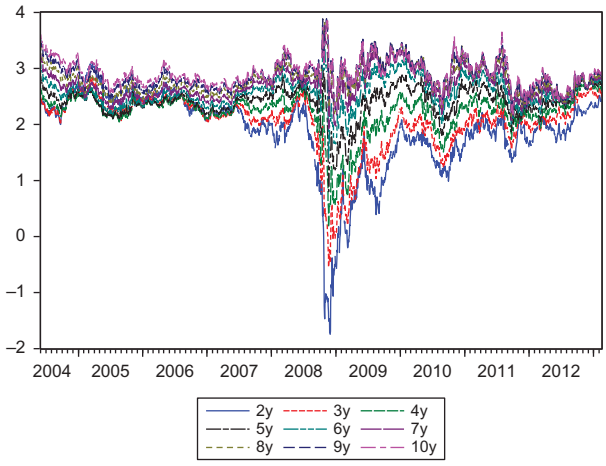

Fig. 2. US Treasury instantaneous forward breakeven inflation rates, 2 to 10 years ahead (in per cent)
Source: Computed following the methodology of Gürkaynak *et al.* (2008) as made available on the Federal Reserve website at http://www.federalreserve.gov/pubs/feds/2008/200805/200805abs.html.

TIPS and conventional US Treasury bonds, again for instantaneous forward rates (Fig. 2), at the same horizons of 2–10 years ahead. The sample period is from the beginning of June 2004 to mid-February 2013.

The real yields and breakeven inflation rates are calculated following the methodology of Gürkaynak *et al.* (2008) as made available on the Federal Reserve website at http://www.federalreserve.gov/pubs/feds/2008/200805/200805abs.html (accessed on 22 April 2013). Gürkaynak *et al.* (2008) use the following method to calculate real yields and breakeven inflation rates. They first fit yield curves to nominal US Treasury prices, using a Nelson–Siegel–Svensson yield curve, which imposes a parametric form for the yield curve, based on Nelson and Siegel (1987) and Svensson (1994). They then calculate continuously compounded instantaneous forward nominal yields from these yield curves, $f^m_{\text{nom}}(t)$, for horizons m years ahead. They also fit yield curves to TIPS prices using a Nelson–Siegel–Svensson yield curve. They then calculate continuously compounded instantaneous forward real yields from these real yield curves, $f^m_{\text{real}}(t)$, for horizons m years ahead. Breakeven inflation rates are then calculated from these nominal and TIPS yields as the inflation rates which, if realized, would leave an investor indifferent between holding a TIPS and a nominal Treasury security. The continuously compounded instantaneous forward breakeven inflation rate is calculated as follows, $\pi_f{}^m(t) = f^m_{\text{nom}}(t) - f^m_{\text{real}}(t)$, for horizons m years ahead.

Market-based daily measures of inflation expectations can be derived from nominal US Treasury bonds and TIPS, as described above, and an alternative measure is based on inflation swaps. Both measures of inflation expectations are imperfect, since they do not just reflect pure expectations, but also contain risk and liquidity premia, which may vary over time. For the period 1997 to mid-2008, Söderlind (2011) documents that US breakeven inflation rates derived from nominal and index-linked government bonds were affected by shifts in inflation risk premia and liquidity premia. Galati *et al.* (2011) note that inflation swap rates include inflation risk premia and liquidity premia, and that it is therefore difficult to draw definitive conclusions regarding the behaviour of inflation expectations by studying inflation swap rates. An advantage of using nominal US Treasury bonds and TIPS to measure inflation expectations is that they do not contain much credit risk, and are therefore closest to risk-free rates. A disadvantage of using nominal US Treasury bonds and TIPS to measure inflation expectations is that the US government bonds can be subject to a flight to safety and liquidity in a crisis, so that their prices can be distorted by changes in risk and liquidity premia due to this. By contrast, inflation swaps contracts involve credit risk, so that inflation expectations implied by inflation swaps may be distorted by credit risk premia.

Macroeconomic news and forward guidance announcements

We control for the effect of macroeconomic news on real yields and breakeven inflation rates by including surprises in 11 US macroeconomic indicators in the regressions, based on Moessner and Nelson (2008). The macroeconomic data surprises are calculated as the difference between the real-time data releases and median Bloomberg survey expectations, normalized by their SD.

For a description of the FOMC's use of explicit forward policy rate guidance as an unconventional monetary policy tool at the zero lower bound of the policy rate, see Yellen (2013). Relevant excerpts for new explicit policy rate guidance announcements from FOMC statements are reproduced in Table 1. After a new wording of the FOMC's explicit policy

Table 1. Explicit FOMC policy rate guidance announcements

Date[a]	FOMC statements[a]
16 December 2008	The Federal Open Market Committee decided today to establish a target range for the federal funds rate of 0 to 1/4 per cent. […] the Committee anticipates that weak economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time […]
18 March 2009	[…] the Committee will maintain the target range for the federal funds rate at 0 to 1/4 per cent and anticipates that economic conditions are likely to warrant exceptionally low levels of the federal funds rate for an extended period.
9 August 2011	The Committee currently anticipates that economic conditions – including low rates of resource utilization and a subdued outlook for inflation over the medium run – are likely to warrant exceptionally low levels for the federal funds rate at least through mid-2013.
25 January 2012	[…] the Committee […] currently anticipates that economic conditions – including low rates of resource utilization and a subdued outlook for inflation over the medium run – are likely to warrant exceptionally low levels for the federal funds rate at least through late 2014.
13 September 2012	[…] the Committee […] currently anticipates that exceptionally low levels for the federal funds rate are likely to be warranted at least through mid-2015.
12 December 2012	[…] the Committee […] currently anticipates that this exceptionally low range for the federal funds rate will be appropriate at least as long as the unemployment rate remains above 6–1/2 per cent, inflation between one and two years ahead is projected to be no more than a half percentage point above the Committee's 2 per cent longer-run goal, and longer-term inflation expectations continue to be well anchored.[…]

Note: [a]Based on FOMC press releases.

rate guidance was introduced, for example that the FOMC 'anticipates that economic conditions are likely to warrant exceptionally low levels of the federal funds rate for an extended period', this or a similar wording was repeated in subsequent FOMC statements, until it was changed for a new wording. To capture the surprise component of the statements, we only consider those dates, given in Table 1, when a new wording was introduced, not those when a previous wording was repeated, in our main specification. We consider new explicit policy rate guidance from the time after the zero lower bound on policy rates had been reached on 16 December 2008, that is when the policy rate remained unchanged, in order to avoid confusion with the effect from an actual change in the fed funds target rate.

III. Method

To determine the reactions of US Treasury real bond yields or breakeven inflation rates to explicit policy rate guidance by the FOMC, we use the approach applied by Moessner (2013a) to study the reactions of nominal interest rates implied by Eurodollar futures rates, and by Moessner (2014) to study the reactions of US equity prices and risk measures. Daily changes in m-year-ahead US Treasury instantaneous real forward rates or breakeven inflation rates (in percentage points), $\Delta y^m(t) = y^m(t) - y^m(t-1)$, for horizons $m = 2$–10 years ahead, are regressed on a dummy variable for the announcements of explicit FOMC policy rate guidance, $d_{PRG}(t)$, and on the surprise components of 11 US macroeconomic data releases, $surprise_j(t), j = 1, \ldots, 11$, to control for the effect of economic news,

$$\Delta y^m(t) = c + a * d_{PRG}(t) + \sum_{j=1}^{11} \left(b_j * surprise_j(t)\right) + \varepsilon_t \qquad (1)$$

where $d_{PRG}(t)$ takes the value of 1 on days when the FOMC provided new explicit policy rate guidance after the zero lower bound had been reached, as listed in Table 1, and zero otherwise. We use Newey–West-adjusted SEs.

Our approach in Equation 1 to capture the surprise component of the policy rate guidance announcements is to only consider those announcements where a new wording was introduced, and not those where a previous wording was repeated. We perform a robustness test by also considering those policy rate guidance announcements where a previous wording was repeated. The dummy variable $d^{rp}_{PRG}(t)$ takes the

value of 1 on days when the FOMC provided explicit policy rate guidance after the zero lower bound on the policy rate had been reached when there was a repetition of a previous wording,[1] and we add $d^{rp}_{PRG}(t)$ as an additional dummy variable in Equation 1 to give

$$\Delta y^m(t) = c + a_1 * d_{PRG}(t) + a_2 * d^{rp}_{PRG}(t) + \sum_{j=1}^{11}\left(b_j * surprise_j(t)\right) + \varepsilon_t \quad (2)$$

On some dates the FOMC's explicit policy rate guidance coincided with the FOMC's announcements regarding asset purchases as part of the first LSAP Programme (LSAP1), LSAP2, the maturity extension program (MEP) and LSAP3 (Bernanke, 2012; Hofmann and Zhu, 2013). We therefore also estimate the effect of explicit policy rate guidance separately for those announcements where it was not associated with asset purchase announcements, $d^{nap}_{PRG}(t)$, and those where it was associated with asset purchase announcements, $d^{wap}_{PRG}(t)$,

$$\Delta y^m(t) = c + a_1 * d^{nap}_{PRG}(t) + a_2 * d^{wap}_{PRG}(t) + \sum_{j=1}^{11}\left(b_j * surprise_j(t)\right) + \varepsilon_t \quad (3)$$

The dummy variable $d^{nap}_{PRG}(t)$ equals 1 on dates when the FOMC provided new explicit policy rate guidance but did not make announcements on asset purchases (9 August 2011 and 25 January 2012), and zero, otherwise. The dummy variable $d^{wap}_{PRG}(t)$ takes the value of 1 on dates when the FOMC provided new explicit policy rate guidance and also made announcements on asset purchases (18 March 2009, 13 September 2012 and 12 December 2012), and zero otherwise, with $d_{PRG}(t) = d^{nap}_{PRG}(t) + d^{wap}_{PRG}(t)$. The dates of asset purchase announcements are taken from Hofmann and Zhu (2013).

Using daily changes, i.e. a shorter 1-day window, for the event study regressions, has the advantage that the window is so narrow that less other news that could affect market prices is contained within it. On the other hand, a shorter window has the disadvantage that it may capture reactions that may be reversed later, or that it does not capture the full reaction. For robustness, we therefore also present results for a longer 5-day window in the event study regressions, replacing $\Delta y^m(t)$ with $\Delta^l y^m(t) = y^m(t+4) - y^m(t-1)$ in Equations 1–3. Using such a longer window can show if the reactions are more persistent, and therefore more economically meaningful, rather than being immediately reversed, and may capture a fuller reaction to the news.

It is standard in the event study regressions literature to estimate the effect of news with a single regression for each yield and maturity, see, e.g., Cook and Hahn (1989), Fleming and Remolona (1997), Haldane and Read (2000) and Kuttner (2001). Advantages of this approach are its simplicity and parsimonious specification. Disadvantages of this approach are that it does not allow for dynamic interactions between the different maturities, or for correlated error terms. Other papers estimate the effects on yields of different maturities with seemingly unrelated regressions (SURs) (e.g. Andersson *et al.*, 2006), whose advantage is that it allows for correlated error terms. Another option is to use a vector auto regression (VAR) or a vector error correction model (VECM) to study the effect of news, whose advantage is that it allows to model the dynamic interaction between yields at different maturities and between different kinds of yields, for example, of risk-free and risky securities (e.g. Ramchander *et al.*, 2005; Simpson *et al.*, 2005). In this article, we adopt the standard approach, considering only risk-free securities.

IV. Results

Effects on real yields

Table 2 shows the results of Equation 1 estimated for instantaneous forward real US Treasury yields. We can see that explicit FOMC policy rate guidance announcements significantly reduced real forward

[1] The dummy variable $d^{rp}_{PRG}(t)$ takes the value of 1 on the following dates when a previously introduced wording was repeated: 28 January 2009, 29 April 2009, 24 June 2009, 23 September 2009, 4 November 2009, 16 December 2009, 27 January 2010, 16 March 2010, 28 April 2010, 23 June 2010, 10 August 2010, 21 September 2010, 3 November 2010, 14 December 2010, 26 January 2011, 15 March 2011, 27 April 2011, 22 June 2011, 21 September 2011, 2 November 2011, 13 December 2011, 13 March 2012, 25 April 2012, 20 June 2012, 1 August 2012, 24 October 2012 and 30 January 2013.

Table 2. Reactions of US Treasury real forward rates to explicit FOMC policy rate guidance

	1-day window				5-day window			
Horizon in years	c	d_{PRG}	R^2	No. of obs.	c	d_{PRG}	R^2	No. of obs.
2	−0.0011	−0.1826***	0.0303	2121	−0.0025	−0.2183*	0.0066	2127
3	−0.0010	−0.2310**	0.0512	2121	−0.0037	−0.2941*	0.0115	2127
4	−0.0010	−0.2257**	0.0492	2121	−0.0046	−0.2965*	0.0144	2127
5	−0.0010	−0.1942*	0.0403	2121	−0.0053	−0.2582*	0.0122	2127
6	−0.0010	−0.1551	0.0310	2121	−0.0058	−0.2051	0.0092	2127
7	−0.0009	−0.1178	0.0235	2121	−0.0062	−0.1522	0.0076	2127
8	−0.0008	−0.0864	0.0189	2121	−0.0065	−0.1075	0.0072	2127
9	−0.0006	−0.0627	0.0169	2121	−0.0066	−0.0744	0.0074	2127
10	−0.0005	−0.0468	0.0166	2121	−0.0067	−0.0538	0.0078	2127

Notes: ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Newey-West-adjusted SEs are used. Coefficients on surprises in 11 US macroeconomic variables are not shown. Sample period: 2 June 2004–15 February 2013.

rates at horizons of 2–5 years ahead, with the largest reduction for the 1-day window of 23 basis points on average per announcement at the 3-year ahead horizon. We can also see from Table 2 that the reductions are somewhat larger in magnitude and remain significant for the 5-day window at the horizons of 2–5 years ahead, albeit only at the 10% significance level, with the largest reduction in real yields of 30 basis points at the 4-year ahead horizon. This shows that the effects of the forward guidance announcements are not just transitory, but persist for a longer period of a week.

Table 3 shows the results of Equation 2. We can see that the dummy variable for forward guidance announcements where a new wording was introduced, $d_{PRG}(t)$, remains significant at all the horizons of 2–5 years ahead when the dummy variable for forward guidance announcements where a new wording was repeated, $d^{rp}_{PRG}(t)$, is added to the regression, for both the 1-day and 5-day windows. Moreover, the dummy variable for forward guidance announcements where a new wording was repeated, $d^{rp}_{PRG}(t)$, is insignificant at all horizons, for both the 1-day and 5-day windows. This suggests that forward guidance announcements with repeated wordings were not perceived as containing news by market participants, and provides support for only including $d_{PRG}(t)$ in our main specification.

Table 4 shows the results of Equation 3. We can see for the 1-day window that while explicit FOMC policy

Table 3. Reactions of US Treasury real forward rates to explicit FOMC policy rate guidance, adding repeated guidance announcements

	1-day window					5-day window				
Horizon in years	c	d_{PRG}	d^{rp}_{PRG}	R^2	No. of obs.	c	d_{PRG}	d^{rp}_{PRG}	R^2	No. of obs.
2	−0.0011	−0.1826***	0.0011	0.0303	2121	−0.0023	−0.2185*	−0.0178	0.0067	2127
3	−0.0010	−0.2310**	0.0057	0.0512	2121	−0.0036	−0.2943*	−0.0106	0.0115	2127
4	−0.0012	−0.2256**	0.0108	0.0495	2121	−0.0045	−0.2966*	−0.0052	0.0144	2127
5	−0.0012	−0.1940*	0.0150	0.0410	2121	−0.0052	−0.2583*	−0.0034	0.0122	2127
6	−0.0012	−0.1549	0.0180	0.0321	2121	−0.0058	−0.2051	−0.0019	0.0092	2127
7	−0.0012	−0.1175	0.0200	0.0248	2121	−0.0062	−0.1522	0.0008	0.0076	2127
8	−0.0010	−0.0861	0.0210	0.0203	2121	−0.0065	−0.1074	0.0046	0.0072	2127
9	−0.0009	−0.0624	0.0213*	0.0184	2121	−0.0068	−0.0743	0.0091	0.0074	2127
10	−0.0008	−0.0466	0.0210*	0.0180	2121	−0.0069	−0.0536	0.0136	0.0079	2127

Notes: ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Newey–West-adjusted SEs are used. Coefficients on surprises in 11 US macroeconomic variables are not shown. Sample period: 2 June 2004–15 February 2013.

Table 4. Reactions of US Treasury real forward rates to explicit FOMC policy rate guidance, distinguishing whether or not associated with asset purchase announcements

Horizon in years	1-day window					5-day window				
	c	d^{nap}_{PRG}	d^{wap}_{PRG}	R^2	No. of obs.	c	d^{nap}_{PRG}	d^{wap}_{PRG}	R^2	No. of obs.
2	−0.0011	−0.1415***	−0.2101**	0.0307	2121	−0.0025	−0.1671**	−0.2526	0.0067	2127
3	−0.0010	−0.1717***	−0.2708*	0.0522	2121	−0.0037	−0.2376***	−0.3320	0.0116	2127
4	−0.0010	−0.1665***	−0.2654	0.0504	2121	−0.0046	−0.2675***	−0.3159	0.0144	2127
5	−0.0011	−0.1429***	−0.2286	0.0413	2121	−0.0053	−0.2621***	−0.2556	0.0122	2127
6	−0.0010	−0.1140***	−0.1827	0.0317	2121	−0.0058	−0.2363***	−0.1842	0.0093	2127
7	−0.0009	−0.0874***	−0.1382	0.0239	2121	−0.0062	−0.2029***	−0.1183	0.0078	2127
8	−0.0008	−0.0666***	−0.0997	0.0191	2121	−0.0065	−0.1702***	−0.0654	0.0076	2127
9	−0.0006	−0.0526***	−0.0695	0.0169	2121	−0.0066	−0.1425**	−0.0288	0.0078	2127
10	−0.0005	−0.0447***	−0.0483	0.0166	2121	−0.0067	−0.1212	−0.0087	0.0081	2127

Notes: ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Newey–West-adjusted SEs are used. Coefficients on surprises in 11 US macroeconomic variables are not shown. Sample period: 2 June 2004–15 February 2013.

rate guidance announcements not associated with asset purchase announcements had a significant effect on real forward rates at horizons of 2–10 years ahead, with the largest reduction of 17 basis points on average per announcement at the 3-year ahead horizon, those associated with asset purchase announcements had a significant effect on real forward rates only at horizons of 2 and 3 years ahead, again with the largest reduction at the 3-year ahead horizon, at 27 basis points on average per announcement. These results suggest that the effect of the FOMC's explicit policy rate guidance on real yields was not just due to associated asset purchase announcements. This conclusion carries over to the 5-day window, with the dummy variable for forward guidance not associated with asset purchase announcements being more significant than the dummy variable for forward guidance associated with asset purchase announcements.

Considering all forward guidance announcements combined in Equation 1, the article finds that explicit FOMC forward guidance announcements led to a reduction of around 23 basis points on average per announcement for the 1-day window, and of around 30 basis points on average per announcement for the 5-day window, for 3-year ahead real forward rates where the effect was largest. The result for the 1-day window suggests that in the absence of FOMC forward guidance, real US Treasury yields at the 3-year ahead horizon would have been higher by around 46 basis points if we count only the two forward guidance announcements not associated with asset purchases, and by around 115 basis points if we consider all forward guidance announcements, including those associated with asset purchase announcements. But in the latter case, some of the effects are likely due to the associated asset purchase announcements. Based on Equation 3, the article finds that explicit FOMC forward guidance not associated with asset purchase announcements led to a reduction of around 17 basis points on average per announcement for the 1-day window, and of around 24 basis points on average per announcement for the 5-day window, for 3-year ahead real forward rates where the effect was largest for the 1-day window. The result for the 1-day window suggests that in the absence of FOMC forward guidance, real US Treasury yields would have been higher by around 34 basis points at the 3-year ahead horizon if we consider only the two forward guidance announcements not associated with asset purchase announcements.

Effects on breakeven inflation rates

To determine the reactions of breakeven inflation rates to explicit policy rate guidance by the FOMC, we perform the regressions of Equations 1–3 using changes in forward breakeven inflation rates as left-hand side variables. Results of Equation 1 for forward breakeven inflation rates are shown in Table 5.

We can see that forward breakeven inflation rates were little affected for the 1-day window by the explicit policy rate guidance, with a significant reduction of only 6–7 basis points at horizons of 6–8 years ahead, and no significant effect at the remaining horizons. For the 5-day window, there is a significant increase at the 2–4-year ahead horizons. But since this effect is

Table 5. Reactions of US Treasury forward breakeven inflation rates to explicit FOMC policy rate guidance

	1-day window				5-day window			
Horizon in years	c	d_{PRG}	R^2	No. of obs.	c	d_{PRG}	R^2	No. of obs.
2	0.0003	0.0294	0.0176	2089	−0.0050	0.1324*	0.0058	2096
3	0.0001	0.0289	0.0203	2089	−0.0060	0.1614**	0.0069	2096
4	0.0001	−0.0017	0.0210	2089	−0.0066	0.1295**	0.0089	2096
5	0.0000	−0.0363	0.0205	2089	−0.0069	0.0735	0.0064	2096
6	−0.0001	−0.0608**	0.0228	2089	−0.0071	0.0191	0.0047	2096
7	−0.0003	−0.0707**	0.0237	2089	−0.0072	−0.0208	0.0051	2096
8	−0.0004	−0.0667**	0.0227	2089	−0.0073	−0.0418	0.0063	2096
9	−0.0006	−0.0512	0.0208	2089	−0.0075	−0.0439	0.0076	2096
10	−0.0007	−0.0274	0.0188	2089	−0.0076	−0.0296	0.0085	2096

Notes: ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Newey–West-adjusted SEs are used. Coefficients on surprises in 11 US macroeconomic variables are not shown. Sample period: 2 June 2004–15 February 2013.

only significant at the 5-day horizon, but not at the 1-day horizon, it could be due to other news, rather than the forward guidance announcements. Moreover, we can see from Table 7 that significant increases at shorter maturities for the 5-day window are largely due to forward guidance announcements coinciding with asset purchase announcements, rather than to forward guidance announcements not associated with asset purchase announcements. This suggests that the effect is likely to be due to the associated asset purchase announcements.

We can also see that for the 1-day window forward guidance not associated with asset purchase announcements led to a significant reduction in forward breakeven inflation rates of around 5–10 basis points on average per announcement at horizons of 4–7 years ahead. Such guidance associated with asset purchase announcements led to a small increase in forward breakeven inflation rates at horizons of 3 and 4 years ahead.

We also find for breakeven inflation rates that the dummy variable for forward guidance announcements where a new wording was introduced, $d_{PRG}(t)$, remains significant when the dummy variable for forward guidance announcements where a new wording was repeated, $d^{rp}_{PRG}(t)$, is added to the regression, for both the 1-day and 5-day windows. Moreover, the dummy variable for forward guidance announcements where a new wording was repeated, $d^{rp}_{PRG}(t)$, is insignificant at most of the horizons, for both the 1-day and 5-day windows (Table 6).

Table 6. Reactions of US Treasury forward breakeven inflation rates to explicit FOMC policy rate guidance, adding repeated guidance announcements

	1-day window					5-day window				
Horizon in years	c	d_{PRG}	d^{rp}_{PRG}	R^2	No. of obs.	c	d_{PRG}	d^{rp}_{PRG}	R^2	No. of obs.
2	0.0001	0.0296	0.0147	0.0182	2089	−0.0056	0.1330*	0.0497*	0.0067	2096
3	−0.0001	0.0291	0.0142*	0.0211	2089	−0.0064	0.1618**	0.0314	0.0073	2096
4	−0.0001	−0.0015	0.0110	0.0216	2089	−0.0068	0.1297**	0.0154	0.0090	2096
5	−0.0001	−0.0362	0.0084	0.0209	2089	−0.0070	0.0736	0.0079	0.0064	2096
6	−0.0002	−0.0607**	0.0072	0.0231	2089	−0.0072	0.0192	0.0059	0.0047	2096
7	−0.0003	−0.0706**	0.0074	0.0240	2089	−0.0073	−0.0207	0.0067	0.0051	2096
8	−0.0005	−0.0666**	0.0088	0.0231	2089	−0.0075	−0.0417	0.0087	0.0064	2096
9	−0.0007	−0.0510	0.0110	0.0214	2089	−0.0076	−0.0437	0.0111	0.0076	2096
10	−0.0009	−0.0273	0.0135	0.0196	2089	−0.0077	−0.0294	0.0132	0.0085	2096

Notes: ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Newey–West-adjusted SEs are used. Coefficients on surprises in 11 US macroeconomic variables are not shown. Sample period: 2 June 2004–15 February 2013.

Table 7. Reactions of US Treasury forward breakeven inflation rates to explicit FOMC policy rate guidance, distinguishing whether or not associated with asset purchase announcements

Horizon in years	1-day window					5-day window				
	c	d_{PRG}^{nap}	d_{PRG}^{wap}	R^2	No. of obs.	c	d_{PRG}^{nap}	d_{PRG}^{wap}	R^2	No. of obs.
2	0.0003	−0.0080	0.0545	0.0181	2089	−0.0050	0.0244	0.2047**	0.0063	2096
3	0.0001	−0.0260	0.0658***	0.0218	2089	−0.0060	0.0290*	0.2502**	0.0078	2096
4	0.0001	−0.0524***	0.0324**	0.0226	2089	−0.0066	0.0162	0.2055***	0.0096	2096
5	0.0000	−0.0755***	−0.0101	0.0216	2089	−0.0069	−0.0099	0.1294***	0.0068	2096
6	−0.0001	−0.0885***	−0.0423	0.0233	2089	−0.0071	−0.0371	0.0568	0.0049	2096
7	−0.0003	−0.0893**	−0.0583	0.0239	2089	−0.0072	−0.0564	0.0030	0.0051	2096
8	−0.0004	−0.0793	−0.0582	0.0228	2089	−0.0073	−0.0636**	−0.0273	0.0064	2096
9	−0.0006	−0.0614	−0.0443	0.0209	2089	−0.0075	−0.0579***	−0.0345	0.0076	2096
10	−0.0007	−0.0390	−0.0197	0.0189	2089	−0.0076	−0.0416***	−0.0215	0.0085	2096

Notes: ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Newey–West-adjusted SEs are used. Coefficients on surprises in 11 US macroeconomic variables are not shown. Sample period: 2 June 2004–15 February 2013.

Long-term breakeven inflation rates (at the 10-year ahead horizon), which are commonly used as measures of monetary policy credibility, were not significantly affected for the 1-day window by forward guidance announcements, so that they would have been similar in the absence of forward guidance.

V. Conclusions

We studied the impact of explicit policy rate guidance by the FOMC used as an unconventional monetary policy tool at the zero lower bound of the policy rate on real and breakeven US Treasury yield curves. We found that explicit FOMC policy rate guidance announcements led to a significant reduction in real yields at horizons of 2–5 years ahead. By contrast, long-term breakeven inflation rates were little affected, suggesting that inflation expectations have remained well-anchored, and that explicit FOMC policy rate guidance has not adversely affected central bank credibility.

The results of this article suggest that the reduction in medium-term nominal bond yields and nominal money market interest rate futures due to FOMC forward guidance announcements found in Moessner (2013a, 2013b) for a 1-day window is mainly accounted for by a fall in real yields, with changes in inflation expectations only playing a small role. The result for the reduction in real yields is consistent with the result of Moessner (2014) that FOMC forward guidance led to an increase in US equity prices, since lower real yields would be expected to lead to higher equity prices. The result that long-term inflation expectations were little affected by the explicit FOMC forward guidance at the zero lower bound suggests that FOMC forward guidance was not perceived as a time-inconsistent commitment by the central bank to being irresponsible. This result is consistent with the findings of Moessner and Nelson (2008) that the conditionality of the pre-crisis forward guidance provided by the FOMC was understood by market participants, and was not interpreted as an unconditional commitment.

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